SCIENCE

Class 10

BOARD OF SECONDARY EDUCATION, RAJASTHAN, AJMER

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Book - Science

Class - 10

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Book - Science

Class - 10

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Foreword

For students, textbook is the basis of sequential studies, confirmation, review and future studies. The level of school text book becomes very important from the content and teaching - method's perspective. Text-books should not be made insentient or to glorify things. Even today text-books are an important instrument of teaching-learning process, which cannot be ignored.

For the last few years the syllabus of Board of Secondary Education, Rajasthan was felt to be lacking in representation of linguistic and cultural events of Rajasthan. Keeping this in view the state government decided to implement its syllabus through Board of Secondary Education, Rajasthan, for the students of class 9-12. In accordance to this, Board, has got assembled the text-books for classes 9 to 11 from the session 2016-17 based on the set syllabus. Hope these text books will be instrumental in providing the students with originality of thought process, contemplation and expression.

Prof. B.L. Choudhary
Chairman
Board of Secondary Education Rajasthan
Ajmer

Preface

This text-book of science for class X of Board of Secondary Education Rajasthan has been written for the creative learning of the students.

According to the syllabus, twenty chapters have been compiled in this text-book. Recent information has been incorporated at relevant points which will enhance the utility and content of the text book.

In the text-book information regarding food, human health, genetics, blood groups, chemistry in everyday life, atomic theory, light, electric current, natural resources, economic importance of plants and animals, biodiversity and its conservation etc., have been incorporated.

Important points have been outlined at the end of each chapter which will help students while studying. From examination preparation point of view, objective type questions, very short type, short type and essay type questions have been included.

The technical words have been used in the text in accordance with the standard dictionaries. Figures, charts and tables have been used in the text-book, as per the need. The sequentiality of content has been maintained in the text. Efforts have been made to maintain the level according to the students of class X.

Suggestions are invited from intellectuals, authors and teachers. Despite all efforts, some errors may have persisted in the present text. The suggestions of readers are welcomed in this aspect too. Your suggestions will go a long-way in the betterment of the present text.

Convener

Science

Time : 3.15 Hours | Total marks : 80

S.N.	Name of Unit	Serial No. of Chapters	Name of Chapters	Marks Weightage	Total Marks of Unit
1.	Human body and Activities	1	Food and Human Health	4	17
		2	Human System	6	
		3.	Genetics	4	
		4.	Immunity and Blood Groups	3	
2.	Substance and Reactions	5.	Chemistry in Every-day Life	4	16
		6.	Chemical Reaction and Catalyst	3	
		7.	Atomic theory, Periodic Classification and Properties of Elements	5	
3.	Physical Events	8.	Carbon and and its Compounds	4	15
		9.	Light	5	
		10.	Electric Current	5	
		11.	Work, Energy and Power	5	
4.	Natural Resources	12.	Main natural Resources	4	12
		13.	Waste and its Management	3	
		14.	Economic Importance of Plants and Animals	5	
5.	Earth and Space	15.	Structure of Earth	3	12
		16.	Universe and Organic Evolution	3	
		17.	Search of Life Outside Earth	3	
		18.	Indian Scientists : Biography and Achievements	3	
6.	Environment	19.	Biodiversity and Its Conservation	5	5
7.	Road Safety	20.	Road Safety Education	3	3

Details of the Syllabus

Unit-1 Human body and Activities

Chapter-1 Food and Human Health

- Balance and unbalance food, Vitamin malnutrition, protein malnutrition, mineral malnutrition, human health : properties of drinking water and harmful; effects of polluted water obesity, blood pressure; intoxicant- gutkha, tobacco, alcohol, opium, other intoxicant substances, misuses of medicines, adulturation in food products.

Chapter-2 Human System

- Digestive system, respiration and respiratory system, blood and circulatory system, excretory system, reproductive system, nrevous system and endocrinal system.

Chapter-3 Genetics

-Mendelism, discovery of Mendelism, genetics terminology, Mendel's laws of inheritance and importance.

Chapter-4 Immunity and Blood Groups

- Antigen and antibody, blood and blood groups, Rh factor, blood transformation, significance of blood group heredity, importance of organ and body donation.

Unit-2 Substance and Reactions

Chapter-5 Chemistry in Everyday Life

- Acid, base, salt : definitions, general properties, uses pH scale, importance of pH in daily life, some important compounds in everyday life : sodium chloride, bleaching powder, baking soda, washing soda, plaster of paris, soap and detergent.

Chapter-6 Chemical Reaction and Catalyst

- Physical and chemical change, chemical equation, chemical reaction : addition, replacement, dissociation, slow and fast reversible and irreversible reactions, oxidation - reduction, neutralization, types of catalyst and properties.

Chapter-7 Atomic theory, Periodic Classification and Properties of Elements

- Atomic theory of Dalton, atomic model of Thomson, Rutherford's, gold foil experiment, hypothesis of Neil's Bohr, necessity of classification, classification, Mendeleef's periodic table, modern periodic table, periodicity in properties, valency, atomic size, metallic and non-metallic properties.

Chapter-8 Carbon and and its Compounds

-Characteristics of carbon atom, hydrocarbons and classification of hydrocarbons, Allotropes of carbon, Catenation in carbon, nomenclature of simple organic compounds - Alkane, Alkene, Alkyne.

Some important organic compounds useful in daily life.

Unit-3 Physical Events

Chapter-9 Light

- Reflection of light, laws of reflection, spherical mirrors, image formation by spherical mirrors, mirror formula, magnification, refraction, refraction by spherical lens, image formation in lens, power of lens, defect in eyes and their corrections.

Chapter-10 Electric Current

- Electric current, unit of current, potential and potential difference, prevailing symbols of useful equipments in electrical circuits, ohm's law, resistance, dependence of resistance on length and cross-sectional area, resistivity, combination of resistances, thermal effect of current, magnetic effect of current, direction of magnetic field, magnetic field and field lines, electro magnetic induction, electric generator.

Chapter-11 Work, Energy and Power

- Work, unit of work, energy, types of energy, mechanical energy, kinetic energy, potential energy, electrical energy, conservation of energy (C.F.L., L.E.D. etc.) power, unit of power, electric power.

Unit-4 Natural Resources

Chapter-12 Main Natural Resources

- Meaning of natural resources, types of natural resources, management of natural resources, judicious use and conservation, need for conservation, ways of conservation, forest conservation and management, social forestry, conservation of wildlife, water conservation and management, conservation of coal and petroleum, participation of people in conservation of natural resources Chipko movement.

Chapter-13 Waste and its Management

- Definition of waste, types of waste, sources of waste, losses due to waste, waste management.

Chapter-14 Economic Importance of Plants and Animals

- Economic importance of plants - food plants, medicinal plants, plants of constructional importance, fibre yielding plants, timber wood : economic importance of animals, apiculture, sericulture, lac culture, fishery, animal husbandry, wool industry, coral and coral reefs, pearl culture.

Unit-5 Earth and Space

Chapter-15 Structure of Earth

- Origin and evolution of earth, structure of earth, energy system of the earth - internal and external tectonic forces- volcano, earthquake, tsunami, weathering erosion, wind, water, glaciers, oceanic currents.

Chapter-16 Universe and Organic Evolution

- Origin of the universe, indian cosmology, physical and spritual theories for the origin of life, origin and types of fossils, organic evolution, origin of species, phylogeny.

Chapter-17 Search of Life Outside Earth

- Position of the earth in space, possibilities of life in space, main space campaign, India in space, international space station.

Chapter-18 Indian Scientists : Biography and Achievements

- Indian Scientists : Biography and Achievements- Sushruta, Charak, C.V. Raman, Dr. Homi Jahangir Bhabha, Prafulla Chandra Ray, Dr. Panchanan Maheshwari, Dr. Salim Ali (Ornithologist), Dr. A.P.J. Abdul Kalam.

Unit-6 Environment

Chapter-19 Biodiversity and Its Conservation

- Levels of biodiversity, global biodiversity, biodiversity of India, biodiversity hot spots, importance of biodiversity, threats to biodiversity, conservation of biodiversity.

Unit-7 Road Safety

Chapter-20 Road Safety Education

Prescribe Book -

SCIENCE - Board of Secondary Education Rajasthan, Ajmer

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Chapter - 1
Food and Human Health

Nutrition is the basis of life. Organism gets different types of nutrients from its surrounding atmosphere. These products by the process of digestion becomes part of the body and fulfils its different requirements. For maintaining good health, balance diet is required. Balance diet makes the body strong and it helps to increase the immunity power to fight against diseases and it also helps to make the mind sharp and healthy. In the absence of healthy diet, fatigue and different diseases may occur. On the basis of experiences it has been known that for the activities of life carbohydrate, protein, fat, minerals, vitamins and water should be available in sufficient quantity. Balance diet is one that contains all the essential nutrients. Deficiency or unavailability of any of the nutrient makes the diet unbalanced. If one or more nutrients are unavailable for a long period of time, then it is called malnutrition. The effect of malnutrition can be seen on the body in many ways. Different components of nutrition fulfill different requirements of the body. Thus it is clear that if any nutrient is absent in diet then the corresponding work done by that nutrient will not be done.

1.1 Balance and unbalance food

One of the main reasons for malnutrition in our country is that people do not get adequate amount of balanced food. Many examples can be found where in due to bad habits, balance food is not taken up properly and the person shows the symptoms of malnutrition. The effect of malnutrition manifests both in physical and mental weaknesses. Here we will discuss some of the important side effects of malnutrition.

1.1.1 Vitamin malnutrition

Vitamins are a very minute part of the food but they are functionally very important. Clear symptoms are seen if one or more vitamin are absent in the diet. The Table given below shows different diseases and their symptoms due to the deficiency of vitamins.

Table 1.1 Diseases and their symptoms due to the deficiency of vitamins

S. No.	Vitamin	Disease due to deficiency	Symptoms of the disease
1	Vitamin A	Night Blindness	Unable to see at night or in light
2	Thiamine (B 1)	Beri Beri	Low heart beat, weakness in muscles and nerves
3	Riboflavin (B2)	Riboflavinosis	Rupturing around mouth linings and skin of lips and memory loss
4	Niacin (B3)	Pellagra	Appearances of dry scales on tongue and skin.
5	Ascorbic acid (C)	Scurvy	Bleeding from gums, appearance of spots on the skin.
6	Calciferol (D)	Rickets	Bones of leg bends, inward bending of knees

1.1.2 Protein Malnutrition

Due to poverty people are unable to add protein in adequate amount in their food and becomes victims of Malnutrition.

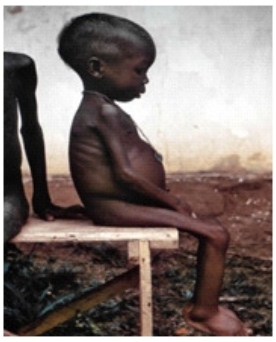


Fig. 1.1 a Kwashiorkor

Fig. 1.1 b Marasmus

Chiefly small children are affected by it. Protein is an important nutrient for pregnant women and adolescents. Deficiency of protein causes kwashiorkor disease. Childs stomach swells, looses apetite, behaviour becomes irritative, skin becomes pale, black, dry, spoty and starts rupturing. In addition to protein if nutrition lack adequate amount of energy then body shrinks and becomes weak, eyes sinks deep and becomes lusterless, this condition is termed as marasmus.

1.1.3 Mineral Malnutrition

Different types of minerals also play an important role in the functioning of the body and their deficiency causes different type of disorders in the body. Element Iron is a part of hemoglobin and its deficiency leads to paleing of face due to anemia, calcium makes bones strong and its deficiency makes bones weak and brittle. Due to the deficiency of Iodine the activity of the thyroid gland slows down and causes goiter.

Table 1.2 Important Minerals, source and function

S. No.	Name of the Element	Main Sources	Important Function
1	Sodium	Common salt, Fish, meat, egg, milk	Contraction of muscles, transmission of neural charges, electrolysis of body, maintaining balance
2	Potassium	All food products	Control of muscles, transmission of neural charges, electrolysis of body, operates different cellular reactions
3	Calcium	Milk, Egg, Green vegetables	Makes bones and teeth strong along with vitamin D
4	Phosphorus	Milk, green vegetable, pearl millet, finger millet, dry fruits, liver and kidney	Makes bones and teeth stronger with calcium
5	Iron	Liver, kidney, Egg, Meat, Blood, Pearl millet, Finger millet, Curd, vegetables, carrot, jaggery	Formation of hemoglobin, oxidation of tissues
6	Iodine	Salt, sea food, green leafy vegetable, sea fish, black berry, rock salt	Formation of thyroxine harmone

1.2 Human health

1.2.1 Properties of drinking water and harmful effects of polluted water

We humans are exploiting the available limited water sources in such a manner that in the near future we will have water crisis. Most of the usable water comes from rivers, lakes and underground sources. While using the water we are also polluting it. In this way we are hurting our life donar with double edged sword. It is useless to discuss about the uses of water, if you say "Water is life" then it would not be an exaggeration. Water is used for drinking, preparing food, bathing, washing utensils and clothes, agriculture and industries. Water is the only product found naturally on earth, which exists in all three states of matter, solid (ice), liquid (water) and gas (vapours). The water which we get contains many types of particles and microorganisms. Some of these are useful while the others are harmful for us.

Potable water should have the following properties-

Water should not have visible particles and vegetation, should not have harmful microbes, pH of water should be balanced, water must have adequate amount of dissolved oxygen. Water helps our body to carry out different responsibilities. All the metabolic activities of the body is carried out by water. Therefore a doctor also suggests us to drink minimum 8 glass of water per day. You must drink more water if you do more physical work. Metabolism of body works in a proper way if adequate amount of water is drunk. Toxic elements comes out of the body by drinking 8-10 glass of water per day, and the body remains diseases free. Adequate amount of water in the body makes the body healthy and energetic, and the body does not feel tired. Water maintains adequate amount of fibres in the body that improves our immunity power and susceptibility to diseases decreases. Unnecessary fat don't get desposited in the body if abundant water is drunk. Sufficient intake of water reduces the chances of any kind of allergy to the body. In addition to that infection to lungs, asthama and intestinal diseases also do not occur. Regularly drinking a lot of water also avoids the danger of calculus. Drinking adequate amount of water protects us from disease like common cold.

Side effects of contaminated water-

Many diseases grips us if the potable water is contaminated. These diseases are caused by the presence of pathogenic microorganism in the water, which enters into the body with water. The main pathogens are viruses, bacteria, protozoa and worms. These pathogens causes cholera, dysentery like diseases and can easily affect anyone. Contaminated water can cause many communicable diseases. It may also cause dangerous diseases like hepatitis, flu, typhoid, jaundice etc. Dracunculiasis was once a serious problem in Rajasthan. A worm ***Dracunculas medinensis*** is the causing agent. The female always lays its eggs inside water out of the hosts (Human) body. This disease spread to other people if the contaminated water is used for drinking. No patient of drancunculiasis has been found after the year 2000, because of the efforts made by Naru abolition program. To stop its re-emergence and to rescue from water borne diseases drinking water should be filtered, boiled and cooled before use. Bathing, washing clothes in rivers, ponds should be prohibited and the water reservoirs should be cleaned frequently because "Healthy tomorrow is where, there is healthy water".

1.2.2 Obesity

Obesity is that condition when excessive body fat gets accumulated in the body to the extent that it starts to have harmful effect on health. This could reduce the potential age. Body Mass Index (BMI) is

the ratio of human weight and height. When the BMI is between 25 to 30 Kg/m^2 it is pre obesity stage and when the BMI is over 30 kg/m^2 than it is obesity.

Fig. 1.2 Obesity

Obesity is associated with many diseases such as, heart disease, diabetes mellitus, sleep apnea, many types of cancer and osteoarthritis.

There are many reasons for obesity **the important ones are-** Obesity and weight gain is due to the imbalance between intake of energy and its use. Eating high fatty food, Junk food, and synthetic food, less exercise, hypothyroidism, sedentary life style, without proper physical work, fat starts to accumulate in the body.

1.2.3 Blood pressure

Pressure exerted on the walls of the blood vessels by blood flowing in it is called Blood pressure. Arteries are those blood vessels which carries blood from the heart to all the tissues and organs in the body. Blood pressure of a person is expressed in systolic/ diastolic like 120/80, Systolic is the above number that shows pressure of arteries when the heart contracts and pumps the blood into arteries. Diastolic is the number below that shows the pressure of arteries when the heart relaxes and its muscles becomes loose.

The systolic blood pressure of a normal person is between 90 to 120 mm mercury level and diastolic blood pressure is between 60-80 mm. The equipment used for measuring blood pressure is called sphygnomanometer. Stephen Hales in 1733 measured the blood pressure of horses for the first time and Coplan had defined blood pressure in 1983.

Fig. 1.3 Sphygnomanometer.

Low Blood Pressure - It is when the blood pressure in your arteries and veins is abnormally low. When the blood pressure is extremely low then the oxygen and the nourishing food don't reach the important organs like heart, brain and kidneys, thus these organs stops working properly and can damage the organs permanently.

High Blood Pressure - It is due to excessive pressure in arteries. It is caused by anxiety, anger, jealousy, confusion, eating more food than needed. Consumption of white sugar, spices, oil, ghee, pickle, sweets, meat, tea, cigarette, alcohol sedentary life and absence of exercise. Timely diagnosis of high blood pressure is important.

Such patients should eat food containing potassium, like fresh fruits, packed food stuff should be avoided, amount of calcium and magnesium in food should be balanced. Eat more food item that contain fibre, saturated fats (Meat and vegetable ghee) should be reduced. In addition exercise regularly, walking for 30 minutes is the best exercise. Yoga, meditation pranayam should be done daily, smoking and drinking alcohol should be avoided.

1.3 Intoxicant and Human Health

Many people start using narcotic substances for illusion of pleasure but slowly they gets addicted to these substances and starts using these intoxicants in

more amount. Every intoxicant has its harmful side effect on the human body and makes the person, a permanent patient. Some of the intoxicants in common use in the society and their harmful side effects are given below.

1.3.1 Gutkha

It is prepared from betelnut pieces, kattha, lime, synthetic scent and thin metal sheets, tobacco is also mixed in some Gutkha. With the expansion of the pouch culture it is available in every village and molder. Ladies and children are also using it openly. Use of Gutkha not only causes economic loss but also harms physically . Muscles of the jaws become hard and the jaws will not open properly, this is due to a disease called sub mucous fibrosis. Synthetic products present in Gutkha contain many carcinogenic substances.

1.3.2 Tobacco

Tobacco is obtained from the leaves of the plant ***Nicotina tabaccum***, which belongs to the family solanaceae. Leaves contain 1-8% of alkaloid named nicotine. Tobacco is used in many ways. Majority of people chew it with paan, (Betel leaf), Gutkha or lime, some inhale its powder or use it like paste to rub on teeth and gums. Tobacco is used in bidi, cigarette, cigar, chilam, hukkas or in other ways**.**

Following are the losses of tobacco use-

- Chances of mouth, tongue, throat cancer increases by the regular use of tobacco.
- Nicotine present in tobacco thickens the walls of arteries, due to which the blood pressure and heartbeat increases.
- The rate of embryo development slows down if tobacco is used by pregnant women during pregnancy period.
- Carbon mono oxide present in the cigarette's smoke damages red blood cells and affects the oxygen transporting capability of the blood.

The side effects of cigarette, bidi etc are seen not only on the user but are also seen in people sitting besides the user because the nicotine containing smoke in the air reaches their lungs too. That is why legally, smoking is prohibited in public places. According to the information received approximately 60 lakh people dies untimely every year because of tobacco use, out of these 50 lakh dies due to using it directly (Actively) and 10 lakh dies due to indirect use (Passively).

13.3.3 Alcohol

Alcohol is manufactured in many ways, but the main component in all is ethyl alcohol (C_2H_5OH). Its percentage is different in different types of alcohol. The trend of consuming alcohol is increasing day by day and its side effects are emerging. Following are the harmful side effects of using alcohol.

After drinking alcohol it reaches liver through blood. Liver converts excess alcohol into acetaldehyde, which is poisonous.

Control and coordination of the body is affected by the consumption of alcohol, which reduces work efficiency, probability of accident also increases.

Consumption of alcohol reduces memory power, affect the nervous system.

Alcohol causes fatty liver disease, which has an effect on the synthesis of protein and carbohydrates.

Due to its use the economic condition of a person falls and it also hurts the persons social status.

1.3.4 Opium (*Papaver somniferum*)

Opium is the dried latex obtained from the opium's capsule. The latex contains about 30 types of alkaloids, among them morphine, codine, nicotine, somniferine and papaverine are main. Morphine and codine are used to make painkiller medicines that's why it is cultivated. Many people use opium and its toxic product heroine to get the feeling of peace and

happiness. Offering opium is a common custom in the rural areas on occasion of mourning or happiness.

Fig. 1.4 Opium capsule

Many mothers in rural areas gives opium to their small children for sleeping. Whatever the reason may be, use of opium makes a person addicted. Initially less quantity is taken but gradually the person is forced to increase its quantity. Many people are addicted to drinking boiled opium dried capsule (fruit). A person continues to remain sick because of his decreased immunity power, ultimately the person dies untimely. Doctors and NGO's can help to overcome this habit.

1.3.5 Other Intoxicant substances

Cocaine, cannabis, charas, hemp, hasis, LSD (lysergic acid diethyl amide) etc are also intoxicants in trend. Young people start to use these for many reasons or get caught in this. Distance from family, increased criminal tendency, physical and mental weakness are the harmful side effects of using these products.

1.3.6 Misuses of Medicines

According to a survey on the demand of intoxicants in south Asia it was found that 42 percent use alcohol, 20 percent use opium, 30 percent use heroine, 6 percent use cannabis, and 18 percent people use other intoxic substances. According to a report people are also using doctors prescribed medicines like morphine, pethedine, buprenofrin, propoxifin, nitragipam diagipam as intoxicants. Use of smack has also increased. In Punjab, Rajasthan, Uttar Pradesh and Gujarat the traditional consumption of opium is still continuing where as in North East part of India heroine injection is taken. Small children use nontraditional substances like, acetone, petrol, solvent, oil as intoxicant. Children growing up on streets easily get addicted to intoxicants and alcohol. They inhale shoe pasting gum, correction fluid, spray paint, nail polish, rubber cement, dried erasers, markers and gasoline. Trying to be unaware of the truth of the life and their hunger, these intoxicated children buys scary dreams, swelling in lungs, kidney failure, mental illness and the physical and mental problems which are never cured.

1.4 Adulteration in food products

Today it is a common belief among public that all the things available in the market are adulterated. Anxiety of the public is natural. Havoc of adulteration is more on the items of our daily use. Adulterated food items are in abundance in our country. Adulterated Ghee, milk, oil, tea, spices are openly sold in the market. If someone gets ill after eating these products then the condition is even worse, because the life saving drugs are also fake. According to an estimate around 30-40 percent products are adulterated. Looking at the adulterated food products we can see that how easily the people who manufacture these products are duping us. First of all let us take the debated case of the cold drinks. In our country even the government does not have any information about the standardization of the quantity of elements used in making cold drinks. Infact the chemicals like lindane, melethian and chlorpyriphom mixed in cold drinks are considered responsible for cancer, nervous, reproductive diseases and damages the immune system.

During the manufacturing of the cold drinks phosphoric acid is mixed in it, which directly affects the teeth, it has the capacity to even dissolve the iron. The chemical ethylene glycol mixed in it does not allow

the water to freeze even at zero degree, commonly it is called as "Sweet poison". Boric, erithorbic and benzoic acid collectively increases the acidity of cold drinks, which causes burn in stomach, indigestion sensation in brain, irritability and acidity. It also hinders the development of bones. 0.4 pps lead is mixed in cold drink which is hazardous for brain, liver and muscles. Caffeine mixed in it causes Insomnia and headache.

Now a day milk too has also become a sample of adulteration inspite of being healthy. It has more ill effect than benefits. People are drinking urea, detergent, soda, poster colour, refined oil in the name of milk. Tests conducted by the health dept. of U.P. has brought out an alarming statistics that 25% of the people of the state are drinking useless adulterated and harmful milk. The condition of edible oil and ghee in the market is also very bad, Seeds of argimone, cheap palm oil are mixed in mustard oil.

It is common practice to mix vegetable ghee in native ghee, brick powder in chilli powder, artificial green colour on fennel, lead chromate and yellow soil in turmeric, sulphur in chilli and coriander, papaya seeds are mixed in black pepper. Chemical injection for bringing bright color in fruits and vegetables, lead and copper solution is sprayed for fresh appearance, and silver nitrate is sprayed on cauliflower for whitish color. Khansari dal is mixed in gram and tur dal, corn flour in gram flour, pulses and rice are artificially polished. Such colors are used in sweets which can lead to cancer and can bring deformities. Fake mava is coming into market. Adulteration in medicines have crossed all the limits. This can be judged from the fact that Mashelkar committee on the issue of counterfiet drugs and drug exchange has recommended death penalty to the people involved in this type of work.

Now the question arises what are the legal provisions available to over come this leprosy of adulteration? The truth is that the root cause of the problem is that, there is absence of necessary standards in the country. With reference to safe food the main law in India is prevention of food adulteration act of 1954. The rule 65 of this law regulates the adulteration of insecticides and adulteration in food products, but this rule is failing to convict the guilty people, because of that people again do the same business after their release. Regardless of how tough the law can be made, deliberately or accidentally weakening the investigation work, the use of money, muscle and political influences and the slow paced judicial process does not change, nothing is going to happen. If the government is really determined to stop adulteration, then there is no two opinion that it cannot be stopped. The requirement is just a solid policy and the proper implementation of it.

Important Points

1. Nutrition is the basis of life, balanced diet is required for the smooth operation of the body. Deficiency of protein, carbohydrate, vitamins, mineral in diet causes diseases.
2. Water is life, water is necessary for many activities in our daily life. Contaminated water can spread many diseases in humans.
3. Junk food and artificially synthesized food stuffs are attractive and tasty but these can cause disorders like obesity, blood pressure and diabetes.
4. Intoxicants like gutkha, tobacco, opium, alcohol, cannabis etc. are used by many people. These have negative effect on the body. Incurable diseases like cancer and many other disease are caused by some of these intoxicants.
5. Most of the products sold in market are adulterated, even than we are continually using them, because of that many harmful side effects are caused on our body.

Practice questions

Objective type questions

1. Causal agent of dracunculiasis disease is -
   (a) Bacteria (b) Worm
   (c) Virus (d) Protozoa
2. How much is the normal blood pressure of healthy body -
   (a) 120/80 (b) 100/60
   (c) 140/80 (d) None of the above
3. Tobacco belongs to which family -
   (a) Malvaceae (b) Liliaceae
   (c) Solanaceae (d) Fabaceae
4. Main ingredient of alcohol is -
   (a) $C_2 H_5 OH$ (b) $CH_3 OH$
   (c) $CH_3 COOH$ (d) $C_6 H_{12} O_6$
5. Which disease is caused by the deficiency of iodine -
   (a) Night blindness (b) Rickets
   (c) Sterility (d) Goiter

Very short type questions

6. Write the scientific name of opium plant.
7. What is the reason for fatty liver disease?
8. Which is the harmful ingredient found in tobacco?
9. Write the name of the blood pressure measuring instrument.
10. Write the name of the causing agent of dracunculiasis.

Short type questions

11. What do you mean by balanced diet and malnutrition?
12. What are the harmful effects of protein deficiency on human body?
13. What should be the qualities of drinking water?
14. Write down the harmful effects of contaminated water.
15. Which alkaloids are present in opium's milk?
16. Write the harmful effects of tobacco.
17. Write down the symptoms and reasons of submucous fibrosis.

Essay type questions

18. What is kwashiorkor disease? Write the symptoms and prevention measures.
19. How can you prevent the practice of opium in society?
20. Write the name of diseases and symptoms caused by vitamin deficiency.
21. Describe the harmful effects of cold drinks on our body.
22. Write an article on adulteration in food products.
23. Explain the losses due to minerals malnutrition.

Answer key

1. (b) 2. (a) 3. (c) 4. (a) 5. (d)

Chapter -2
Human System

The human body is a wonderful and complex structure of nature that operates by the interaction of its different structural units. The organization of the body begins with atoms, molecules and compounds and together with cells, tissues, organs and complex body systems forms the human body. The human body works with mutual coordination of its constituents. Cell is the basic structural and functional unit of the body. Different cells work for different body functions. Group of cells performing similar functions constitutes a tissue such as muscles, bones etc. Two or more type of tissues interacts with each other to discharge a function. Such group of tissues forms an organ (like stomach, liver, etc.). Various organ of the body interact with each other to perform a specific function and form a body system/organization. For example- digestive system, respiratory system etc. Various body systems work jointly in close coordination and form a human body. In this lesson, you will be given detailed information about various systems working in the human body.

2.1 Digestive System

Human beings receive the energy and raw organic substances necessary for their body from the food. The food is made from various components such as proteins, carbohydrates, fats, vitamins, minerals and salts etc. Most of these components present in the food are in complex form. For absorption in the body the complex food items are simplified.To accomplish this process, right from the intake of food to defecation, a system comprising of various organs and glands function in close coordination. This system is called as the **Digestive System**. In the process of digestion, with the help of various chemical processes and enzymes, the complex nutrients and larger food molecules are converted into simple, small and soluble substances. The various organs and glands involved in digestive system are as follows (Figure. 2.1).

(A) Organs

(1) Mouth
(2) Pharynx
(3) Esophagus
(4) Stomach
(5) Small Intestine
(6) Large Intestine
(7) Rectum

(B) Glands

(1) Salivary gland
(2) Liver
(3) Pancreas

All these organs together makes up **Alimentary canal** that starts from the mouth and goes down to the anus. It is about 8-10 meters long. It is also called as **Digestive Canal**.

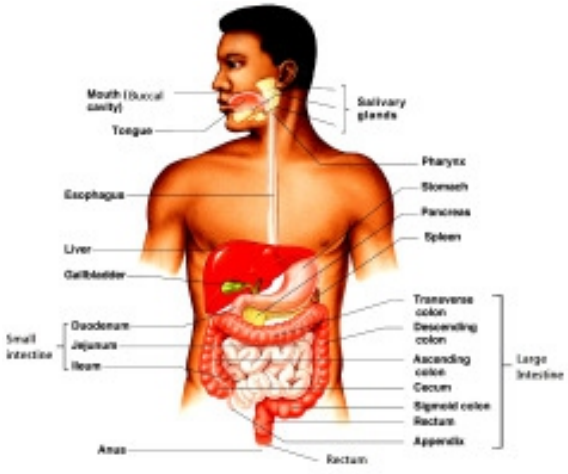


Figure 2.1 Human Digestive System

Alimentary canal performs three major functions-

(A) Digestion of food after its simplification.

(B) Absorption of the digested food.

(C) Movement of food from mouth to anus.

The digestive juices secreted by various glands present in the digestion canal or present elsewhere are responsible for the digestion of the food. These digestive juices simplify the complex food by various chemical processes and convert it to a form that could be taken up by the body. Many nutrients are found in the digested food juice such as proteins, carbohydrate, fats, minerals, salts, vitamins, water etc. These nutrients are absorbed with the help of specialized cells that are found in various parts of the alimentary canal. The mouth fed food in its long journey moves through the contraction and expansion of various muscles present in the alimentary canal.The sphincter muscles controls the movement of food, digested food juice and the food remnants at different levels.

2.1.1 Organs used in Digestive System

As is known to you that various organs staring from mouth to anus works for the digestive system (Figure 2.1). Now we will have a detailed discussion about these organs.

2.1.1.1 Mouth

The front portion of the alimentary canal starts from the mouth and opens in the **Buccal cavity**. It is a bowl shaped organ. The upper portion of mouth has a hard and lower portion has a soft Palate. A muscular tongue that can rotate all around is present within the Buccal cavity. The tongue is attached to the basal posterior part of the buccal cavity through **Frenulum lingual** and it goes up to the middle part of the buccal cavity.

The mouth is surrounded by two muscular lips, which helps to open and close the mouth and capture the food.

Both the Jaws which are found in upper and lower portion of the mouth have a set of 16 teeth (16-16 teeth). All teeth are located in a coop found in the jaw.Such a mold is called **Gum**. This position of jaw and teeth is called as Thecodont. Humans have **Diphyodont** type of teeth arrangement in which two different types of teeth *viz* temporary teeth (milk teeth) and permanent teeth are found in their life span.

There are four types of teeth -

(A) Incisors - These are the front teeth that carry out nibbling and cutting of food. They come out at six months of age.

(B) Canines- These teeth work to tear and chop the food. They oust at the age of 16-20 months. Both the jaws have 2-2 canines each. They are more developed in carnivorous animals.

(C) Premolars - They are helpful in chewing the food. Both the jaws have 4-4 premolars. They become fully developed at the age of 10-11.

(D) Molars - These teeth are helpful in chewing of food. Six molar teeth are present in every jaw.

2.1.1.2 Pharynx

Buccal cavity on the posterior part of tongue and palate is joined with a sac/ flask shaped Pharynx. It is through the pharynx that food moves to the esophagus or food pipe and air to the trachea or wind pipe. Pharynx through its structure ensures that in no condition food can enter in the wind pipe and air in the food pipe. Both these pipes have openings on the lower part of the pharynx - wind pipe is present on the front

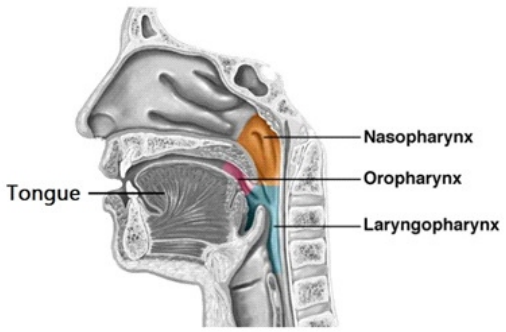


Figure 2.2 Different divisions of Pharynx

while food pipe is found on the posterior side. The structure of the pharynx is divided into three parts (Figure 2.2) -

(A) Nasopharynx

(B) Oropharynx

(C) Laryngopharynx or Hypopharynx

2.1.1.3 Esophagus

It is a narrow muscular tube that is about 25 centimeters long. It starts from the lower part of the pharynx, moves through the cervix, thoracic region and the diaphragm and enters in the upper part of the abdomen.The main work of esophagus is to bring the food from the mouth cavity to the stomach.

Some mucus glands are found in the esophagus. Mucus excreted from these glands makes the food slimy and sticky. The muscles present in the esophagus provide a special movement called **Peristalsis movement** to the food. Through this movement food moves to the stomach. A flap or lid made up of special tissues is present at the top of the esophagus.This flap is called **epiglottis**. At the time of swallowing of food, the epiglottis closes and prevents food from entering the trachea.

2.1.1.4 Stomach

The portion of the alimentary canal past the esophagus is stomach. It is muscular J shaped structure, which is located between the esophagus and the duodenum, left of the abdominal cavity and posterior of the diaphragm.It is a flexible organ that can hold one to three liters of food. The stomach can be divided into three parts-

(A) Cardiac portion: This is the larger left portion where the esophagus enters in the stomach.

(B) Pylorus: This is the smaller right portion through which the stomach joins with the small intestine and its contents flows out of the stomach and goes into the duodenum.

(C) Fundus Portion: This is the portion which lies in between the above two portions. It is present just under the diaphragm.

Two muscular sphincters are also found in the stomach. These two muscles control the passage of the contents present in the stomach are -

(A) Cardiac or lower esophageal sphincter - This divides the pharynx and the stomach and do not allow the movement of acidic food from the stomach back to the esophagus and pharynx.

(B) Pyloric Sphincter- This divides the stomach and the small intestine and controls the movement of food from stomach to the small intestine.

2.1.1.5 Small Intestine

Small intestine is a very important organ of the digestive system which starts from the pyloric part of the stomach and ends at the large intestine. The average length of the small intestine in humans is seven meters.This organ of the alimentary canal is responsible for the maximum digestion and absorption. Small intestine is divided in three different parts -

(A) Duodenum - It is the first and the smallest part of the small intestine attached to the stomach, which plays the most important role in the biochemical digestion of the food (by the enzymes) (table 2.1).

(B) Jejunum- It is the central part of the small intestine. Here, dietary juices digested in the duodenum are absorbed. The function of absorption is mainly conducted by special type of cells called enterocytes.

(C) Ileum - This is the terminal portion of the small intestine which opens in the large intestine. This part absorbs those nutrients (extensively bile salts and vitamins) which are not absorbed in the Jejunum.

2.1.1.6 Large Intestine

The Ileum is further connected to the large intestine. Some special bacteria are found here. These bacteria helps in the digestion of residual undigested food received from the small intestine by simplifying it through fermentation. The main function of the large intestine is to absorb water and mineral salts and to evacuate the undigested food through the anus. In humans, the large intestine is divided into three parts-

(A) Caecum - This part is associated with Ileum. Here, further absorption of the digested food that comes from the Ileum takes place and the remaining waste is passed to the colon. Slightly underneath the first part of the caecum (which is attached to the Ileum), a four-five inch long tube-shaped organ projecting inwards is found and is called as **Vermiform Appendix**. It is present near the junction of the small intestine and the large intestine

(B) Colon - The portion of the large intestine ahead of the cecum is called as Colon. It is about 1.3 meter long inverted U shaped duct like structure. It can be divided into four parts-

(1) Ascending Colon -about 15 cm long duct.

(2) Transverse Colon -about 50 cm long duct.

(3) Descending Colon - about 25 cm long duct.

(4) Sigmoid Colon - about 15 cm long duct.

(C) Rectum - Rectum is the terminal end of the Alimentary canal. It is about 20 cm long. The terminal 3 cm portion of the rectum is called **Anal Canal**.The anal canal opens outside through the **anus**. The alimentary canal ends at the anus. Two sphincter - external sphincter and internal sphincter are found in the anal canal. These sphincter muscles control the outwards movement of the waste products remained after the absorption of digested food juices.

2.1.2 Digestive Glands

In humans, in addition to the glands/secretary tissues present in the alimentary canal, three major glands viz Salivary gland, Liver and Pancreas are also found.

2.1.2.1 Salivary Gland

This gland produces saliva in the mouth. Saliva is a mixture of a serum like fluid and a sticky mucosa. The liquid part wets the food and mucous acts as a lubricant. The main functions of saliva are - to start digestion of the starch present in the food within the mouth itself, to make the food lubricious and soluble, and to clean the teeth, mouth and tongue. Salivary gland is of three types (Figure 2.3).

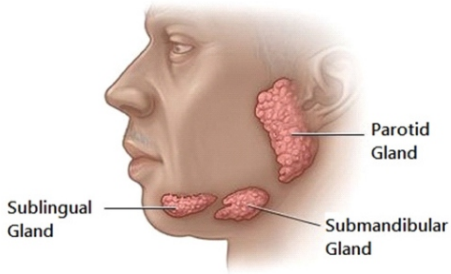


Figure 2.3 Salivary glands of Human

(A) Parotid gland - It secrets a serum like fluid and is found in the cheeks.

(B) Submandibular salivary gland - It is a mixed gland through which fluid and mucus are secreted.

(C) Sublingual gland - This is found beneath the tongue and secrets the mucus like liquids.

2.1.2.2 Pancreas

It is a compound gland which secretes endocrine hormones- Insulin and Glucagon and exocrine Pancreatic juices.This gland is surrounded by liver, pharynx and spleen. It is 6 to 8 inches long U shaped structure (Figure 2.4).The enzyme released by this gland (Table 2.1) helps in the digestion of proteins, fats and carbohydrate in the intestine. Insulin and glucagon hormones together control the level of blood glucose in the body

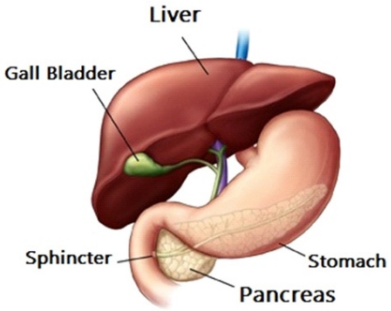


Figure 2.4 Human Pancreas and Liver

2.1.2.3 Liver

This is the largest and one of the most vital digestive gland of the human body. It is a triangular organ located beneath the diaphragm (Figure 2.4). Its maximum weight is inclined towards the right side.

From the front, liver appears to be divided into two parts - right and left lobes. On looking from the front surface to the bottom, two extra lobes are also visible. The liver is made up of about 100,000 small hexagonal structural and functional units called **Liver Lobules**. This gland produces bile. The bile secreted from the liver flows to the Gall Bladder through the Hepatic duct system and bile duct. The gallbladder is located on the concave lower side of the liver. The bile produced by the liver is stored in the Gall Bladder. From here the bile moves through common bile duct into the duodenum.

2.1.3 Digestion of the Food

The digestion of food is mainly carried out by many mechanical and biochemical processes. Within the alimentary canal the enzymes released by various

Table 2.1 Digestive Juices secreted by various digestive organs and their work

S.No.	Organ/Glands secreting the digestive juices	Secreted Enzyme	Work (Complex to simpler form)	Place of Work
1.	Salivary Gland	Ptylin or Amylase	Polysaccharides (like starch, Glycogen) → Smaller polysaccharides, Maltose	Buccal Cavity
2.	Stomach (Gastric Juices)	1. Pepsin 2. Renin	1. Protein → Peptide 2. Casein → Paracasein	Stomach
3.	Pancreas	1. Amylase 2. Trypsin 3. Chymotrypsin 4. Carboxypeptidase 5. Lipase 6. Nuclease	1. Starch → Maltose 2. Protein → Peptide 3. Protein → Peptide 4. Protein, Peptide, Amino acids 5. Fats → Mono-glyceride, fatty acids 6. DNA and RNA → Nucleotides	Small Intestine
4.	Intestinal Juices	1. Maltase 2. Lactase 3. Sucrase 4. Lipase 5. Nuclease 6. Dipeptidase 7. Phosphatase	1. Maltose → Glucose 2. Lactose → Glucose 3. Sucrose → Glucose 4. Fats → Fatty acids, Glycerol 5. Nucleic Acid and Nucleotide → Nucleosides and Sugars 6. Dipeptide → Amino acid 7. Nucleotide → Nitrogenous base, Ribose	Small Intestine
5.	Liver	Bile salts	Fat → Fatty acid/ Fat Globule	Small Intestine

organs and glands simplify the food nutrients by hydrolysis. These enzymes generally belong to the hydrolases group. The key enzymes working in digestion are as follows-

(i) Carbohydrate digesting - Amylase, Maltase, Sucrase.

(ii) Protein digesting - Trypsin, Chymotrypsin, Pepsin etc.

(iii) Fat digesting - Lipase

(iv) Nucleases - Nucleotidase, Nucleases

The task of chewing and mixing food with saliva is transacted in the mouth cavity. The mucus of the saliva helps the food particles to aggregate with each other and form **bolus**. Food in the form of bolus now moves by means of peristaltic movement and through the pharynx and esophagus reaches to the stomach. The entry of food in the stomach is controlled by the cardic/lower esophageal sphincter. Enzyme ptyalin or amylase present in the saliva begins the hydrolytic decomposition of carbohydrate within the buccal cavity. Here about 30 percent of the starch is simplified to maltose. Three types of secretions - gastric mucus, proenzyme pepsinogen and hydrochloric acid are found in the stomach. Mucus is secreted by Foveolar cells or surface mucous cells. Proenzyme pepsinogen is converted into active enzyme pepsin in the acidic atmosphere created by the hydrochloric acid and then it starts the breakdown of proteins present in the food. The gastric juice of new born infants also contains another enzyme called Renin along with pepsin. This helps in the digestion of milk proteins (Table 2.1).

Oxyntic cells present in the stomach secrets hydrochloric acid. The food stays in the stomach for few hours only and through muscular contraction mixes with gastric juices and creates chime.

The partially digested food from the stomach moves to the small intestine. Maximum digestion process occurs in Duodenum. Through different ducts various digestive juices like pancreatic juice, bile salts and intestinal juices are discharged in the small intestine. These juices contain many enzymes which cause the digestion of the various nutrients present in the food (Table 2.1).

The bile salt emulsifies the fat. This is important for the fat digestion. Bile also activates lipase enzyme.

The food that is simplified/ digested in the Duodenum is then absorbed by the Jejunum and Ileum. With the help of blood, the absorbed food nutrients are then transported to various cells. The undigested and unabsorbed material from the ileum moves to the large intestine. The large intestine mainly functions to absorb water and salts and excretes the undigested food. The undigested part of the food concentrates and becomes compact and hard. It temporarily remains stored in the rectum. Through a neural reflex the faces propagates outside.

2.2 Respiration and respiratory system

2.2.1 Respiration

To perform their various functions, cells require energy. To acquire this energy, cells use O_2 to oxidize the nutrients.This process results in the production of ATP and release of harmful CO_2 gas. For the process of obtaining energy, the entry of atmospheric O_2 in the body and expulsion of CO_2 is absolutely essential. This exchange of gases occurs through the blood. The blood dissolves the O_2 gas in itself and transports it to various organs and tissues of the body. The CO_2 generated by various body parts is dissolved in the blood which ultimately directs it into the atmosphere. This exchange of gases (O_2 and CO_2) in between the environment, the blood and the cells is called **Respiration**. During the respiratory process, oxygen rich air is transported through the nose, throat and respiratory ducts (bronchial tubes) to the air chamber / follicles called **Alveoli** found in the lungs. The membrane of the alveolus is very fine and contains a meshwork of capillary vessels. The oxygen brought by the inhaled air is received by the blood contained in the capillary

vessels of the alveoli membrane and the carbon dioxide brought by the blood is released into the air alveoli. By the process of breathing, lungs release this impure air into the atmosphere.

2.2.2 Human Respiratory System

The human respiratory system is mainly classified into three parts- the upper respiratory system, the lower respiratory system and the respiratory muscles (Figure 2.5).

2.2.2.1 Upper Respiratory System

The upper respiratory system mainly comprises of the nose, mouth, pharynx and larynx (Figure 2.5).

(A) Nose: This is the first respiratory organ which starts with a pair of externally visible nostrils. It is a big cavity like structure which is divided into two parts by a slender bone and a thin membrane. The posterior part of the nasal cavity opens in Nasopharynx. The fine hairs found in the nasal cavity, the blood flowing in the thin membrane, the cilia and the mucous, together through mutual cooperation purifies the inhaled air by removing the dust particles, pollen grains, fungi etc. present in the air. Only after this purification, the inhaled air enters in the lungs.

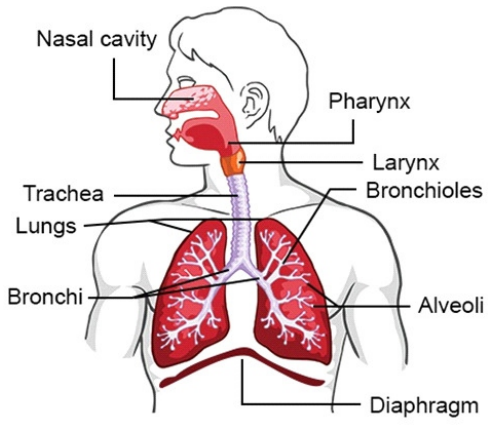


Figure 2.5 Human Respiratory System

(B) Mouth: Mouth works as a secondary organ in the respiratory system. Nostrils play main role in breathing. However, at the time of need mouth can also be used for breathing.

It is worth noting here that the breath taken from the mouth is not pure like a breath taken from the nostrils.

(C) Pharynx: Pharynx is a muscular funnel type structure which extends from the posterior part of the nasal cavity to the upper portion of the esophagus.The pharynx is divided into three parts viz- Nasopharynx, Oropharynx, and Laryngopharynx. The nasopharynx is the first portion of the pharynx which is found in the posterior part of the nasal cavity. Air after passing through the nasal cavity moves into the nasopharynx and reaches to the oropharynx. The breath taken from the mouth directly enters the oropharynx. From oropharynx air passes through the laryngopharynx and with the help of epiglottis enters into the Larynx. **Epiglottis** is a flap like elastic cartilage structure which acts as a switch between the esophagus and wind pipe/ trachea. As we know pharynx also helps to engulf the food, in this situation epiglottis acts as a lid which ensures that the air enters only in trachea and food in food pipe.

(D) Larynx: It is a small structure which connects the laryngopharynx and the trachea (Figure 2.5 and 2.6). It is made up of nine types of cartilages. During food engulfing, epiglottis acts as a covering of the larynx and prevents the food to enter in the larynx. Special structures called vocal cords/ vocal folds are found in the larynx. Vocal cords are mucus membranes which vibrate with the movement of air and produce various sounds.

2.2.2.2 Lower Respiratory System

The lower respiratory system mainly comprises of trachea, bronchi and bronchiole, alveoli and lungs.

(A) Trachea: This is about 5 inch long tubular structure which is made up of C- shaped rings of hyaline cartilage covered by Pseudo stratified ciliated columnar epithelium. Cartilage rings prevents the tracheal to stick with each other and keep the tracheal open all times. Trachea joins the larynx to bronchi and

transports the breath from neck to the chest region. After reaching in the thoracic cavity, the trachea divides into two branches-the left and the right bronchi which then enter into the lungs of the respective side (Figure 2.6). These branches are called **primary bronchi**. The epithelium present in the trachea synthesizes mucus which purifies the inhaled air and forwards it towards the lungs.

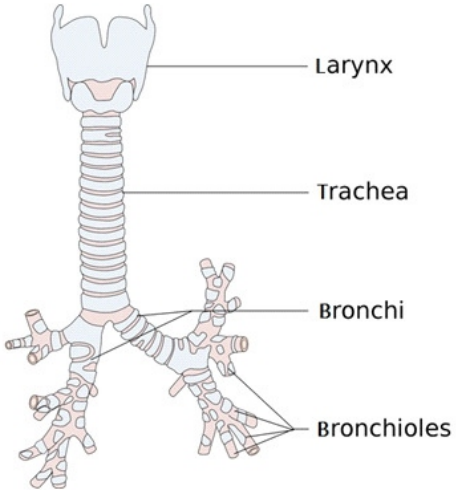


Figure 2.6 Trachea in Human Respiratory System

(B) Bronchi and Bronchiole: The trachea divides into the left and right bronchi. After reaching inside the lungs, the primary bronchi divides into smaller branches called **secondary bronchi**. In every segment of the lung, secondary bronchi further divides into **tertiary bronchi** (Figure 2.5 and 2.6). Each tertiary bronchus divides into smaller **bronchioles**. The bronchioles are distributed all over the lungs. Further every bronchiole divides into smaller terminal bronchiole. Bronchi and bronchiole together forms a tree like structure which remains divided into a number of branches. Special structures called **Alveoli** are found at the terminal end of these branches. The gaseous exchange occurs through these alveoli.

(C) Lungs: Lungs are flexible, soft and light pink coloured organs. A pair of lungs is found just over the diaphragm on left and right sides of the chest. Lungs are made up of numerous bronchi, alveoli, blood vessels, lymphatic vessels, flexible fibers, membranes and several cells (Figure 2.6).

The right lung is slightly smaller in length than the left lung, however it is slightly broader. Men's lungs are slightly heavier than women's lungs. The left lung is divided into two lobes while right one is divided into three. Each lobe is further divided into many subdivisions. Each subdivision splits into several small blocks in which branches of the bronchi, the arteries and the veins divide and forms an independent unit (Figure 2.5).

Each lung is made up of spongy tissue, in which many capillaries and about 30 million alveoli are found. The alveoli are cup like structures which are found at the end of the terminal bronchioles. It is surrounded by several capillaries. Rows of Squamous Epithelium are found in the alveoli which helps in the exchange of the gases from the blood flowing in the capillaries.

2.2.2.3 Lower Respiratory System

Some muscles are needed for gaseous exchange through the lungs. These muscles help in inhalation and exhalation of gases. Diaphragm is primarily responsible for respiration. The diaphragm is a thin sheet like structure which is made up of skeletal muscles found on the surface of the thoraces. On contraction of the diaphragm, the air passes through the nostrils and enters into the lungs. The relaxation of diaphragm causes the exit of air from the lungs. Additionally, special types of muscles called Inter coastal muscles are found in the ribs which helps in the contraction and relaxation of diaphragm.

2.2.2.4 Physiology of Respiration

The pulmonary movement of air is such a rhythmic process of inhalation and exhalation of air in the lungs which facilitates the gaseous exchange. For this aero-navigation, the respiratory system uses - (1) the negative pressure gradient between the atmosphere and the alveoli and (2) the contraction-relaxation of the

diaphragm. Because of these reasons the high pressure air from the atmosphere enters inside the lungs.

The respiration process is carried out at two levels:

(A) External Respiration: In this respiration the gaseous exchange between the air filled alveoli and blood flowing in the capillaries occurs due to difference between the partial pressure of the gases between them.

(B) Internal Respiration: In this respiration the exchange of gases between the blood flowing in the capillaries and the tissues occurs through diffusion.

2.3 Blood and Circulatory System

2.3.1 Blood

Blood is a type of liquid connective tissue present in human and other animals that transports essential nutrients and oxygen to cells and metabolic waste products and carbon dioxide from the cells. It is a slightly alkaline fluid whose pH is 7.4. Blood formation occurs in red bone marrow. The formation of blood in the embryo and newborns occurs in the spleen.A normal person has approximately five liters of blood. Blood consists of two parts - the fluid part called **plasma** and a solid portion which is made up of cells. Plasma makes up 55 percent of blood and contains approximately 92 percent water and 8 percent organic and inorganic substances.

The blood cells are of three types -

(A) Red Blood Cells (RBC) - They comprises 99 percent of total blood cells. These cells contain a protein called haemoglobin. It is the presence of haemoglobin which imparts red colour to the blood. These cells lack nucleus and their average age is 120 days. They are also called as Erythrocytes and all produces in Red bone marrow.

(B) White Blood Cells (WBC)-These cells impart immunity and are formed in red bone marrow. They are also called Leucocytes. Hemoglobin is not found in these cells, due to which they are colorless and hence are called white blood cells. These cells are of two types - granulocytes and agranulocytes. Examples of granulocytes are neutrophils, eosinophil's and basophils. The most common white blood corpuscles in the blood are neutrophils. In terms of numbers, the neutrophils are the predominant white blood cell found in the blood. Lymphocytes and Monocytes are predominant agranulocytes. Lymphocytes are of three different types - B lymphocytes, T lymphocytes and Natural Killer cells. Lymphocytes are the cells which provide immunity. Monocytes on maturation differentiate into macrophages. Monocytes, macrophages and neutrophils are the major phagocytic cells of the body which phagocytose the external antigens.

(C) Platelets - These are also called as Thrombocytes. Their number in the blood is about 3 million per cubic millimeter. The average life of platelets is only 10 days. These cells primarily help in blood clotting and are devoid of nucleus.

2.3.1.1 Functions of the Blood

Blood is a vital tissue in the body of the organisms which perform many types of functions. The main functions of blood are:

1. Exchange of O_2 and CO_2 between the environment and the tissues.
2. Transport of nutrients to different body parts.
3. Controlling the body's pH.
4. Controlling the temperature of the body.
5. Execution of the immunity related works.
6. Transportation of hormones and other necessary signaling molecules as per the need.
7. Excretion of the waste products out of the body.

2.3.2 Types of Blood

On the basis of the presence and absence of special type of antigen A and B that are found on the surface of red blood cells, human blood has been divided into four groups - A, B, AB and O. A person with A blood group has A antigen, person with B blood

group has B antigen and person with AB blood group has both A and B antigen on the surface of their red blood cells.The red blood cells of the person having O blood group has no antigen on their surface. These groups of blood are called **ABO blood groups**.

In addition to the A and B antigen, another antigen called **Rh** is also found on the surface of the red blood cells. The blood of persons having Rh factor is called Rh Positive (Rh +ve) while the blood of the persons devoid of the Rh antigen is called Rh negative (Rh -ve). About 80 percent of people in the world have Rh positive blood.

2.3.3 Blood Circulation

The circulatory system is a combination of various organs that transport gases, digested food nutrients, hormones, excretory products etc. among various body cells. In humans, closed circulatory system is found which is comprised of blood, heart and blood vessels (Figure 2.7). Apart from blood, another fluid called **lymph** also forms a part of this transport. The lymph moves through a special mechanism called **lymphatic system**. This is an open type circulatory mechanism.

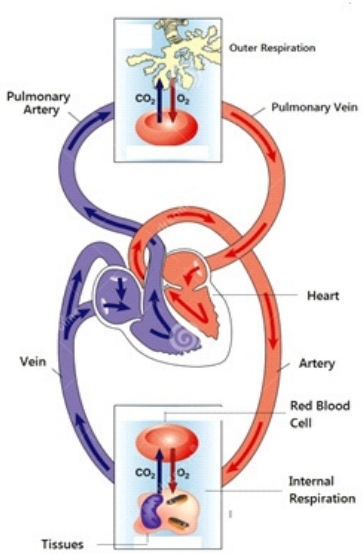


Figure 2.7 Blood Circulation

In the circulatory system, blood acts as a liquid medium, that plays key role in movement of transportable substances. The heart is the center of this system that continuously pumps blood in the blood vessels.

2.3.3.1 Heart

A human heart is a red coloured, closed fist shaped hollow organ which is made up of muscular tissues. It remains surrounded by a double walled membrane cover. This cover is called **pericardium**. Pericardium contains a fluid called pericardial fluid. This fluid protects the heart against the external shocks. Four chambers are found in the heart - the upper two are relatively small and called **Atrium**; the lower two parts are relatively larger and are called **Ventricles**. So, on dividing the heart vertically in the left and right parts, we find each part of the heart contains an Atria and one Ventricle. The atria and ventricles of the left side are connected with each other through a **bicuspid valve**, which is called a **mitralvalve** or left **Atrioventricular valve (AV valve)**. The atrium and ventricles of the right side are connected with each other through a **tricuspid valve** which is also known as right **Atrioventricular valve (AV valve)**. These valves prevent the blood to move in reverse direction. The opening and closing of the heart valves generates a typical sound of **Lub-Dub**. This sound is the sound which we feel during the heart beat. The right and left

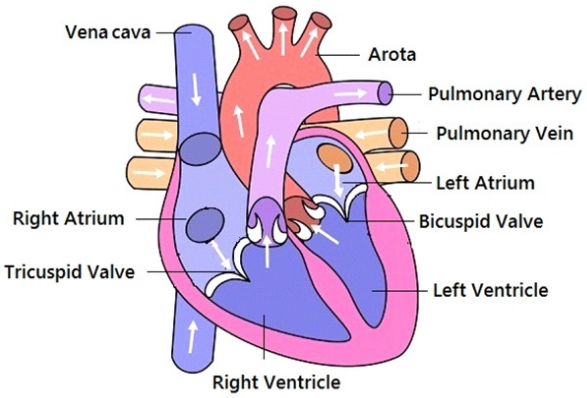


Figure 2.8 Human Heart

atria and ventricles remain separated from each through muscular membranes (Figure 2.8).

The Auricles and ventricles are engaged in continuous rhythmic contraction and relaxation. Through this action the heart pumps blood into different parts of the body. The impure waste from the body is brought to the right atrium by **Vena cave**. After collecting in the right atrium, the right AV valve opens and the blood from the atrium enters inside the ventricle.On contraction of the right ventricle, the pulmonary artery transports the impure blood to the lungs.Within the lungs, through the respiration process, this impure blood is oxidized and made clean.

The pulmonary vein brings the pure blood from the lungs into the left atrium. From left atrium through the left AV valve blood enter in the left ventricle. Due to contraction of the left ventricle, the Arota (the largest artery of the body) transports the oxygenated purified blood to different parts of the body. This cycle runs continuously and is called **heart cycle**. The contraction of heart is called **Systole** and the relaxation is called **Diastole**.

In the circulation process, the blood passes twice through the heart - firstly the impure blood from the body and then pure blood from the lungs enters in the heart (Figure 2.7). The pure blood is then sent back from the left ventricle to the body through Aorta (the largest astery). This type of circulation is called double circulation - one is Systemic circulation and the second is Pulmonary circulation. Some cardiovascular muscles are self-stimulating and control's the pace of the heart's activities. These are called **pace maker**.

2.3.3.2 Blood

Details of the blood have been discussed previously (2.3.1 and 2.3.2) in this chapter.

2.3.3.3 Blood Vessels

Circulation of blood in the body is done by the blood vessels. Blood vessels forms a network within which blood flows and reaches to the cells. They are of two types-

(A) Artery - The blood vessels in which the oxygenated pure blood flows are called arteries. They transport the blood ahead of the heart.

(B) Veins - The blood vessels in which the deoxygenated impure blood containing the body wastes flows are called veins. They transports blood towards the heart.

Blood vessels after reaching the tissues and organs form an extensive cluster of capillaries.

2.4 Excretory System

The excretory system is a mechanism to expel out the waste material from the body. Therefore, excretion is a body system in which the waste products generated by the body cells are disposed out of the body.

All organisms through metabolic processes, keep accumulating waste products such as ammonia, urea, uric acid, carbon dioxide etc. The removal of waste products from living organisms is an essential process, otherwise such wastes (especially nitrogenous wastes) may function like toxin. The carbon dioxide is expelled out through lungs. For the emission of accumulated nitrogenous waste, a special mechanism called the **excretory system** works. The kidneys play a key role in this mechanism.

Nitrogenous wastes are of three different types -

(A) Ammonia: - Animals which excrete ammonia are called Aminotelic. Many bony fishes, amphibians and aquatic insects excretes ammonia by this process. Excessive water is required for the excretion of ammonia.

(B) Urea: - Urea emission is primarily done by mammals, sea fishes and others. These organisms are called Ureotelic. Liver converts the ammonia produced by the cells into urea. Urea is then filtered and excreted by the kidneys.

(C) Uric acid: - Birds, reptiles, insects etc. excretes uric acid. Such organisms are called Uricotelic. These

organisms convert ammonia into the Uric acid. Uric acid is excreted in the form of globules or paste along with very little water.

2.4.1 The human Excretory System

The human excretory system collects and expel out the liquid waste of the body. This system consists of two Kidneys, one Urinary bladder, two Ureters and one Urethra (Figure 2.9).

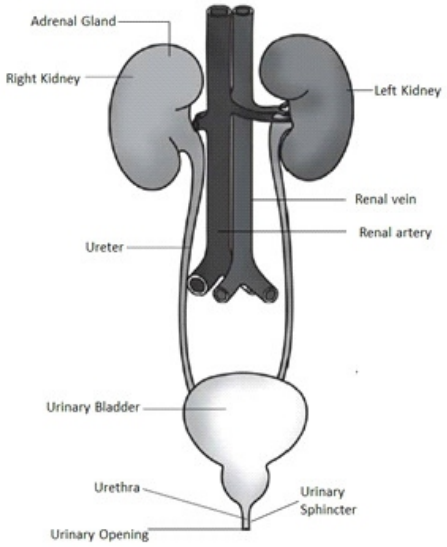


Figure 2.9 The Human Excretory System

(A) Kidney: It is the main excretory organ of the human body (Figure 2.9 and 2.10). It excretes about 75-80 percentage of the liquid waste out of the body. It also controls all the juices released in the body. It is a dark brown coloured bean shaped structure. A pair of kidneys is located on the posterior side of the abdominal cavity and below the stomach on right and left side of the spinal cord. The left kidney is slightly more superior to the right kidney. A groove/ indentation is found on the central surface of the kidney, which is called **Renal Hilum**. The urinary ducts/ ureter, nerves and blood vessels enter the kidney through the hilum. In the inner part of the hilum, a funnel shaped Renal Pelvis is found. Each kidney consists of two parts, the outer Cortex and the inner Medulla. Each kidney is made up of several million functional units called **Nephrons** (Figure 2.10 and 2.11). Each nephron has two parts -

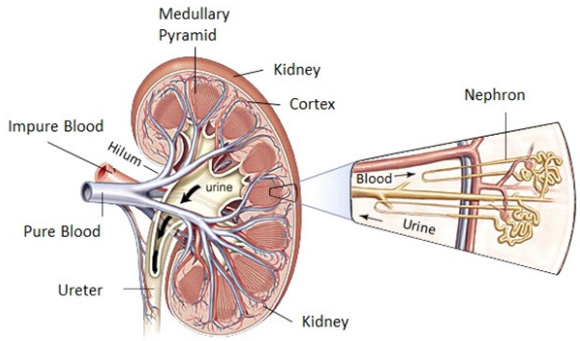


Figure 2.10 Structure of Human Kidney

(a) Bowman 's capsule -

It is a cup-shaped bag found in the upper portion of the Nephron. A meshwork of capillaries of branch afferent arteriole is found in the Bowman's capsule. These bunches are called **Glomerulus**. One end of glomerulus is joined to the Renal Artery which brings oxygenated blood containing the metabolic wastes in the Bowman's capsule while the other end which transports the filtered blood out of kidney is joined with the Renal vein.

(b) Renal Tubule -

This is the duct that starts from the bottom of the Bowman's capsule and its second part remains connected to the urine collecting duct (Figure 2.11). The first section of this duct is called **proximal convoluted tubule (PCT)**. In the central part, this tube forms a hair pin loop like structure called **Henle-Loop**. The terminal portion of this tube is called **distal convoluted tubule (DCT)**. DTC remains connected with the collecting duct of the nephron.

(B) Urinary Bladder : It is a muscular sac like organ which stores urine coming from the kidney. It is present in the pelvic region just above and behind the pubic bone. It shapes like a pear. It helps in urination and can store 400 ml to 600 ml of urine. The urine descends down from the kidneys into the bladder through ureters.

(C) Ureters: They are a pair of tubes that carry urine from both the kidneys to the urinary bladder. These

tubes are made up of smooth muscles and have a size of 25-30 cms (in adults).

(D) Urethra : It is a tube like structure which carry the urine from the bladder to the exterior of the body. In males it is connected to the penis and in females it ends just above the vaginal opening. In males it also carries semen which it receives from the ejaculatory ducts. Length of the male urethra is larger as compared to females.

2.4.2 Urine formation

The formation of urine is carried out in three stages - The glomerular filtration, re-absorption and secretion. All these functions are carried out in different parts of the kidney. The blood keeps flowing continuously in the kidney. This blood is brought by the renal artery and contains metabolic waste products. Both kidneys filter about 1000-1200 ml blood every minute. The branch afferent arteriole in Bowman's capsule converts into large number of capillaries. These capillaries forms a bunch.

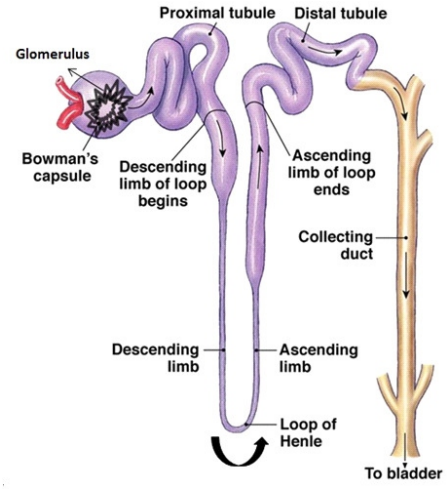


Figure 2.11 Structure of the Human Nephron

The filtration of the blood is carried out in the nephron. Here glucose, salts, amino acids, urea etc. are filtered from the blood and are collected in the Bowman's capsule. This filtrate then passes through the renal tubule. The walls of the renal tubule are made up of simple cuboidal epithelia. These cells almost completely re-absorb the glucose, amino acids and other useful substances from the filtrate. These reabsorbed substances are then replenished in the blood stream. About 99% filtrate is re-absorbed in the renal tubules. Importantly the waste products like urea are not reabsorbed. The renal vein carries the clean blood from the kidney. After re-absorption of the nutrients by nephrons, the clean blood is passed to the efferent arteriole. The unabsorbed filtrate containing the waste substances remain within the renal tubules. Such waste containing liquid forms urine. The urine from the nephron is transported to the collection tube from where urine enters in the urinary tract/ ureter. From each of the kidney one ureter opens in the urinary bladder. The bladder is the organ where urine is stored. With the collection of the urine, the bladder enlarges. When enough urine gets accumulated, the central nervous system sends a signal to the bladder. This signal cause the contraction of the bladder muscles and relaxation in the bladder/urethral sphincter muscles. As a result excretion of the urine takes place.

2.4.3 Other organs employed in excretion

In addition to the kidneys our lungs, skin, liver etc also helps in the excretion of the body wastes. Lungs help in the expulsion of the CO_2, while liver helps to excrete bilirubin, biliverdin, vitamins, steroid hormones etc along with the feaces. Skin through sweat expels out salts, urea and lactic acid while sterols, hydrocarbons etc are secreted along with the sebum.

2.5 Reproductive System

Reproduction is one of the most important body system found in the living beings in which one organism gives birth to the offspring's.Sexual reproduction is found in humans. It is a bisexual reproductive process in which male's synthesis sperms (male gametes) while female produces egg (female gametes). The fertilization of the egg with the sperm produces zygote which further gives rise to a new organism.

The reproductive cells which are responsible for the sexual reproduction develops in specific period of life called puberty. At this stage signs of sexual

development start to become visible and leads to sexual maturity. In boys the features of puberty are voice heaviness, development of mustache and beard, growth of pubic hairs near the genital organs and underarms, oiliness of the skin etc. In females, the development of the breast and increase in its size, oiliness of the skin, growth of pubic hairs near the genital organs, start of the menstrual cycle etc marks the start of the puberty. Puberty in females is marked at the age of 12-14 years while in males this age is 13-15 years. Generally the sexual maturity is achieved at the age of 18-19 years.

During this period a human being undergoes transformation in his sensations and his intellectual and mental levels. The root cause of various changes seen in between the age of puberty and the age of sexual maturity is the secretion of various hormones.The main sexual hormone in human males is **Testosterone** while in females **Estrogen** and **Progesterone** are the major sexual hormones.

2.5.1 Male Reproductive System

The male reproductive organs can be classified as primary and secondary sexual organs (Figure 2.12).

2.5.1.1 Primary Reproductive Organs

They are the organs which produces the sex cells or gametes. They also secrete some hormones. These organs are called **gonads**. The male gonads are called Testis. A pair of testis is present in humans and these are responsible for the synthesis of male reproductive cells called **sperms**.Testis are present outside the abdominal cavity in a pouch like structure called **Scrotum**.Testis consists of two parts - one which produces sperms and second which acts as an endocrine gland and secrets testosterone hormone.

2.5.1.2 Secondary Reproductive Organs

All the organs other than Primary Reproductive Organs which are involved in the reproductive system are called Secondary Reproductive Organs (Figure 2.12).

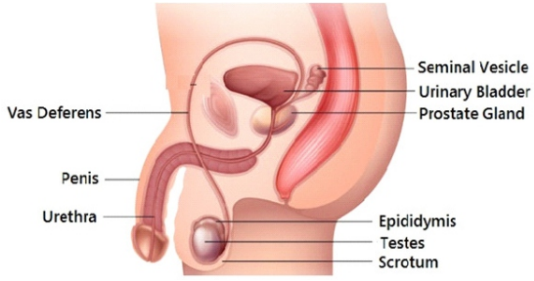


Figure 2.12 Male reproductive System

(A) Scrotum:

Scrotum is important to keep the testis stable. The sperm production requires a temperature lower than the temperature of the body. The scrotum functions as a device which regulates the temperature of the testis. Temperature of the scrotum is lower than the other organs of the body.

(B) Vas Deferens:

The sperms take the help of Vas Deferens to reach the seminal vesicles. Vas Deferens is a duct like structure which together with ureter forms a common vessel and hence sperms and urine both flow through a common route. A pair of these ducts is found in the body. One duct carry sperm from each of the testis and along with the seminal vesicle joins with the left and right ejaculatory duct.

(C) Seminal Vesicle:

The Vas Deferens opens up in a pouch like structure called Seminal Vesicle. This pouch is used for the storage of sperms before ejaculation. The seminal vesicle produces a fluid which helps in the formation of semen. This fluid also provides swimming movement and nourishment to the sperms.

(D) Prostate Gland:

It is a walnut like structure which acts as an exocrine gland. It produces and secretes a fluid which forms a part of semen. This fluid helps in providing motion to the sperms.

(E) Urethra:

It is a muscular duct which begins from the urinary bladder and joins with the ejaculatory vessels to form Urinogenital canal. Through this duct urine, sperms, secretions of glands like prostate etc comes out. This duct passes through the penis and opens outside through Urinogenital canal.

(F) Penis:

It is a cylindrical organ located in the pubic region, it hangs from the middle of the scrotum. It is an erectile copulatory organ. In the normal conditions it remains small and flaccid and is used for urination. During the sexual intercourse, this organ becomes erectile and is used to deliver semen (with sperms) into the female genital organs.

2.5.2 Female Reproductive System

The female reproductive system has also been divided into primary and secondary sexual organs

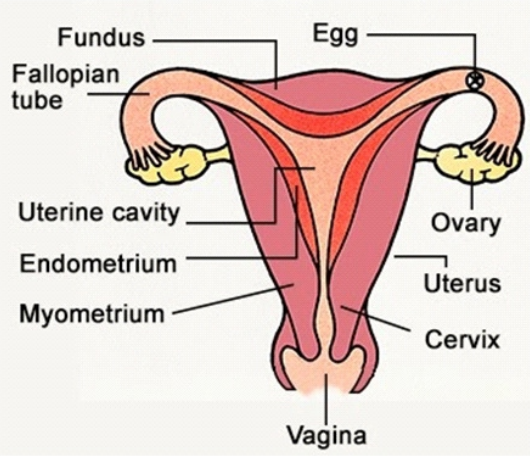


Figure 2.13 Female Reproductive System

2.5.2.1 Primary Reproductive Organs

In females a pair of **ovaries** works as primary sexual organs (Fig. 2.13). The ovaries have two major functions - first, it produces female germ cells (ovum). Second, it acts as an endocrine gland and secretes two hormones - Estrogen and Progesterone. Both the ovaries are found in the pelvic region of abdominal cavity beneath the kidneys on both sides of the uterus. Numerous distinct structures called ovarian follicles are found in each ovary. These follicles produce ovum/ egg. After maturation, the egg is released from the ovary and through fallopian tubes it reaches to the uterus. Hormones released from the ovaries helps in - female sexual transformation, egg formation etc.

2.5.2.2 Secondary Reproductive Organs

Like in males, the organs other than the Primary Sexual Organs which are involved in the reproductive system are called **Secondary Reproductive Organs** (Figure 2.13).

(A) Fallopian Tubes

It is a long coiled tubular organ which is located on both sides of the uterus. These ducts transport the eggs from the ovaries into the uterus. It is 10-12 cm long and extends beyond the abdomen. It helps in creating conducive conditions for fertilization.

(B) Uterus

The uterus is a pear shaped hollow muscular genital organ found in the lower abdomen in between the urinary bladder and rectum (posterosuperior to the bladder and anterior to the rectum) where both the fallopian tubes join and form a pouch like structure. Its wider side (fundus) faces upwards and the narrow part (cervix) faces downwards. Through cervix, the uterus opens in the vagina. Uterus is the place where the egg fertilized by the sperm gets implanted and develops into the embryo. Placenta which acts as a link between the mother and the embryo also develops here.

(C) Vagina

It is approximately 8-10 cm long muscular and tubular structure found in the middle of the bladder and rectum and functions as female copulatory chamber. This organ also works as a canal for the flow of menstruation discharge and delivery pathway (birth canal). Lactic acid producing bacteria i.e. *Lactobacillus* are found in the vagina. The presence

of lactic acid and carbonic acid keeps the vaginal atmosphere acidic.

2.5.3 Phases of Reproduction

The flowing stages of reproduction are found in the human beings-

(A) Gametogenesis: The process of production of the haploid gametes in the testis and ovaries is called gametogenesis. This process in male testis produces sperms and the process is called as **spermatogenesis**. The process of gamete formation in the female ovaries which leads to the production of eggs is called **Oogenesis**.

(B) Fertilization: The eggs present in the female uterus come in contact with the sperms liberated by the male during the intercourse. They conjugate with each other and forms **Zygote**. This process is known as fertilization.

(C) Cleavage and embryo implantation: The zygote undergoes a series of mitotic divisions and forms a structure called **Blastula**. The blastula gets implanted in the endometrium wall of the uterus. This process is called Embryo implantation.

(D) Accouchement/ Delivery: Embryo, after its implantation passes through many stages of development and leads to the development of foetus in the uterus. After the full development of the baby in the uterus, child birth takes place. The process of giving birth is called accouchement/ delivery.

2.6 Nervous and endocrine system

In humans, different organs work in harmony and coordination. This harmony and co-ordination is very important for the smooth functioning of various organs and organ systems. Independently, no organ system can function appropriately. For establishing the mutual coordination among various body organs and body systems, a special system called **Nervous system** functions in the body.

To make coordination among the various body systems even better, another system called the **Endocrinal system** also works in the human body. The nervous system cannot control work of all the cells. In such a condition, the control is established by the endocrinal system. In this system many ductless glands secretes hormones. These hormones work as messenger and control the functioning of different organs. Both the above systems functions to - deliver the information and sensations perceived from the environment to different organs, allows the organs to react appropriately and to establish coordination among different organs.

2.6.1 Human nervous system

The human nervous system is a system which establishes the coordination between different organs and environment and among various organs. Moreover, it controls the functioning of body organs.

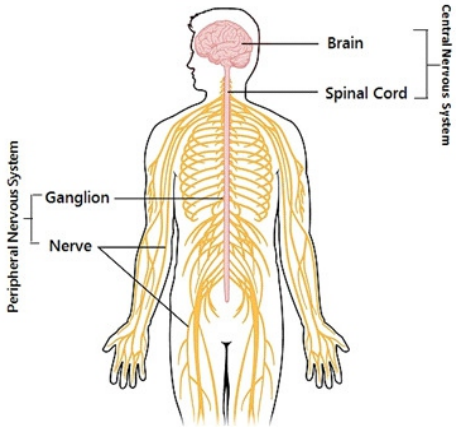


Figure 2.14 Human Nervous System

The nervous system can be classified into two parts - (A) The Central Nervous System and (B) The Peripheral Nervous System. The central nervous system mainly consists of Brain, Spinal Cord and the nerves coming out of them. The peripheral nervous system is made up of two different types of nerves - **(A) The Sensory nerves:** nerves which transfer the stimulus from the tissues and organs to the central nervous system. **(B) Motor nerves:** nerves which transfer the regulatory stimulus from the central nervous system to the corresponding organs. Functionally the

peripheral nervous system has been classified into two parts: (A) Somatic nervous system and (B) Autonomous nervous system.

2.6.1.1 Central Nervous System

Brain, spinal cord and the nerves coming out of them together comprise the central nervous system (Figure 2.14).

(A) Brain

Human brain is one of the central organs of the body which works for the exchange of the information , provide commands and control various body systems.Various activities of the body like temperature control, human behavior, blood circulation, respiration, looking, listening, speaking, gland secretions and others are monitored by brain. It is most complex organ of the body with a weight of about 1.5 kg and is protected by the skull.The brain envelop contains a groove shaped fluid called **Cerebrospinal Fluid** (CSF acts as a cushion to provide protection to the brain). Brain is divided into three parts (Figure 2.15) - fore brain, mid brain and hind brain.

(1) Fore Brain

The cerebrum, thalamus and hypo-thalamus together forms the fore brain. Cerebrum constitutes 80-85% portion of the human brain. It is that part of the brain where knowledge, consciousness and thinking related works are executed. An elongated deep fissure divides the cerebrum into the right and left cerebral hemispheres.

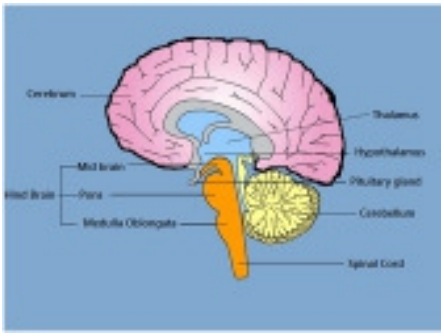
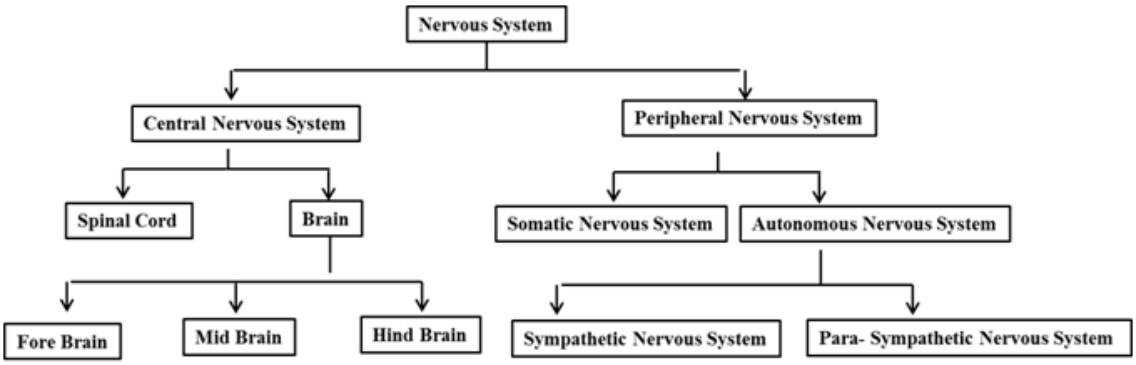


Figure 2.15 Human Brain

Each hemisphere in the outer area contains a **Grey matter** which is called as **Cortex**. On the inner side is found **white matter** which is called as **Medulla**. Many nerves are found in the grey matter. Because of the presence of excessively large number of nerves this matter looks grey. Both these hemispheres are joined with each other through a strip of **Corpus Callosum**. The cerebrum is surrounded from every side by thalamus. Thalamus is the center of the sensory and motor signals. Another portion called Hypothalamus is located on the **Diencephalon** part (which is present on the basal part of the thalamus) of the fore brain.This section makes sense of hunger, thirst, sleep, temperature, fatigue, expression of feelings etc.

(2) Mid Brain

Mid brain is divided into four lobes and is present in between the hypothalamus and the hind brain. Each lobe is called the **Corpora quadrigemina**. The upper two are responsible for the sight and the lower two



are responsible for the hearing.

(3) Hind Brain

This part comprises of the Cerebellum, Pons and Medulla Oblongata. Cerebellum is the second largest part of the brain that regulates the voluntary muscles (such as muscles of hands and feet). It is a somewhat an unusual surface that provides extra space to Neurons. Pons connects the different parts of the brain. Medulla oblongata controls the involuntary actions like heartbeat, blood pressure, secretion of digestive juices etc. Medulla is the last part of the brain that remains connected to the spinal cord.

(B) Spinal Cord

The length of spinal cord is about 45 cm. It is an important organ of the central nervous system. Through medulla oblongata, the hind brain remains joined with the spinal cord. Spinal cord is a neural canal which, for its safety, remain housed in between the vertebra column. A narrow central tube is found in the central part the spinal cord which remains surrounded by a two-layer thick wall - the inner layer is called **Grey Matter** and the outer layer is called **White Matter**. The Grey matter is located in the form of a long column-from the start to the terminal region of the spinal cord. Just like the grey matter, many small columns of the white matter are also found in the spinal cord. The spinal cord mainly works to conduct and regulate the involuntary actions. Additionally, it provides a passage for the impulses coming from and going to the brain.

2.6.1.2 Peripheral Nervous System

This is a group of nerves which originates from the brain and spinal cord and conveys the impulses coming from and going to the central nervous system. This system works extrinsic to the central nervous system and hence it is known as Peripheral Nervous System. It is of two types:

(A) Somatic Nervous System

This system works for the execution of functions which are performed as per our wish. With the help of this system, the central nervous system responds to the external stimuli and transects the functions of muscles etc.

(B) Autonomous Nervous System

This system is responsible the functioning of those organs that do not work by one's desire, rather works automatically such as heart, lungs, endocrine glands etc. This system is comprised of a series of groups of nerves with which the nerve fibers of the various internal body organs remains connected.

The autonomic nerve system has been classified into two parts-

(1) Sympathetic Nervous System

This system controls the alertness and excitement in a person. In the case of emergency situations, this system provides extra energy to the person's body. The enhanced heart rates, the increase in breathing speed etc. which are seen in the emergency situations are transacted by the sympathetic system.

(2) Para - Sympathetic Nervous System

This system is responsible for the conservation of the energy in the body. This system becomes functional during the resting hours and starts the conservation of the energy. This system slows down the heart rate, shrinks the pupil of the eye and enhances the secretion of the saliva and digestive juices.

2.6.1.3 Neuron

Neuron is the structural and functional unit of the nervous system through which this system sends signals from one part of the body to other. Neurons keep most of the cells/tissues of the body in touch with the central nervous system.

The neurons receive both the external and internal stimuli. Through electro- chemical impulses these stimuli moves from one neuron to another and reach the central nervous system. The reactionary stimulus from the central system is also send through the neurons.

Every neuron is made up of three units (Figure 2.16) -

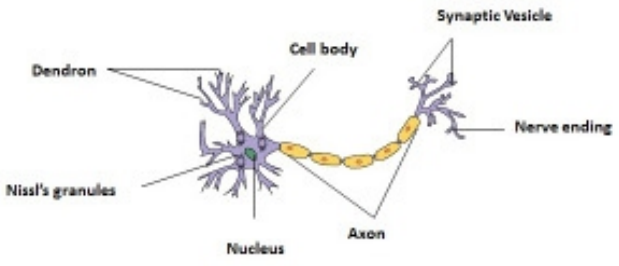


Figure 2.16 Structure of Neuron

(A) Cell Body

This part is also called as Cytone. The cell body contains a nucleus and other typical cell organelles. Within the cytoplasm characteristic highly stained Nissl's granules are found.

(B) Dendron

They are small fine filaments which are found as branches of cell body. The Dendron's send the stimuli towards the cell body.

(C) Axon

It is a long cylindrical projection that starts from the cell body and forms thread like branches.The axons conduct the electric impulse away from the neurons. Every branch of the axon forms a bulge like structure called **synaptic knob**. Every synaptic knob contains synaptic vesicles which contains chemicals called **Neurotransmitters**. These neurotransmitters play an important role in transmission of the neural stimuli. The point of joining of the dendrite of one neuron with the Axon of other is called **Synapse**. At this point the neurotransmitters are found.

2.6.1.4 Physiology of Nervous System

Many neurons join with each other and form a chain like structure. They join various body parts with the brain and the spinal cord. Sensory nerves respond to various stimuli like sound, light, touch etc. and send them to the central nervous system. This work is executed with the help of a series of electrochemical impulses. This is also called as **nervous impulse**. The nervous impulse propagates the stimulus received through the sensory organs (skin, tongue, nose, eyes and ears) to the central nervous system. The nervous impulse weakens as it reaches from the Dendron to the Axon. The neurotransmitters present at the synapse make these impulses strong and sends them ahead. In turn the responding signals (impulse) from the central nervous system are broadcasted by the motor nerves which in-turn activates the muscles and the glands.

2.6.2 Endocrine System

The endocrinal system is such a system which along with the nervous system establishes co-ordination between various cellular activities of the body. The nervous system cannot keep long time control over all the cellular activities. Therefore for continued long term regulation, hormones secreted by the endocrine system are required in the body. The endocrinal system works through the endocrinal glands. Such glands are ductless and directly secrets their secretion (hormones) into the blood stream.

Some glands in our body can function both as endocrine and exocrine. For example pancreas as an endocrinal gland secrets insulin and glucagon hormone while as an exocrine gland it secrets digestive enzymes. The testis and ovary also function similarly.

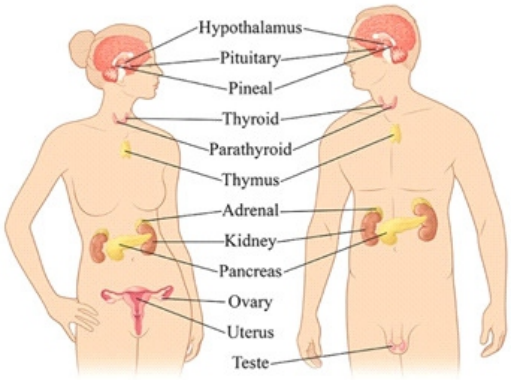


Figure 2.17 Human endocrinal System

The endocrinal glands, in addition to hormone secretion also work to store and release the hormones. Various endocrine glands present in the human body are - Hypothalamus, Pituitary gland, Pineal gland, Thyroid gland, Parathyroid gland, Adrenal gland, Pancreas, Thymus, Testis, Ovaries etc (Figure 2.17). In addition to these, some other organs like Liver, Kidneys, Heart etc also release hormones.

Hypothalamus plays the most important role in establishing the control by the endocrinal system. Hypothalamus collects different information's from various parts of the brain. Through various secretions and nerves the collected information is send to the pituitary gland. On the basis of the information received, the pituitary gland through its own secretions, directly or indirectly, control the activities of other endocrinal glands.

As per the instructions received through secretions of the pituitary gland, other glands release various hormones. In the human body these secreted hormones transacts and controls various works like growth, metabolic activities etc. The hormones put their effect by linking with the specific proteins present on the target cells/tissues.

2.6.2.1 Important human Endocrine Glands

(A) Hypothalamus:

The Hypothalamus is the basal part of the Diencephalon (Forebrain). It mainly regulates the hormone production and secretion by Pituitary gland. Hypothalamus contains many hormone secreting cells. Two types of hormones are secreted by the hypothalamus:

(1) Releasing hormones - which induces the pituitary gland to release its hormones.

(2) Inhibitory hormones - which inhibits the hormone production by the pituitary gland.

(B) Pituitary gland:

This gland is found in the lower portion of the brain near the hypothalamus. This gland can be divided into two parts - **Adenohypophysis** and **Neurohypophysis**. The Adenohypophysis is also called as anterior pituitary gland and the Neurohypophysis is also called as posterior pituitary gland. This is the **master gland** of the body which synthesize and secret many hormones like Somatotropin (growth hormone), Prolactin, Thyroid stimulating hormone, Oxytocin, Vasopressin, Gonadotropin etc.

(C) Pineal Gland:

This gland is found in the upper part of the fore brain and secrets a hormone called **Melatonin**. This hormone is important for the regulation of body's internal clock.

(D) Thyroid Gland:

This gland is situated on both the sides of the trachea. Most importantly this gland secrets **Thyroxin hormone** which regulates the metabolic activities that are based upon this hormone. The thyroxin hormone helps in the synthesis of red blood corpuscles. It also regulates the protein, carbohydrate and fat metabolism. Iodine is required for the synthesis of thyroxin hormone. The lack of iodine results in decreased production of thyroid hormone and may result in a disease called **Goiter**.

(E) Parathyroid Gland:

This gland is found in the posterior part of the thyroid gland and secrets a hormone called **Parathormone**. The main function of parathormone is to control calcium and phosphate levels in blood. Lack of this hormone may cause tetany (parathyroid tetany) disease.

(F) Pancreas:

Pancreas secret two Endocrine hormones - **Insulin** and **Glucagon**. Insulin is secreted by β - cells of islets of Langerhans of this gland while Glucagon is secreted by α- cells of the islets of Langerhans. The main function of insulin is to control the blood glucose level by converting glucose into glycogen. Glucagon

on the other hand stimulates the conversion of glycogen into glucose. Therefore both these hormones collectively control the level of sugar in the blood. If due to some reasons there is a reduction in the level of blood insulin, the level of sugar in blood and urine increases and a disease called **Diabetes Mellitus** is caused.

(G) Adrenal Gland:

A pair of adrenal glands is found on top of the kidneys. They secrete two kind of hormones called **adrenaline** or **epinephrine** and **noradrenaline** or **norepinephrine**. These hormones work to protect the body in emergency conditions. In emergency conditions these hormones are released more rapidly and regulate various functions such as heart beat, heart contraction, respiratory rate, expansion of the pupil of the eyes, etc. These hormones are also called as emergency hormones.

(H) Thymus Gland:

Thymus is situated on the upper side of the heart and the aorta. It releases a peptide hormone called **Thymosine**. This gland is developed maximum in young children and starts to shrink from puberty onwards.

(I) Testes:

This gland is found only in males. This is a sexual gland which secrets male hormone called **Testosterone**. This hormone is responsible for the development of male sexual organs and plays an inductive role in the synthesis of sperms.

(J) Ovary:

This gland is found in the females. It produces and secrets female steroid hormones called **Estrogen** and **Progesterone**. These hormones are helpful in development of female sexual characters, regulation of menstrual cycle, maintenance and up-keeping of the embryo etc.

Important points

1. Cell is the basic structural and functional unit of the body.
2. The co-ordinated collective working of various body organs forms a body system.
3. The process starting from the intake to the excretion of the faeces from digestive system. The major functions of the digestive system are - conversion of complex components of the food into simpler substances and its absorption.
4. At different levels, the sphincter muscle regulates the movement of food, digested food juices and the waste materials.
5. Four types of teeth are found in the jaw *viz* Incisors, Canines, Premolars and Molar. The position of jaw and teeth in humans is called Thecodont. Humans have Diphyodont type of teeth arrangement.
6. Pharynx through its structure prevents the entry of food in the trachea and entry of air in food pipe.
7. Stomach is divided into three portions viz Cardiac, Pyloric and Fundus.
8. The maximum digestion and absorption of the food takes place in the small intestine. The small intestine is divided into three parts - duodenum, jejunum and ileum.
9. The large intestine mainly absorbs the water and minerals and then excretes the unabsorbed food through the anus. The large intestine is also divided into three parts - cecum, colon and rectum.
10. Some glands like - salivary gland, liver and pancreas are also found in the digestive system. These glands through the digestive enzymes help in the digestion of the food. In addition to the glands, the stomach, small intestine and other organs also secrets their enzymes.
11. The exchange of O_2 and CO_2 which takes place between the environment, blood and cells is called respiration. The blood transports O_2 carrying the pure air in the cells and liberates the

CO_2 into the environment through the lungs.

12. The human respiratory system is divide into three parts - the upper respiratory system, the lower respiratory system and the respiratory muscles.
13. The upper respiratory system mainly comprises of the nostrils, mouth, pharynx, Larynx etc.
14. The lower respiratory system is made up of trachea, lungs, bronchi, bronchiole and alveoli.
15. The diaphragm is the main respiratory muscle. Through its contraction, the air enters inside the lungs while its relaxation results in expulsion of the inhaled air.
16. In the internal respiration the exchange of gases occurs between the blood flowing in the capillary tubes and the tissues. It occues through diffusion.
17. Three types of corpuscles *viz* red blood corpuscles, white blood corpuscles and platelets are found in the blood. Additionally, blood contains a fluid portion called plasma.
18. Blood circulation system mainly comprises of the heart and blood vessels.In addition to the blood, one more fluid called Lymph is also found in the body.
19. On the basis of the presence of antigens on the red blood cells, the blood is divided into four groups viz A, B, AB and O. On the basis of presence and absence of Rh antigen, the blood is of two types - Rh positive and Rh negative.
20. The blood vessels in which the pure oxygenated blood flows are called Arteries and those carrying the impure blood are called Veins.
21. Two atria and two ventricles are present in the heart.
22. Urea is the excretory product in human beings .
23. The human excretory system consists of two kidneys, urinary bladder, ureters and urethra.
24. Nephron is the major structural and functional unit of the excretory system.
25. The production of cells responsible for the sexual reproduction starts from the puberty age.
26. Bisexual reproduction process is found in the humans where male produces sperms and females produces ovum.
27. In human males the testosterone is the main sex hormone while in females it is estrogen and progesterone.
28. The reproductive organs are classified in primary and secondary organs. The primary organs are responsible for gamete production. All the organs, except the primary organs, which function in reproductive system, are called secondary organs.
29. The male sex organs are - scrotum, testis, vas deferens, seminal vesicle,Urethra and penis.
30. The female sex organs include- ovary, fallopian tubes, uterus and vagina.
31. For the coordinated functioning of various organs and organ systems in humans, the nervous system and the endocrinal system functions together.
32. The nervous system can be divided into two parts - the central nervous system and the peripheral nervous system.
33. The brain, spinal cords and different neurons arising from them works for the nervous system.
34. Endocrine glands are ductless gland. The hypothalamus regulates the functioning of pituitary gland.

Practice questions

Objective type questions

1. What controls the movement of food, digested food juice and waste at different levels?
   (a) Sphincter (b) Mucosa
   (c) Mucus epithelium (d) Both (b) and (c)
2. Which of the following teeth are most developed in carnivore animals?
   (a) Incisors (b) Canines
   (c) Premolars (d) Molars

3. The main function of Epiglottis is……
…….
(a) To direct the food into the Trachea
(b) Preventing the food from entering the trachea
(c) To direct the food to the esophagus
(d) None of the above

4. Maximum enzymatic digestion of food takes place in ……
(a) Jejunum (b) Ileum
(c) Duodenum (d) Colon

5. Which of the following is not a salivary gland?
(a) Parotid gland
(b) Submandibular gland
(c) Sublingual gland
(d) Pituitary gland

6. Which of the following enzymes is not secreted by the pancreas?
(a) Amylase (b) Trypsin
(c) Renin (d) Lipase

7. Which of the following is secondary respiratory organ?
(a) Mouth (b) Nose
(c) Nasopharynx (d) Larynx

8. The number of lobes found in the left lungs is?
(a) 3 (b) 4
(c) 2 (d) 1

9. …….is found in Alveoli.
(a) Squamous Epithelium (b) Epithelium
(c) Cartilage rings (d) None of the above

10. What is the liquid portion of blood called as?
(a) Serum (b) Lymph
(c) Plasma (d) None of the above

11. Where the development of red blood cells takes place?
(a) Spleen (b) Red bone marrow
(c) Lymph node (d) None of the above

12. Which of the following cells is not a white blood cell?
(a) B - Lymphocyte (b) Platelet
(c) Basophil (d) Monocyte

13. Red blood cells of which of the following blood groups contains both A and B antigens?
(a) O (b) A
(c) B (d) AB

14. How many times does the blood pass through the heart during circulation?
(a) One (b) Three
(c) Two (d) Four

15. The main excretory product of the human body is…….
(a) Ammonia (b) Uric acid
(c) Urea (d) Both (A) and (C)

16. Where is Glomerulus found?
(a) Bowman's Capsule (b) Renal Duct
(c) Henley-Loop (d) None of the above

17. The main human male hormone is
(a) Estrogen (b) Progesterone
(c) Testosterone (d) Both (B) and (C)

18. The primary Sex organs are
(a) Scrotum (b) Ovaries
(c) Testis (d) Both (B) and (C)

19. The Motor nerves deliver the stimuli
(a) From central nervous system to organs
(b) From organs to Central nervous system
(c) Both (A) and (B) are correct
(d) Both (A) and (B) are wrong

20. The Corpora quadrigemina is found
(a) Fore brain (b) Hind brain
(c) Mid Brain (d) Both (A) and (B)

21. Which of the following hormone is not secreted by Pituitary gland?
(a) Growth Hormone (b) Vasopressin
(c) Melatonin (d) Prolactin

22. Which is responsible for the internal clock of the body

(a) Thyroid gland (b) Pancreas

(c) Adrenal gland (d) Pineal gland

Very short type questions

23. Write the name of the basic structural and functional unit of the body.
24. Define digestive system.
25. What is the work of Sphincter muscles?
26. Write the names of glands involved in the digestive system.
27. What is the function of the Incisor teeth?
28. How many parts of the stomach are there?
29. Where does the maximum absorption of digested food takes place?
30. Write the name of the largest gland found in the body.
31. Which gland secrets the Ptyalin enzyme?
32. How many cartilages are found in the Larynx?
33. The mucous in the trachea is produced by .....
34. How much blood is found in a normal person?
35. What is the life span of the Platelets?
36. Name of the vessel in which impure blood flows?
37. What is Pericardium?
38. What is the work of Aorta?
39. What is the process of excretion of ammonia called?
40. Which is the main excretory organ in human beings?
41. Write the name of the organ that produces ovum.
42. Write the name of the major female sex hormone.
43. Where does the placenta implants in mother?
44. Write the name of the systems responsible for establishing the co-ordination among various organs.
45. Where is the grey matter found?
46. Write name of a neurotransmitter.
47. Name of the hormone released by Thyroid gland.
48. Which gland is responsible for the secretion of the adrenalin hormone?

Short type questions

49. Write the names of the organs involved in the digestive system.
50. Explain the structure and function of the stomach.
51. Where is the salivary gland found? Explain its structure.
52. Discuss the main functions of the nostrils.
53. How is pharynx helpful in respiration?
54. Write the importance of respiratory muscles.
55. Define blood and write its functions.
56. What is the role of blood vessels in the blood circulation.
57. Explain the structure of the kidney.
58. Mention the organs besides the kidney which are involved in the process of excretion.
59. Explain the role of the female primary sex organs.
60. What is the function of VasDeferens in the human reproductive system?
61. What is the significance of spinal cord?
62. What is the work of the forebrain? Explain its structure.
63. What is the role of the hypothalamus in the endocrine system?
64. Explain the exocrine and endocrine functions of the pancreas.

Essay type questions

65. Write a detailed note on the human digestive system. Explain the importance of the enzymes in the digestive system.
66. Explain the significance of bronchioles, lungs and respiratory muscles in human respiratory system,
67. What is blood? Discuss various components of blood and explain its importance.

68. Discuss the process of urine formation in human. Describe the structure of the kidney.

69. Draw a well labeled diagram of male reproductive system. Describe the functioning of the primary genital organs in humans.

70. With the help of an illustrative diagram, explain the structure of a nerve.Discuss the importance of hypothalamus and pituitary gland.

Answer key

1. (a) 2. (b) 3. (b) 4. (c) 5. (d) 6. (c) 7. (a) 8. (c)
9. (a) 10. (c) 11. (a) 12. (b) 13. (d) 14. (c)
15. (c)16. (a) 17. (c) 18. (d) 19. (a) 20. (c)
21. (c) 22. (d)

Chapter -3

Genetics

The branch of biology which deals with the study of heredity and variation is called **genetics**. The term genetics was first coined by **Bateson** (1905). This term is derived from the Greek language word ***gene.***

During the process of sexual reproduction various characters are transmitted from generation to generation by gametes. These characters are known as **hereditary characters**. The transmission of hereditary characters from parental generation to offspring is called as **heredity**. The term heredity was coined by **Spencer** (1863). During sexual reproduction variations occur among individuals of the same species due to crossing over during meiosis.

3.1 Mendelism

Gregor Johann Mendel (1822-1884) is called father of genetics because Mendel proposed the laws of inheritance in plants for the first time. Mendel was born on 22th July, 1822 in **Silision** village of **Heinzendarf** state of Austria. In 1842, after receiving a degree in philosophy he became a priest in the church of Brunn town of Austria in 1843. Mendel performed hybridization experiments on garden pea *(Pisum sativum)* for seven years (1856-1863). In 1865, the findings of these experiments were presented in the form of a research paper to the Brunn Society of Natural History. In 1866, these experiments were published in the society's annual proceedings entitled-**"Experiments on plant hybridization**." On the basis of results of these experiments on garden pea, Mendel proposed the laws of inheritance which are also known as **Mendelism**. Mendel died on January 6, 1884.

Gregor Johann Mendel

3.1.1 Reasons for Mendel's success

(i) Mendel studied the inheritance of one character at a time.

(ii) Mendel maintained the statistical record of the experiments and analysed them carefully.

(iii) Mendel selected the plant material for his experiments carefully.

3.1.2 Selection of pea plant

Mendel selected garden pea plant for his experiments because–

(i) Pea plant is annual, therefore, it was possible to study many generations in a short duration.

(ii) It was easy to get pure line or homozygous plants by self pollination because of bisexual flowers.

(iii) Artificial cross pollination can be easily done by emasculation technique.

(iv) Various contrasting characters are present in pea plant.

Mendel selected seven contrasting characters for his experiments which are as follows–

S.N.	Characters of plant	Dominant	Recessive
1.	Shape of seed	Rounded	Wrinkled
2.	Colour of seed	Yellow	Green
3.	Colour of flower	Violet	White
4.	Shape of mature pod	Inflated	Constricted
5.	Colour of immature pod	Green	Yellow
6.	Position of flower	Axial	Terminal
7.	Height of plant	Tall	Dwarf

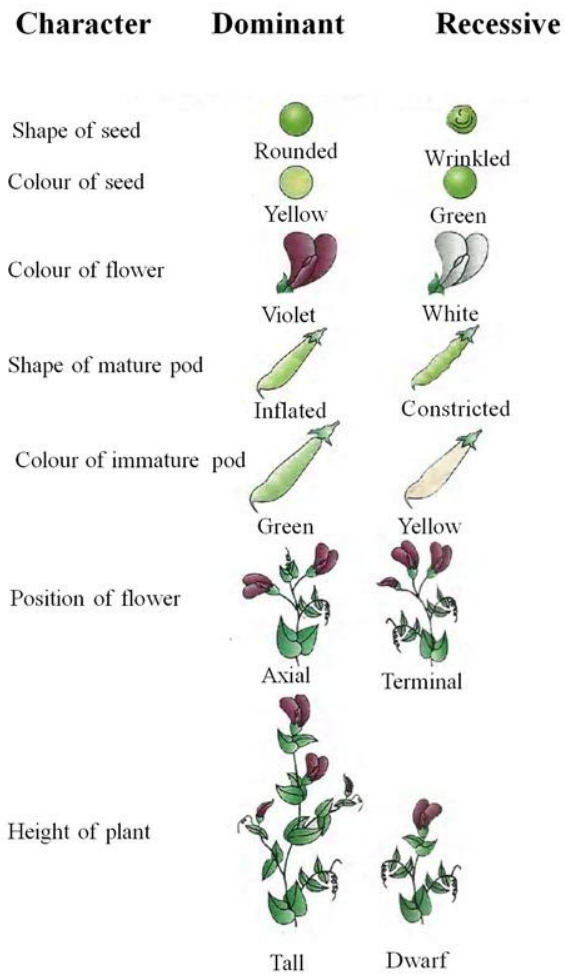


Fig 3.1 Seven pairs of contrasting traits studied by Mendel

3.2 Rediscovery of Mendelism

The laws of inheritance given by Mendel were neglected for about 35 years. The Hugo De Vries of Holand, Carl Correns of Germany and Erich von Tschermak of Austria rediscovered Mendel's laws in 1900 while working separately.

3.3 Genetics terminology

It is very important to understand the following technical terms to understand the laws of inheritance–

1. **Gene -** The factor that controls a character is called gene. Johannsen gave the name gene for factor used by Mendel.

2. **Allelomorph or allele-** Alternative form of a gene which controls any one character is called allelomorph or allele. eg- Height of the plant is controlled by a gene which has two alleles T (Tallness) and t (Dwarfism).

3. **Homozygous -** When both alleles of a gene are similar, the condition is known as homozygous eg- TT or tt.

4. **Heterozygous -** When both alleles of a gene are dissimilar, the condition is known as heterozygous eg-Tt.

5. **Phenotype -** External appearance of an individual is called phenotype. eg - Tall plant which genotypically may be homozygous (TT) or heterozygous (Tt).

6. **Genotype -** Genetic constitution of an individual is called genotype. eg-pure or homozygous tall (TT) and impure or heterozygous tall (Tt).

7. **Dominant characters-** The character which express itself in F_1 generation is called dominant character.

8. **Recessive characters-** The character which does not express itself in F_1 generation is called recessive character.

9. **Monohybrid cross -** Such type of cross in which single contrasting character (Trait) is considered is called monohybrid cross.

10. **Dihybrid cross -** Such type of cross in which two contrasting characters (Traits) are considered is called dihybrid cross.

11. **Trihybrid cross-** Such type of cross in which three contrasting characters (Traits) are considered is called trihybrid cross.

12. Polyhybrid cross - Such type of cross in which many contrasting characters (Traits) are considered is called Polyhybrid cross.

13. Test cross - Such type of cross in which F_1 - generation is crossed with recessive parent, called as test cross.

14. Back cross - Such type of cross in which F_1 generation is crossed with any one of two parents, called as back cross.

15. Reciprocal cross - Such type of cross in which 'A' plant (TT) is considered as male and ' B ' plant (t t) is considered as female and in another cross if 'A' plant (TT) is considered as female and 'B' plant (tt) is considered as male, called as reciprocal cross.

16. Parental generation - The plants which are crossed to obtain the offspring called as parental generation

17. Frist filial generation (F_1 generation) The affspring obtained from parents is called F_1 generation.

18. Second filial generation(F_2 generation) - The offspring obtained from F_1 generation is called F_2 generation.

19. Monohybrid ratio - The ratio obtained from monohybrid cross is called monohybrid ratio.

20. Dihybrid ratio - The ratio obtained from dihybrid cross is called dihybrid ratio.

3.4 Mendel's laws of inheritance

Mendel proposed some important laws through hybridization experiments on garden pea (*Pisum sativum*), Which are called **Mendel's laws of inheritance**. These laws are as follows-

1. Law of dominance
2. Law of segregation or Law of purity of gametes
3. Law of independent assortment

3.4.1 Law of dominance

This law is based on the results of Mendel's Monohybrid cross. According to this law, when a cross takes place in between homozygous contrasting plants, the character which express itself in F_1 generation is called **dominant** and the character which does not express itself in F_1 generation is called **recessive**.

Example – When a pure or homozygous tall (TT) plant is crossed with pure or homozygous dwarf (tt) plant then in F_1 generation all plants (100%) were tall (Tt).

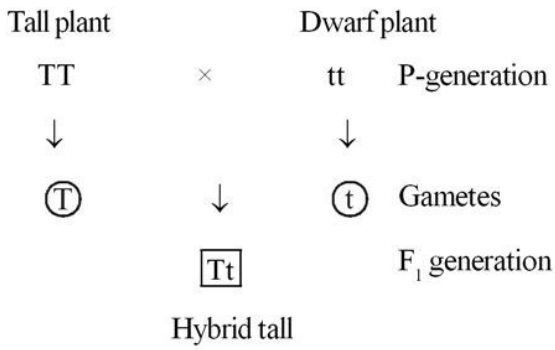


Fig. 3.2 Law of dominance

3.4.2 Law of segregation or Law of purity of gametes

This law is also based on results of Mendel's monohybrid cross. According to this law– During gamete formation from hybrid or heterzygous of F_1 generation, both alleles separte or segregate to each other, therefore, it is called as **law of segregation** and each gamete carries one allele for each character, therefore, it is also called as **law of purity of gametes**.
Example- If homozygous tall (TT) plant is crossed with homozygous dwarf (t t) plant then in F_1 generation all plants were hybrid or heterozygous tall (T t). In heterozygous condition, both alleles are not contaminated with one another, at the time of gamete formation both alleles segregate from each other and

enters in different gametes. Due to this segregation dwarfism (t t) character reappear again in F_2 generation phenotypic ratio obtained from F_2 generation is 3 : 1 and the genotypic ratio is 1 : 2 : 1.

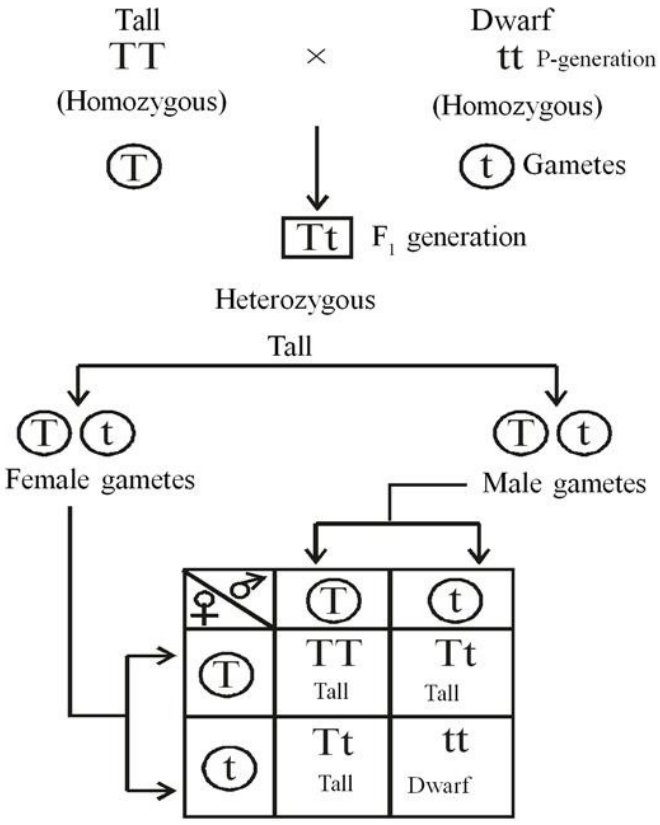


Fig. 3.3 Law of segregation

Phenotypic ratio – 3 Tall : 1 Dwarf

Genotypic ratio –

1 Homozygous Tall : 2 Heterozygous Tall : 1 Homozygous dwarf

1 (T T) : 2 (T t) : 1 (t t)

3.4.2.1 Back cross

If F_1 generation (T t) is crossed with any one parent T T or t t , then it is called as Back cross.

It is of two types -

1. **Out cross -** If F_1 generation (T t) is crossed with dominant parent (TT), called as **out cross**. The offspring obtained from this cross were all tall plants, out of these 50% were homozygons tall (TT) and 50% were heterozygons tall (Tt) plants.

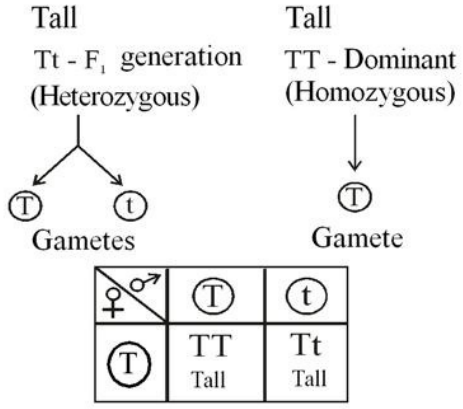


Fig. 3.4 Out cross

Phenotypic ratio – 100% Tall plants

Genotypic ratio – 1 : 1

50%TT : 50 % Tt

(Homozygous) (Heterozygous)

2. **Test Cross -** If F_1 generation (Tt) is crossed with recessive parent (tt), then it is called as **test cross**. The phenotypic and genotypic ratio of offspring obtained from this cross was same i.e. 1:1. 50% heterozygous tall (Tt) and 50% homozygous dwarf (tt) plants are obtained.

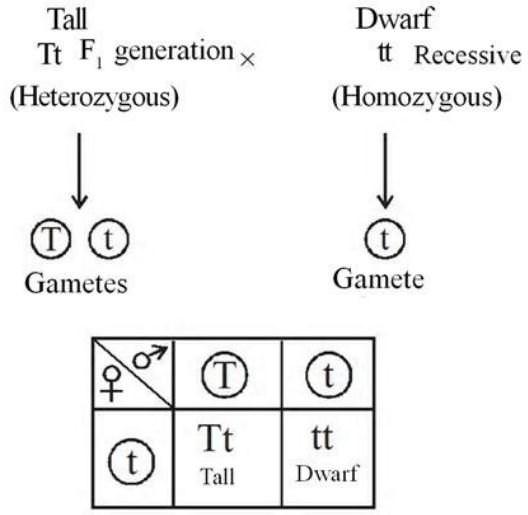


Fig 3.5 Test cross

Phenotypic ratio – 50% Tall : 50% Dwarf

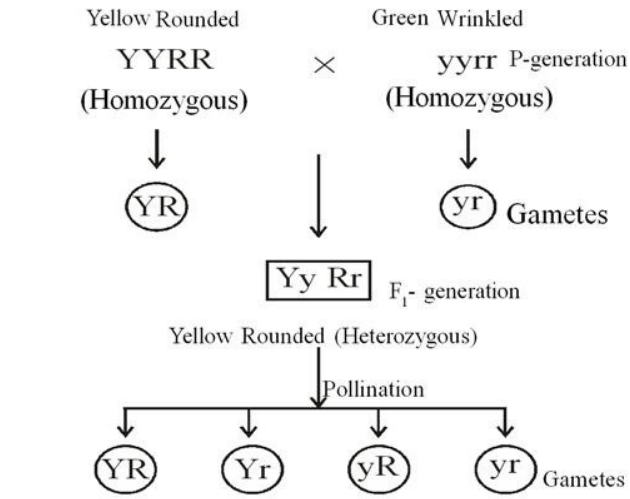
Genotypic ratio –

50% Heterozygous tall (Tt) : 50% Homogzygous dwarf (tt)

3.4.3 Law of independent assortment

This law is based on results of Mendel's dihybrid cross. According to this law-If two or more than two contrasting characters are considered then there is not any effect of inheritance of one character on the inheritance of another character or alleles of each character are not only separate but alleles of different characters behave independently or they assort independently, therefore, it is called as **Law of independent assortment**.

Example–If homozygous yellow round seeded (YYRR) plant is crossed with green wrinkled (yyrr) seeded plant then in F_1 generation all plants were yellow round seeded (YyRr).



♀ / ♂	YR	Yr	yR	yr
YR	YYRR Yellow Rounded	YYRr Yellow Rounded	YyRR Yellow Rounded	YyRr Yellow Rounded
Yr	YYRr Yellow Rounded	YYrr Yellow Wrinkled	YyRr Yellow Rounded	Yyrr Yellow Wrinkled
yR	YyRR Yellow Rounded	YyRr Yellow Rounded	yyRR Green Rounded	yyRr Green Rounded
yr	YyRr Yellow Rounded	Yyrr Yellow Wrinkled	yyRr Green Rounded	yyrr Green Wrinkled

Fig : 3.6 Law of independent assortment

Phonotypic and genotypic ratio of F_2 -generation obtained by self pollination in F_1 generation is 9 : 3 : 3 : 1 and 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1 respectively.

Phenotypic ratio :

9 : Yellow rounded

3 : Green rounded

3 : Yellow wrinkled

1 : Green wrinkled

Genotypic ratio

1	:	2	:	2	:	4	:	1	:
YYRR		YyRR		YYRr		YyRr		yyRR	

2	:	1	:	2	:	1
yyRr		YYrr		Yyrr		yyrr

3.5 Importance of Mendel's laws of inheritance

1. It is important to find dominant character in living organisms because many harmful and lethal recessive genes are not able to express themselves in the presence of dominant gene.

2. Gene concept was proved by mendel's law of segregation.

3. According to law of segregation one gene has two alleles and they control two contrasting characters.

4. With the help of Mendel's laws, we know about the new characters develop in hybrid off spring.

5. Useful characters can be brought into same species and harmful characters can be removed by the method of hybridisation.

6. With the help of Mendel's laws disease resistant and high yielding varieties of crop plants can be developed.

7. A branch of science **Eugenics** related with the improvement of human race is based on Mendel's laws.

Important Points

1. The term genetics was coined by Bateson.
2. Transmission of herditary characters from parents to offspring is called heredity.
3. The study of heredity and variation is called genetics.
4. Gregor Johann Mendel is called father of genetics.
5. Mendel performed hybridization experiments on garden pea (*Pisum sativum*), on the basis of results of these experiments, Mendel formulated the laws of inheritance, called as Mendelism.
6. Hugo de Vries, Carl Correns and Erich Von Tschermak rediscovered the Mendel's laws of segregation.
7. Mendel studied the inheritance of one character at a time.
8. When two alleles of a gene are similiar, they are called as homozygous and if they are dissimilar, then they are called as heterozygous.
9. Offspring obtained from parents is F_1 generation and obtained from F_2 generation is called generation.
10. A character which expresses itself in generation is called dominant and which does not express itself in generation is called recessive.
11. When generation is crossed with recessive then it is called as test cross.
12. When generation is crossed with any one of both the parents called as back cross.
13. According to Mendel's law of segregation or law of purity of gametes, at the time of gamete formation alleles segregate and each gamete carries one alleles for each character.
14. According to Mendel's law of independent assortment, two or more than two gene pairs behave independently of each other while living together.
15. According to Mendel, phenotypic ratio and genotypic ratio obtained from monohybrid cross is 3 : 1 and 1 : 2 : 1 respectively.
16. Phenotypic ratio obtained from generation of dihybrid cross is 9 : 3 : 3 : 1 and genotypic ratio is 1 : 2 : 2 : 4 : 1 : 2 : 1 : 2 : 1
17. Good characters of different genera can be brought in a single genus by **hybridization**.
18. With the help of mendel's laws disease resistant and high yielding varieties of crops can be developed.
19. Mendel's laws confirm the concept of gene.
20. A branch of science Eugenics related with the improvement of human race is based on Mendel's laws.

Practice questions

Objective type questions

1. Who coined the term genetics–
   (a) Mendel (b) Bateson
   (c) Morgan (d) Punnet
2. Experiments of Mendel were on–
   (a) Sweet pea (b) Wild pea
   (c) Garden pea (d) All of the above
3. Study of heredity and variation is called–
   (a) Genetics (b) Geology
   (c) Forestry (d)None of the above
4. Green colour of pea pod is which type of character–
   (a) Dominant (b) Recessive

(c) Incomplete dominance

(d) Codominance

5. Usually number of alleles of a gene are–

(a) Four (b) Three

(c) Two (d) One

6. Mendel selected how many pairs of contrasting characters for his experiments–

(a) 34 (b) 2

(b) 12 (d) 7

7. When F_1 generation is crossed with any one parent, then it is called as –

(a) Reciprocal cross (b) Test cross

(c) Back cross (d) All of the above

8. Ratio of offspring from $Tt \times tt$ cross is –

(a) 3 : 1 (b) 1 : 1

(c) 1 : 2 : 1 (d) 2 : 1

9. Which contrasting character was not selected by mondel for his experiments–

(a) Colour of root (b) Colour of flower

(c) Colour of seed (d) Colour of pod

10. How many types of genotypes formed in F_2 generation of monohybrid cross–

(a) 2 (b) 3

(c) 4 (d) 9

Very short type questions

11. Who is called father of genetics ?

12. Which plant was selected by Mendel for his experiments?

13. What is dominant character?

14. What is knows as the transmission of genetic characters from one generation to another generation?

15. Who rediscovered Mendel's laws?

16. What is the full name of Mendel?

17. Write the name of laws proposed by Mendel.

18. What is test cross?

19. What do you understand by out cross.

20. Which law of Mendel can not be explained by monohybrid cross?

Short type questions

21. Write the difference between phenotype and genotype.

22. Explain the dihybrid cross.

23. Write the reasons of successfulness of Mendel.

24. Why did Mendel select pea plant for his experiments?

25. Write a brief life introduction of the Mendel.

26. Explain the Mendel's law of dominance.

27. Write the importance of Mendel's laws of inheritance

Essay type questions

28. Explain the Mendel's law of segregation with example.

29. What is Mendelism? Explain law of independent assortment in detail.

30. Explain the Mendel's laws of inheritance.

Answer key

1. (b) 2. (c) 3. (a) 4. (a) 5. (c)
6. (d) 7. (c) 8. (b) 9. (a) 10. (b)

Chapter 4
Immunity and Blood Groups

Every day Human body encounters many pathogens, but it does not suffer from diseases very easily. Main reason for this is the presence of pathogen eradicating **resistance power (immunity)** in the body. Immunity could be innate or acquired. The study of all the reactions and related systems that work for the eradication of the pathogen from the body is called Immunology. A large number of cells, lymphatic or immunological organs (like Bone Marrow, Lymph nodes, Thymus, Liver etc.), Blood and Lymph are functional in this system. Two types of immunity works in the body-

A. Innate defense mechanism (innate immunity):

This is an inborn immune system which is also known as nonspecific or natural immunity. It is named as nonspecific because this defense mechanism does not provide specific immunity against a specific pathogen rather it employs a common mechanism against all the antigens. The following factors work for the innate immunity-

(1) Physical Barriers- like skin, cilia and flagella found on nasal cavity and other organs and mucous etc.

(2) Chemical Barriers-like acid found in the stomach, acidic environment of stomach and vagina, chemicals found on the skin, chemicals found in various body secretions like saliva, tears, sweat etc.

(3) Cellular Barriers- cells like Macrophage, Monocytes and Neutrophils which are active in phagocytic activities. Besides, cytotoxic cells like Natural Killer cells also works as cellular barriers.

(4) Fever, Inflammation etc.

B. Acquired defense mechanism (Adaptive immunity): This is also called as Adaptive or Specific immunity. In this type of immunity, the host specifically attacks on specific invader microorganisms or foreign objects. Antibodies are synthesized in this immunity. Antibodies so produced react specifically with the antigens. These reactions stimulate the Cell Mediated Immunity. As a result of all these, antigen is eliminated from the body. Specific immunity is of two types:

(1) Active Immunity-Immunity in which body itself synthesizes antibodies against antigen. This immunity works for that particular antigen against which antibodies are synthesized.

(2) Passive Immunity-Immunity in which specific external antibodies against a particular antigen are introduced in the body. In this immunity, antibodies are not produced by the body.For example - vaccines of Diphtheria and Tetanus.

4.1 Antigen and Antibody

Antigens (Ag) are those outer pathogen or substance which after entering in the body activates the B lymphocytic cell to differentiate in antibody secreting plasma cells. Antigens induce them to produce antibodies and specifically react with these antibodies.

Antibodies (Ab) are the proteins which are produced as a result of interaction of antigens with the B cells present in the body and can specifically get coupled with that particular antigen. This pairing is a fundamental requirement for the success of immune system and depends upon the structural uniqueness of the Antigen.

4.1.1 Antigen

Normally they are foreign pathogens or substances which have a molecular weight of 6000 Daltons or more. They can be of various chemical groups like proteins, polysaccharides, lipids or nucleic acids. Sometimes few body substances and body cells (like virus infected or cancerous cells) can also act as antigens. After entering inside the body, an Antigen first encounters the innate immune system. Afterwards this Antigen

activates the specific defense system.

Antigens couples with the specific antibodies and forms Antigen- Antibody complexes. Most chemicals other than proteins can interact with the antibodies but they are not very active in the antibody production.

The whole molecule of Antigen does not interact with the Antibody rather only a specific part of it can join with the Antibody molecule. This part of Antigen is called as **Antigenic Determinant or Epitope**. In proteins, a chain of 6-8 amino acids acts as Antigenic determinant. A protein can have many Antigenic determinants. The total number of epitope is called as **Valence of the Antigen**. Valence of most bacterial antigens is 100 or more.

The destruction of antigen by specific immunity is carried out in four steps.

1. Differentiation between self and foreign Antigen.
2. Plasma cell formation by the activated B cells. They are produced on the basis of the epitope(s) present on the foreign antigen.
3. Synthesis of specific Antibodies by the Plasma cells.
4. Destruction of the Antigen by Antigen (Ag) - Antibody (Ab) reactions and Cell Mediated Immunity.

4.1.2 Antibody

Antibodies are also called as Immunoglobulin's (Ig). They are Gamma Globulin (γ globulin) proteins which are synthesized by the Plasma cells and are found in the blood and other body fluids. Antibodies identify and interact with the antigen to make it ineffective. The portion of the antibody which interacts with the Antigen is called **Paratope**.

4.1.2.1 Structure of Antibody

Antibody has a shape similar to the Y alphabet of English. It is composed of four structural units. There are two heavy and large [H] and two light and small [L] polypeptide chains. One heavy and one light chain together forms HL dimer. Two such [HL] dimers together forms an Antibody. In other words an Antibody molecule is made up of two homogeneous halves. Both these halves are joined with each other through disulfide bonds. Each of the half is made up of one H and one L polypeptide chain. The H and L chain found in each of the halves are also joined with disulfide bonds. Each heavy chain is made up of 440 amino acids while each L chain is made up of 220 amino acids. The heavy chain is attached with a carbohydrate moiety. Each heavy and light chain can be divided into two parts - **(a)Variable Portion:** This portion reacts with the Antigen and is found onthe NH_2 end of the chain. This portion is also called Fab portion. **(b) Constant Portion:** This portion is situated at the COOH end of the chain and is also called as F_c portion. The point of origin of the Y structure of most of the Antibodies is flexible and is known as **Hinge region** (Figure 4.1). Being flexible this region permits the variable portion of the Antibody to adjust according to the size of the antigen and react with it.

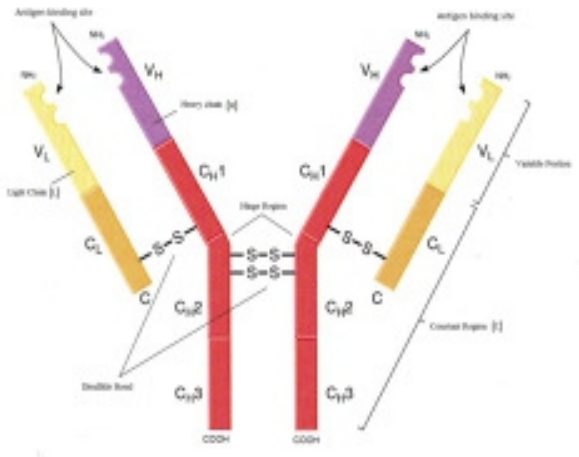


Figure 4.1: Structure of Antibody

4.1.2.2 Types of Antibodies

Five different types of heavy polypeptide chains are found among the Antibodies. They are denoted by Greek letters α (Alpha), γ (Gamma), (Delta), ε (Epsilon) and μ (mu). On the basis of the presence of heavy chain present, Antibodies can be divided into five types (Table 4.1). IgA has a dimeric structure while IgM has a pentameric structure. All the other antibodies

are monomeric. The main antibody of the body is IgG and is present in blood and other body fluids. IgG is the only antibody that can cross the placenta and reach to the embryo. Among all the antibodies found in the serum IgG has the highest concentration. IgM is the first Antibody which is produced in response to an Antigen.IgG is produced after the production of IgM. IgA is the only Antibody found in Mothers' milk. This Antibody is vital for the immunity of the new born baby. IgE Antibody primarily works on Basophil and Mast cells and participates in Allergic reactions.

S.No.	Type of Antibody	Present Heavy Polypeptide Chain
1.	IgG	γ (Gamma)
2.	IgM	μ (Mu)
3.	IgA	α (Alpha)
4.	IgE	ε (Epsilon)
5.	IgD	δ (Delta)

4.2 Blood and blood groups

Blood is a fluidic living tissue which is thick, sticky and red coloured and flows into the blood vessels. This is made up of Plasma (nonliving liquid medium) and Blood Corpuscles (living cells). Plasma functions to transports the nutrients absorbed by the intestine to various body organs and carry the harmful substances from different organs to the excretory organs. Three different types of blood corpuscles are found in the blood.

(1) Red Blood Corpuscles- Transports and exchange gases

(2) White Blood Corpuscles- Protects the body from pathogens

(3) Platelets - Protects the blood vessels and helps to prevent bleeding.

4.2.1 Blood Groups

Firstly, Karl Landsteiner, an Australian Scientist in 1901 classified the blood into different blood groups. On the basis of presence or absence of various Antigens on the surface of Red Blood Corpuscles, blood has been classified into various groups. Normally these Antigens can be proteins, glycoproteins, carbohydrates or glycolipids. These Antigens are synthesized from single allele or related gene which is inherited from both mother and father.

Two types of Antigens (Antigen 'A' and Antigen

Table 4.2 Various Blood Groups (ABO and Rh grouping)

S.No.	Blood Group	ABO Blood grouping		Rh Grouping	Antibody found in the Blood
		Antigens present on the surface of the RBC	Genotype of the Antigen	Rh Antigen present on the surface of the RBC	
1.	A^+	A	I^AI^A or I^Ai	Present	Anti B
2.	A^-	A	I^AI^A or I^Ai	Absent	Anti B
3.	B^+	B	I^BI^B or I^Bi	Present	Anti A
4.	B^-	B	I^BI^B or I^Bi	Absent	Anti A
5.	AB^+	A and B	I^AI^B	Present	Anti A and Anti B both absent
6.	AB^-	A and B	I^AI^B	Absent	Anti A and Anti B both absent
7.	O^+	None A and B	ii	Present	Anti A and Anti B both present
8.	O^-	None A and B	ii	Absent	Anti A and Anti B both present

'B') are found on the surface of the Red Blood Corpuscles. Based upon the presence of these two Antigens, four blood groups are found - A, B, AB, and O (Table 4.2). This classification is called **A B O blood grouping**. 'A' type blood has 'A' antigen on the surface of Red Blood Corpuscles while 'B' type blood has 'B' antigen on the surface of Red Blood Corpuscles. AB type blood has both 'A' and 'B' Antigens on the surface of Red Blood Corpuscles.Red Blood Corpuscles of 'O' type blood is devoid of both 'A' and 'B' Antigens (Table 4.2).

Apart from 'A' and 'B' Antigens, another Antigen named Rh can also be found on the surface of the Red Blood Corpuscles. If Rh antigen is present on the surface of the Red Blood Corpuscles, blood is called **Rh positive (Rh+)**. The blood in which Red Blood Corpuscles are devoid of Rh Antigen is called **Rh negative (Rh-)** (Table 4.2).This classification system is called as **Rh Grouping**.

Persons having 'A' type blood group have IgM type Anti B antibody in their body. In the same way Anti A Antibody is found in persons having type B blood and Anti A and Anti B antibodies in the blood of the persons with O blood group. The persons with AB blood group have neitherAnti AnorAnti B antibodies (Table 4.2). If a person with 'A' blood group is transfused with Type B blood, Anti B antibodies present in his blood will destroy the B type Red Blood Corpuscles. This is the case with every mismatch blood transfusion. Hence, before blood transfusion it should always be taken into consideration that the blood group of the donor and the recipient belongs to the same group. A person with 'O' type blood group is called **Universal Donor** while a person with 'AB' blood group is called **Universal recipient**. This means that a person with 'O' type blood can donate blood to all and person with 'AB' type of blood can accept blood from all.

4.3 Rh Factor

Rh (Rhesus) factor is a protein of about 417 amino acids. It was discovered in a spices of monkey named Macaca rhesus (*Macaca mullatta*). This protein is also found on the surface of the human Red Blood Corpuscles. About 85% of the human population in the world is Rh+ while the rest 15 % is Rh-.

Five different types of Rh factors - **Rh.D, Rh.E, Rh.e, Rh.C and Rh.c** are found in humans. The frequency of these Rh factors in human population is as follows: Rh.D (85%), Rh.E (30%), Rh.e (78%), Rh.C(80%) and Rh.c (80%). Among all the Rh factors, Rh. D is most important and predominantly immunogenic.

Not only the blood group but matching of the Rh factor is important for blood donation. Transfer of blood from Rh+ person to a Rh- person results in the development of IgG antibodies against in the reciepient. The IgG antibodies so produced works against the Rh factors. These antibodies destroy the Red Blood Corpuscles possessing the Rh factor by the process of **Agglutination**. Accumulation of large amount of harmful compound called **Bilirubin** in the blood. The excess amount of bilirubin cause impairment of liver and spleen functioning. This may lead to the failure of the kidney and can ultimately result in the death of the person. Here, this is to be noted that the Anti Rh Antibodies are not pre-synthesized rather they are produced after the first contact of Rh negative blood with Rh positive blood.

If during the pregnancy, mother is Rh negative and the foetus is Rh positive, special attention is required at the time of childbirth. During the first delivery, blood of the mother and the foetus mixes with each other. This leads to the production of Rh Antibodies in the mother. The first baby is born normal. The complicacy may arise during the second pregnancy, if this time too fetus is Rh negative. Through placenta, Rh Antibodies present in mother's blood mixes with the circulating foetal blood. Here they reacts with the Rh proteins present on the surface of the foetal

Red blood cells. These Antibodies destroys the Red blood corpuscles through Agglutination and leads to hemagglutination. This may even lead to the death of the foetus in the mother's womb. Even if the infant survives, he becomes very weak and generally suffers from hepatitis. This disease is called as **Erythroblastosis fetalis** (Figure 4.2). For the treatment of this disease, mother is vaccinated with anti IgG Antibodies (anti Rh.D) within 24 hours of the first delivery. These are called **RhogamAntibodies**. By destroying the fetal Rh positive blood cells present in themother's blood, these Antibodies inhibit the production of Anti Rh Antibodies in the mother. Many times,for the treatment of this disease, foetal blood is replaced by the process of transfusion.

Many times Rh incompatibility is the main cause of hemolysis due to blood transfusion.

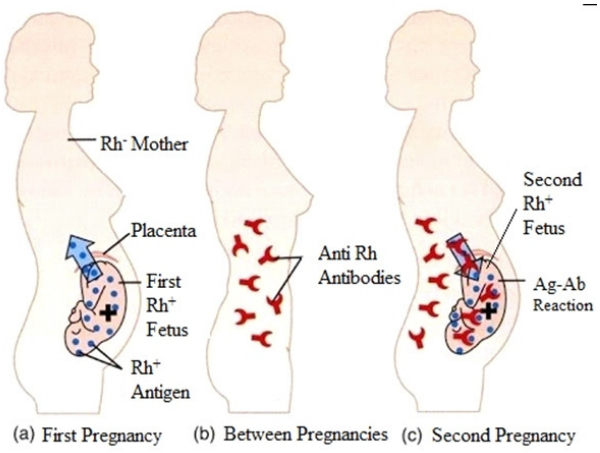


Figure 4.2: Erythroblastosis foetalis

4.4 Blood transfusion

This is a method in which blood or blood products like platelets, plasma, etc are transferred from the circulatory system of one person to another. Dr. Jean-Baptiste Denys, a French physician on 15 June 1667 carried out blood transfusion for the first time. He transfused blood in a 15-year old boy from a sheep. Although ten years later blood transfusion from animals to humans was prohibited.

4.4.1 Requirement for Blood transformation

Blood transfusion is absolutely necessary in the flowing situations-

1. At the time of injury or excessive bleeding
2. Serious blood deficiency
3. During Surgery
4. In the condition of deficiency of platelets in the blood
5. Patients of Hemophilia
6. Patients of Sickle Cell Anemia.

4.4.2 Process of Blood Transfusion

Blood Transfusion is a scientific process which is accomplished as follows-

(A) Blood Collection

(1) Before the process of blood collection, donor is examined medically.

(2) After medical examination, blood from the donor is collected in special sterilized pouches containing anticoagulants. Cannula of suitable capacity is used for blood collection.

(3) The collected blood is kept in a refrigerator. This prevents the bacterial growth and down regulates the cellular metabolism in the blood.

(4) The stored blood is subjected to different tests like Blood group, Rh factor, Hepatitis B, Hepatitis C, HIV etc.

(5) After blood collection, the donor is kept under medical surveillance for some time so that the treatment of any repercussion,if arises due to blood donation,could be treated. (Normally no unusual reaction takes place in the body after blood donation). In humans, plasma is replenished in 2-3 days after the blood donation while after 36 days, blood cells are restored in the blood circulation.

(B) Transfusion

(1) Prior to transfusion, the patient's blood is matched with the blood of the donor (ABO, Rh etc). Transfusion can only be carried out after this process.

(2) The collected blood is brought out of the storage area just 30 minutes before the start of the transfusion process.

(3) Blood is transfused only through intravenous mode. This is a four hour long procedure which is mediated by the help of a cannula.

(4) Medicines are given by the doctor to prevent the transfusion related reactions like fever, chill, pain, cyanosis, irregularity of the heart beat and others.

On the basis of source of blood, transfusion can be of two types-

(1) Allogenic transfusion - Such a Transfusion in which blood collected from other persons is used.

(2) Autogenic transfusion - Such a Transfusion in which blood collected from the person itself is used.

After processing the donated blood can also be segregated into various components like Red Blood Cells, Plasma and Platelets. These components are then stored in refrigerated conditions. In addition to humans, blood transfusion can be carried out in animals also.

4.4.3 Precautions to be taken during Blood Transfusion

1. Matching ABO Antigen in the blood of the patient and the donor.
2. Testing donor's blood for the absence of any pathogen or harmful substance.
3. Matching the Rh factor (especially Rh.D.) in the blood of the donor and the patient.
4. Storage of the collected blood in refrigerated conditions (after completing the desired processes).
5. In every circumstance, protecting the collected blood from contamination.
6. Blood collection and transfusion must essentially be carried out in the presence of a physician.

The following diseases or infections can occur due to the carelessness observed during the transfusion (i) Infection of HIV-1 and HIV-2 (HIV-Human Immuno deficiency Virus) (ii) Infection of HTLV 1 and HTLV-2 (HTLV - Human T-Lymphotropic Virus) (iii) Hepatitis -B and Hepatitis C infection. (iv) Creutzfeldt-Jacob disease etc.

4.5 Significance of blood group heredity

Many different blood types are found in humans. They are addressed as ABO blood group system. The control of expression of the blood group depends on the coordination of three alleles. All these allelesare part of the same gene and are represented by IA, IB and I^O or *i*. The Antigen A and Antigen B found on the surface of the Red Blood Corpuscles are produced by allele I^A and I^B respectively. The I^O and *i* alleles are recessive and are not involved in the production of any blood Antigen.

The expression of blood group in a person is dependent on the interaction between any two alleles. Based on the presence of type of alleles, six gene formats of the blood are found in humans (Table 4.3). O -Blood group is a result of homozygous recessive gene interaction. These genes show Mendelain inheritance.

Table 4.3 Genotype of Blood Groups

S.No.	Blood type	Genotype
1.	A	$I^A I^A$
		I^A i
2.	B	$I^B I^B$
		I^B i
3.	AB	$I^A I^B$
4.	O	i i

There are many applications of Blood Group inheritance. It is mostly used to &solve the paternal disputes, in carrying out successful blood transfusions, in the treatment of neonatal blood hemolysis and hereditary disorders like hemophilia etc. The use of blood group inheritance in the solution of paternity related disputes can be understood through the following example :- let's assume that two couple are claiming for a child whose blood group is B. The male of one of the couple has O (*ii*) blood group and the female has AB (I^AI^B) blood group. The male in second couple has A (I^AI^A) and female has B (I^A i) blood group.

In these conditions, as per the Mendels' law of inheritance, the child can have the flowing possible blood groups (Figure 4.3).

It is clear from the figure 4.3 that it is the couple one who could produce a baby of B blood group and they are the actual parents of this child.

In the similar way knowledge of genetic inheritance is very important for successful blood transfusion and the treatment of the hereditary diseases.

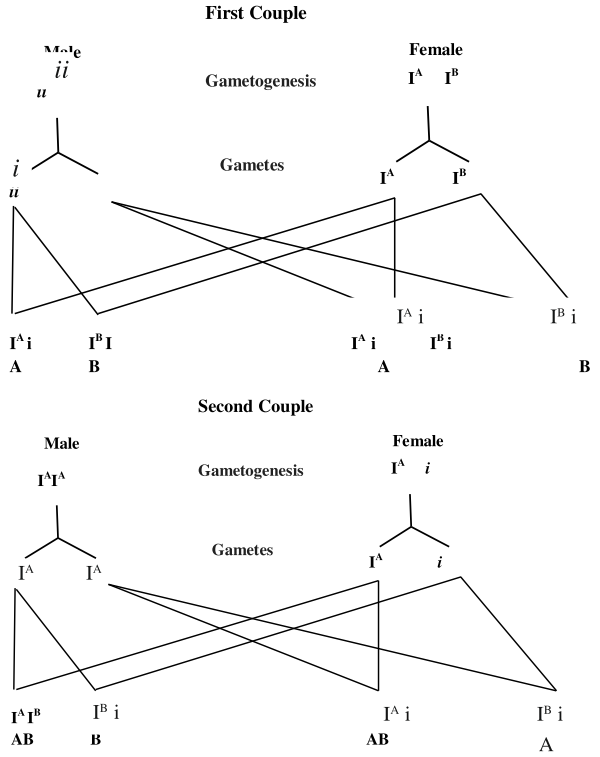


Figure 4.3 Determination of Paternity by Blood group inheritance

4.6 Organ donation and body donation

Donation of a tissue or an organ to another person by a living or dead person is called **Organ Donation**. The organ donated by the donor is implanted in the recipient's body. In this way the life of the recipient can, not only be saved, but he can enjoy a happy life too. Organ donations are generally carried out only after the donor's death. About 50 needy people can be helped from an inanimate body. Hence body donation is very important for organ donation. A child to ninety years old veteran can donate their organs and body.

4.6.1 Importance of organ and body donation

The human body is the masterpiece of nature and in no case it can remain permanent. It is said in the Indian philosophy that the human body is made of - air, water, soil, fire and sky and after death it gets fused in these elements only. Now the question arises that whether there exists any process that can keep our body alive for a long time? It has also been said that "A dead animal fulfills hundreds of human work, but dead human is no use for any one" (*PASHU MARE MANUJ KE SOO KAAM SANWARE, MANUJ MARE KISI KE KAAM NAN AAVE*). Hence, it has become the need of the time that even after death;humans can be used for the welfare of living beings. This can be possible when after death we could remain alive in others. After our death, donation of our eyes, kidneys, liver and other organs could bring happiness in the life of a needy person. This type of donation is categorized as Pure Donation. The donation of this category is considered as the best and most holy charity in our Indian philosophy. From the eternal ages, organ donation and body donation were considered as the work of great virtue by our spiritual teachers. In ancient times, saint Dadhichi donated his bones for the benefit of the society.

There is a need to donate nearly two lakh kidneys every year in India, while availability is only 7000 to 8000 per year. Similarly, every year around 50,000 people live in the hope of heart transplantation but availability of heart in India is only 10 to 15. In India, about 50,000 livers are required every year for transplantation, in India, but only 700 people gets this opportunity. More or less the same condition persists with all the other organs. According to an estimate, every year about five lakh people in India die due to the organ failure and lack of organs for transplantation.

Like organ donation, body donation is such a charity which is absolutely essential for the society. Organ donation is essential for two major reasons: (a) The organs can be obtained from the dead body and

transplanted to the needy. Often, the organ donation is carried out from a brain of dead person. In such cases, the brain of the concerned person ceases to function, but other parts of the body remains functional. Organs like heart, liver, kidney and others can be obtained from these dead persons and can be implanted in the needy individuals. However, statistics show that only one person out of a thousand dies in such a way (brain dead). Within six to eight hours of death, the body can be used for eye donation. (b) To become a best doctor, the medical students need to get training on the dead bodies. Only after the training cum experimental work on dead bodies, medical students can better understand the human body. Thus, organ donation by human beings has become very important these days. It is the ultimate utility of the human body. The donors of such a body can become free from their family relations and socio-religious bondages. They act as inscription for the society.

It is a matter of great disappointment that due to ancient conservative beliefs, the number of organ donors in India is 0.8 per ten lakhs individuals, whereas in developed countries it is 10 to 30. In such a situation, we must realize and understand the importance of organ donation and body donation and help those whose life is very annoying in the absence of some organ. We should come forward for this noble cause and motivate society for this virtuous human work. We should seek help from saints, teachers, intellectuals and others prominent persons of the society to overcome the superstitions prevailing in the society and to educate people for this sacred task with an ultimate aim of providing benefit to the needy people. For this purpose, the Government of India, every year, celebrates August 13 as the Organ donation day.

Many eminent persons of the society have came forward for this noble act. Captain Lakshmi Sehgal (who was involved in the freedom fight with Netaji Subhash Chand Bose) donated cornea at the age of ninety years and filled light in the life of two people. Recently, as per his wish, the family members of the famous author Dr. Vishnu Prabhakar donated his body after his death. The bodies of the former Chief Minister of West Bengal, Shri Jyoti Basu, the renowned social worker Shri Nana Deshmukh and some other eminent persons were also donated after their death as per their wish. Sadhvi Ritambhara and cricketer Gautam Gambhir have also announced to donate their bodies after death. Such persons are real saints in true sense and are flag bearers of this revolutionary idea.

All of us should realize our duty to donate blood, organs and body after death, so that by this sanctified work our needy brothers and sisters can live a comfortable and graceful life.

4.6.2 Who can do Organ and Body donation

Any person regardless of religion, race or gender can donate his organ and body. Persons less than 18 years of age essentially require the consent of their parents or legal guardians. The donor should provide written consent in the presence of two witnesses during his lifetime.

If it has not been done before death, then the right of organ and body donation lies with the person who has the legitimate authority of the body. Organ and body donation in India is legally valid.

Important Points

1. There are two types of immune system in the body - Natural and Acquired.
2. Antigen is an external pathogen that induces antibody production.
3. Antibody is a specific gamma globulin protein that can combine with antigens. They are formed by plasma cells.
4. Antibodies have two heavy and two light glycoprotein chains.
5. Antibodies are of five types -IgA, IgD, IgE, IgG and IgM.
6. Three types of corpuscles-Red blood corpuscles, white blood corpuscles and platelet are found in the blood.

7. On the basis of antigens found on the surface of the red blood cells, human blood is divided into A, B, AB and O types.
8. Person with AB+ blood group can accept blood from all, while person with O+ blood group can donate blood to all.
9. On the basis of the presence or absence of Rh factor on red blood cells, blood is of two types: Rh positive and Rh negative.
10. Five types of Rh factors are found in humans. Rh.D. is most prominent among them.
11. Blood transfusion is a process by which blood or blood based products like plasma, platelet etc. are transferred from the circulatory system of one person to the circulatory system of other.
12. The donated blood after rigorous processing can be separated into different components like red blood cells, plasma, platelet etc.
13. The control of the Blood group depends upon themutual interaction of the three alleles (I^A, I^B and I^A or *i*).
14. In humans, on the basis of the presence of alleles, blood is of the following types -A, B, AB and O.
15. There are many applications of Blood group heredity such as - Solution of paternal disputes, carrying out successful blood transfusions, the treatment of neonatal blood hemolysis and treatment of hereditary disorders like hemophilia etc.
16. The donation of a tissue or organ by any living or dead person to someone in need is called organ donation.
17. Donation of one's body for organ transplantation and medical training is called as body donation.
18. Organ and body donation is of absolute necessity and importance for the betterment of human society.
19. Every year, 13 August is celebrated as Organ donation day in India.
20. Organ and Body donation is legally valid in India.

Practice questions

Objective type questions

1. Cells used in the immune system are not found in ……..
   (a) Bone Marrow (b) Liver
   (c) Stomach (d) Lymph Nodes
2. The plasma cell is the transformed form of which of the following cells?
   (a) B Lymphocyte Cell (b) T Lymphocyte Cell
   (c) Neutrophil (d) Both (a) and (c)
3. Antigenic determinants are found in which of the following?
   (a) Antigen (b) IgG Antibody
   (c) IgM Antibody (d) Plasma cells
4. The first Antibody produced is?
   (a) IgG (b) IgM
   (c) IgD (d) IgE
5. Which antibody is found in mother's milk?
   (a) IgG (b) IgM
   (c) IgD (d) IgA
6. Which of the following cells is not found in the blood?
   (a) Red blood cells (b) White blood cells
   (c) B Lymphocytic cells (d) Epithelial cells
7. Who classified blood in different groups?
   (a) Louis Pasteur (b) Karl Landsteiner
   (c) Robert Koch (d) Edward Jenner
8. Universal donor blood group is
   (a) A (b) AB
   (c) O (d) B
9. Major reason for Erythroblastosis foetalisis
   (a) Blood Transfusion in children
   (b) Rh Incompatibility
   (c) ABO Incompatibility
   (d) Both (a) and (c)

10. Which of the following is used in Allogeneic Transfusion?
(a) The stored blood collected from the person himself
(b) The stored blood collected from some other person
(c) The stored blood collected from sheep
(d) Both (a) and (b)

11. Which of the diseases do not occur due to the carelessness observed during blood transfusion?
(a) Hepatitis B
(b) Malaria
(c) Blood Hemolysis
(d) Creutzfeldt-Jakob disease

12. Which of the following blood group results from homozygous recessive gene interaction?
(a) 'A' Blood Group (b) 'B' Blood Group
(c) 'O' Blood Group (d) 'AB' Blood Group

13. Which among the following is not an application of Blood Group inheritance?
(a) Treatment of Hemophilia
(b) Treatment of Malaria
(c) Treatment of Dengue
(d) Both (b) and (c)

14. Which day is celebrated as Organ Donation Day in India?
(a) 13th September (b) 13th August
(c) 13th May (d) 13th June

15. The number of organ donorsin India (per ten lakh) is
(a) 0.1 (b) 2.0
(c) 0.8 (d) 1.8

Very short type questions

16. How many different types of defense mechanisms are found in humans?
17. How many different types of Antibodies are found in Humans?
18. What should be the minimum molecular weight of an antigen?
19. Which type of proteins are Antibodies?
20. Which antibody can cross placenta to reach the embryo?
21. Write the name of the antibody found on the surface of the mast cell.
22. Which cells found in the blood are involved in gaseous exchanges?
23. Which scientist classified the Blood?
24. Which blood group is universal blood donor?
25. Which blood group contains both A and B antigens?
26. What is the percentage of Rh positive persons in the world?
27. Which Rh factor is most important?
28. Who was the first person to perform blood transfusion?
29. What do you mean by Allogeneic Transfusion?
30. Write down the name of the alleles which controls the blood groups.
31. When does Organ Donation Day celebrated in India?
32. Write the name of two persons who have recently donated their body.

Short type questions

33. Define antibodies.
34. What are antigenic determinant?
35. What is the function of Hinge in an Antibody?
36. What is blood?
37. Explain ABO blood grouping.
38. What is Rh factor? Explain its significance.
39. What is blood donation? Explain.
40. Write precautions to be observed during the blood donation.
41. Explain the need of Organ donation.
42. Explain the gene type's responsible for ABO lood groups.

Essay type questions

43. Explain structure of antibodies.
44. Explain Erythroblastosis fetalis.

45. How does the process of blood transfusion carried out?
46. What is organ donation? Explain its importance.
47. Explain the importance of blood group hereditary.

Answer key

1	(c)	2	(a)	3	(a)
4	(b)	5	(d)	6	(d)
7	(b)	8	(c)	9	(b)
10	(a)	11	(b)	12	(c)
13	(d)	14	(b)	15	(c)

Chapter - 5

Chemistry in Everyday Life

We see that chemicals are used in each field of life, even all our bioactivities are operated by chemicals soap, detergent, beautiful clothes, various things of household consumption are chemical substances. Cement in making buildings, electrical apparatus, satellites, from motor vehical upto agricultural field, everywhere chemicals are used and theories of Chemistry are used. We use medicines when we fall ill, that is also chemical. Many types of sour-sweet substances, food preservatives are all chemical mixtures. Hence, it is true that daily life can not be imagined without chemicals.

5.1 Acid, base and salt

Sour and bitter taste of food is due to acid and base present in it. In nature, acid, base and salt all these three are found in general form.

Acid- Acids are sour in taste. Acid word is made from latin word **Acidus** which means sour. It is found as acetic acid in vinegar, tartaric acid in tamarind, ascorbic acid in orange, formic acid in sting of red ant, hydrochloric acid in digestive juice etc. The primary property of it is that is turns blue litmus paper into red.

Base- It is bitter in taste and turns red litmus into blue. They show soap like behaviour when touched, like sodium hydroxide , (NaOH) potassium hydroxide (KOH), aluminium hydroxide [$Al(OH)_3$], ammonium hydroxide (NH_4OH) etc. They have ability to neutralise acids and are soluble in water.

Acid and base are soluble in water if quantity of water is more in them, then these are called dilute and if quantity of acid or base is more than water then solution is called concentrated.

Salt- salt and water are formed by the reaction of acid and base.

$$\text{Acid} + \text{base} \rightarrow \text{salt} + \text{water}$$

$$HCl + NaOH \rightarrow NaCl + H_2O$$

This reaction is also called neutralization reaction and is a type of exothermic reaction.Salt formed by strong acid and strong base is neutral. Salts formed by strong acid and weak base are acidic and salts formed by weak acid and strong base are basic.

$$HCl + NH_4OH \rightarrow \underset{\text{acidic salt}}{NH_4Cl} + H_2O$$

$$CH_3COOH + NaOH \rightarrow \underset{\text{basic salt}}{CH_3COONa} + HCl$$

Salts have high melting and boiling point. These are generally found in crystal form. In crystal, crystalline water is also present with these. In writing, unit formula of salt, fixed number of water molecules attached are called crystalline water

Eg. $Na_2CO_3.10H_2O$

Here, 10 water molecules are in crystalline form in sodium carbonate salt.

Eg.

$$CaSO_4.2H_2O,\ K_2SO_4.Al_2(SO_4)_3.24H_2O$$

(Gypsum) (Alum)

5.1.1 Definitions : Many scientists gave many definitions of acid and base.

5.1.1.1 Arrhenius theory : Definition of acid and base was at first given by Arrhenius in 1887. **Those substances which give hydrogen ion (H^+) when decompose in water are called acids and those substances that decompose in water and give hydroxyl ion (OH^-) are called bases.**

examples of acid →

$$HCl_{(aq)} \rightarrow H^+_{(aq)} + Cl^-_{(aq)}$$

Hydrochloric acid

$$HNO_{3\,(aq)} \rightarrow H^+_{(aq)} + NO^-_{3(aq)}$$

Nitric acid

$H_2SO_{4\ (aq)} \rightarrow 2H^+_{(aq)} + SO^{-2}_{4\ (aq)}$

Sulphuric acid

$CH_3COOH \rightarrow H^+_{(aq)} + CH_3COO_{(aq)}$

Acetic acid

$H_2CO_3 \rightarrow H^+_{(aq)} + HCO^-_{3(aq)}$

Carbonic acid

All these are acid because they give H^+ ions in aqueous solution. Here free proton which means hydrogen ion (H^+) is the most reactive, so it reacts with water and remains in form of hydronium ion $H_3O^+_{(aq)}$

$$H^+ + H_2O \rightarrow H_3O^+_{(aq)}$$

Some acids gets completely ionized in aqueous solution, these are called **strong acids**. Eg- HCl, H_2SO_4, HNO_3 etc. Some acids do not completely ionise in aqueous solution and remains in un-dissociated form also. These are called **weak acids.**

Eg- CH_3COOH, H_2CO_3 etc.

Examples of base

$KOH_{(aq)} \rightarrow K^+_{(aq)} + OH^-_{(aq)}$

Potassium Hydroxide

$NaOH \rightarrow Na^+_{(aq)} + OH^-_{(aq)}$

Sodium hydroxide

$Ca(OH)_2 \rightarrow Ca^{+2}_{(aq)} + 2OH^-_{(aq)}$

Calcium hydroxide

$NH_4OH \rightarrow NH^+_{4(aq)} + OH^-_{(aq)}$

Ammonium Hydroxide

All these are bases because they give hydroxyl ion (OH^-) in aqueous solution. Those base which get completely ionized in aqueous solution are called **strong bases.** Eg- KOH, NaOH etc. The base which do not ionize completely are called **weak bases**.

Eg.- NH_4OH, $Mg(OH)_2$ etc. According to Arrhenius, when acid and base react, then H^+ and OH^- ions mutually combine to form water, this reaction is called neutralization. Energy is released in this reaction, so it is called exothermic reaction.

$$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O$$

Arrehenius theory was useful for those acids and bases which have H^+ and OH^- ions respectively but nature of acids without H^+ ions and bases without OH^- can not be determined, then a new theory was given.

5.1.1.2 Bronsted Lowry concept of acids and bases

This definition of acids and bases was given by Danish chemist Johannes N. Bronsted (1874-1936) and British chemist Thomas M. Lowry (1874-1936). According to Bronsted-Lowry, ''**Acids are proton donors and base are proton acceptor**''. Here they gave concept of conjugate acids and conjugate base.

HA + B	→	A^- +	HB^+
Acid Base		Conjugate base	Conjugate acid

$(HA\text{-}A^-)$ is called acid-conjugate base pair and $(B\text{-}HB^+)$ is called base-conjugate acid pair.

Eg-

$$H_2O + NH_3 \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$$

Here water is proton donor so it is acid. It gives proton and changes into corresponding base (OH^-) called conjugate base. Ammonia (NH_3) is proton acceptor, so it is base and it accepts proton and changes into ammonium ion (NH_4^+) which is called conjugate acid. These (NH_4^+-NH_3) and (H_2O-OH^-) are called conjugate acid-base pair. These are formed due to presence of a proton or H^+ ion only. Another example is

$$HCl_{(aq)} + H_2O \rightleftharpoons Cl^-_{(aq)} + H_3O^+_{(aq)}$$

These theories do not explain anything about aprotic acids and bases like CO_2, SO_2, BF_3 etc. so the new theory of acid-base was given on the bases of

tron.

5.1.1.3 Lewis concept of acids and bases

In 1923, **Lewis** gave a new theory According to it, **Acids are substances which accept electron pair and base are substances that donates electron pair.** Thus, electron pair acceptor are acids and electron pair donors are bases.

Eg. $BF_3 + :NH_3 \rightarrow F_3B \leftarrow :NH_3$

Acid Base

According to it, Lewis base give electron and lewis acid accept electron to form compound, where both are attached by co-ordinate bond.

According to this theory, electron deficient compound will work like acids and are called lewis acids.

Generally, cations or those compounds whose octet is incomplete are lewis acids.

Eg. $BF_3, AlCl_3, Mg^{2+}, Na^+$ etc

Electron rich or compounds having electron lone pair work as base, are called lewis bases.

Eg. $H_2\ddot{O}, \ddot{N}H_3, OH^-, Cl^-$

In this way, not only H^+ or OH^- containing substances are acids and bases. According to these theories, acidic and basic properties of compounds without hydrogen can also be explained.

5.1.2 General Properties

1. Acid turn blue litmus into red and base turn red litmus into blue.
2. Acids react with metal and produce hydrogen gas.

$$Acid + Metal \rightarrow salt + H_2$$

$$H_2SO_4 + \underset{(Zinc)}{Zn} \rightarrow ZnSO_4 + H_2 \uparrow$$

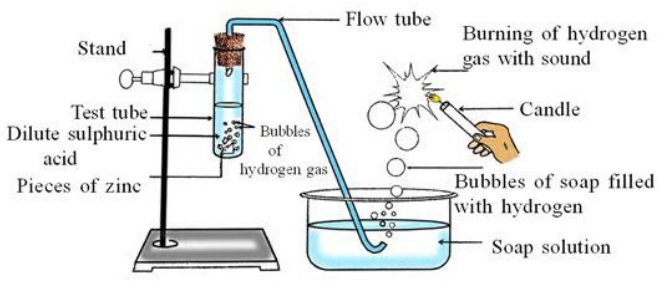


Fig. 5.1 Reaction of metal with acid

This is the reason that sour acidic substances are not kept in metal containers. Zn metal reacts with base NaOH and form salt and hydrogen gas.

$$2NaOH + Zn \rightarrow \underset{sodium\ zincate}{Na_2ZnO_2} + H_2 \uparrow$$

But not all metals on reaction with bases gives H_2 gas.

3. Acid react with metal oxides to gives salt and water.

Metal oxide + acid $\rightarrow$ salt + water

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

Metal oxides react with acid and form salt and water These salts are basic (alkaline) in nature. Non- metallic oxides react with base to form salt and water. These salts are acidic in nature.

Non-metalic oxide + Base $\rightarrow$ salt + water

$$CO_2 + Ca(OH_2) \rightarrow CaCO_3 + H_2O$$

4. Aqueous solution of all acids and bases ae conductors of electricity. These are used as electrolytes.
5. All acids react with bases and loose their properties and become neutral. This reaction is called neutralization.

Acid + Base $\rightarrow$ salt + water

HCl + NaOH $\rightarrow$ NaCl + H_2O

5.1.3 Uses- There are so many uses of acids, bases and salts in our daily life. H_2SO_4, HCl, HNO_3 are also called mineral acids, whereas acids found in natural form in plants and animals are called carbonic organic acids like citric acid, tartaric acid, acetic acid, lactic acid etc. Mineral acids are used in various industries like medicines, paint, fertilizers etc. Hydrochloric acid is used in different industries, in cleaning boiler from inside and in cleaning sink and sanitary specially. Nitric acid is used in making fertilizers and in cleaning gold and silver ornaments. On mixing one part of HNO_3 and three parts of HCl, aqua regia is formed which is very important compound. It can also dissolve metals like gold. Sulphuric acid is used in cells, car batteries and other industries. Sulphuric acid is also called king of acids. Industrial developent rate of any country is measured by consumption of sulphuric acids in different industries. Apart from it, many organic acids like acetic acid is used as vinegar in food products,

preservation of pickle. and also used in cleaning of wood furnitures.

Bases are also used mainly in the industries Sodium hydroxide is used in soap, detergent, paper industries, cloth industries etc. Calcium hydroxide is used to remove acidity of soil. White wash or $Ca(OH)_2$ i.e. lime is a component of insecticide Magnesium hydroxide $[Mg(OH)_2]$ is also called milk of magnesia. It is used as antacid for in removing acidity and constipation of stomach.

There are many uses of salts in daily life, like calcium carbonate $(CaCO_3)$ is used in making floor as marble, in extraction of iron in metallurgy, in making cement etc. We will study uses of washing soda, sodium hydrogen carbonate, sodium chloride in next sections. Silver nitrate $(AgNO_3)$ is mainly used in photography, ammonium nitrate is used in making fertilizers and explosives, alum (phitkari) $(K_2SO_4.Al_2(SO_4)_3.24H_2O)$ is used in the purification of water. In this way there are many salts which are very useful in daily life.

5.2 pH scale

The thermometer is used in measuring the temperature and in similar way pH scale is used in measuring strength of acids and bases.This scale measures concentration of hydrogen ions present in any solution. Here P is taken from a German word potenz i.e. power indicater and H indicates hydrogen ions.

In 1909, **Scientist Sorenson** made pH scale and called exponent of concentration of hydrogen ions as pH. That means, **negative logarithm of concentration of hydrogen ions is called pH.**

$$pH = -\log_{10}[H^+]$$

As free H^+ ions are not present in solution, they combine with water and form hydronium ion $[H_3O^+]$ so value of pH is also

$$pH = -\log_{10}[H_3O^+]$$

More will be the concentration of $[H^+]$ions, less will be the value of pH. The value of pH for neutral solution is 7. For neutral water, concentration of $[H^+]$ and $[OH^-]$ ions is 1×10^{-7} mol/litre so its pH

$$pH=-\log[1\times10^{-7}]$$
$$pH=7\log_{10} \qquad (\log_{10}=1)$$
$$pH=7$$

pH less than 7 = acidic solution

pH 7 = neutral solution

pH from 7 to 14 = basic solution

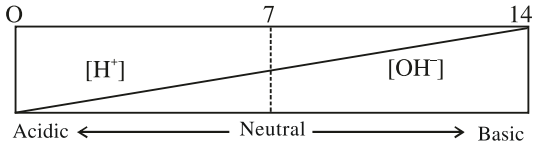
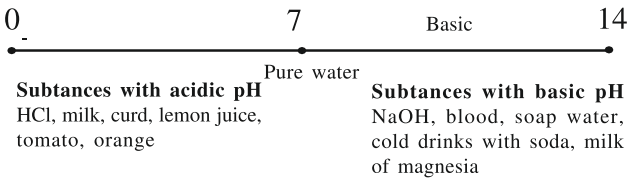


Fig. 5.2 pH Scale

Strength of acid and base depends on concentration of H^+ and OH^- ions in solution. More concentration of H^+ inos show strong acid and more concen tration of OH^- ions show strong base.

pH range of some special solutions



5.3 Importance of pH in daily life - With the knowledge of acidity and basicity, we can face many problems of daily life successfully like as

1. Acidity in stomach - In this problem, stomach faces pain and irritation In this gastric juice having more amount of hydrochloric acid is formed in our stomach which causes pain and burning sense. To get rid of it, antacid which means weak bases like $[Mg(OH)_2]$ milk of magnesia are used. It neutralizes excess amount of acid in our stomach.

2. Tooth decay - Generally pH of mouth is almost 6.5. Bacteria present in the mouth reduce pH of mouth when they react with food remains in teeth by producing acid. Tooth enamel decay when pH value becomes

lower than 5.5 So after eating food, teeth should be cleaned by tooth paste or alkaline solution so that tooth decay can be controlled.

3. Stung of insects - Honey-bee, ant etc insects which have stings when bite us they release acid which comes in contact of our skin. Due to this acid, skin feel pain and burning sense. If at that time alkaline salts like sodium hydrogen carbonate ($NaHCO_3$) are used at that place, then effect of acid will get neutralized.

4. Acid rain- Rain water is considered pure but due to pollutents, its pH is lowering these days. This type of rain is called acid rain. This rain water affects river and soil also. In this way, crop, animal and even whole ecological system is affected. On controlling pollutents, acidic rain can be controlled.

5. pH of soil- By determining the pH of soil, the crops that can be sown in soil can be selected and use of proper fertilizer can also be determined so that good crop is obtained.

5.4. Some useful compounds in everyday life

5.4.1 Sodium chloride (NaCl) :-It is called common salt. It is salt of strong acid and strong base and its pH is 7. Due to 7 pH, its nature is neutral. Industrially, sodium chloride is prepared by drying salty water or ocean water. Salt formed in this way contains many impurities like magnesium chloride ($MgCl_2$), calcium chloride ($CaCl_2$). To obtain it in pure form, hydrogen chloride (HCl) gas is made to flow in large tanks of saturated NaCl solution. In this way, salt (NaCl) is precipitized. Pure precipitized NaCl is then collected.

Properties -

1. It is white solid substance.
2. Its melting point is high 1081 K.
3. It is highly soluble in water.
4. It gets ionised in aqueous solution.

Uses -

1. It is used in food as common salt.
2. It is used in food as preservatives.
3. Freezing mixture is prepared by this.
4. NaOH, Na_2CO_3,$NaHCO_3$, Bleaching powder etc. are formed by using it.

5.4.2 Sodium Hydroxide (NaOH) - It is also called castic soda. Industrially, sodium hydroxide is produced by the electrolysis of sodium chloride. In it, chlorine gas is formed at anode and hydrogen gas at cathode. Sodium hydroxide is obtained in form of solution.

$$2NaCl_{(aq.)} + 2H_2O \rightarrow 2NaOH_{(aq)} + Cl_{2(aq)} + H_{2(g)}$$

Properties -

1. It is a white sleek substance.
2. Its melting point is 591 K.
3. It easily get dissolved in water.
4. It is strong base. In aqueous solution, it remains in ionized form ($Na^+_{(aq)} + OH^-_{(aq)}$) so , it is also strong electrolyte.
5. Its crystals are hygroscopic.

Uses -

1. It is used in making soap, paper, silk industries and other chemicals.
2. It is used in metallurgy of Bauxite.
3. It is used in purification of petroleum.
4. It is used in formation of fats and oils.
5. It is used as laboratory reagent.

5.4.3 Bleaching powder ($CaOCl_2$) - Its chemical name is calcium oxy chloride. It is produced by passing chlorine gas in dry slaked line.

$$Ca(OH_2) + Cl_2 \rightarrow CaOCl_2 + H_2O$$

Calcium Hydroxide

Properties -

1. It is yellow solid substance with sharp smell.
2. It is soluble in cold water.
3. It gives chlorine gas when kept open in air.
4. It gives chlorine gas on reacting with dilute acids.

$$CaOCl_2 + H_2SO_4 \rightarrow CaSO_4 + H_2O + Cl_2 \uparrow$$

$$CaOCl_2 + 2HCl \rightarrow CaCl_2 + H_2O + Cl_2 \uparrow$$

5. Chlorine gas which is released from bleaching powder react with water and form nascent atomic oxygen [O]. This oxygen perform bleaching reaction and behave as oxidizing agent.

$$Cl_2 + H_2O \rightarrow 2HCl + [O] \text{Atomic oxygen}$$

Colured substance + [O] $\rightarrow$ Colourless substance.

Uses -

1. As bleach in cloth industry
2. As bleach in paper industry
3. In purification of drinking water.
4. As oxidizing agent and antibiotic.
5. As reagent in laboratory.

5.4.4 Baking soda ($NaHCO_3$) - It is also called eating soda. Its chemical name is sodium hydrogen carbonate. On mixing it with food substances and heating, CO_2 gas is released as bubbles. In this way food products like cake become soft and spongy and pores are produced in them. Baking soda is made by using NaCl.

$$NaCl+H_2O+CO_2+NH_3 \rightarrow \underset{\text{Ammonium chloride}}{NH_4Cl}+NaHCO_3$$

It is also prepared by passing CO_2 gas in solution of sodium carbonate.

$$Na_2CO_3+CO_2+H_2O \rightarrow 2NaHCO_3$$

Sodium carbonate — Sodium hydrogen carbonate

Properties-

1. It is white crystalline solid.
2. It is hardly soluble in water.
3. Its solution in water is alkaline.
4. CO_2 gas is released on heating it.

$$2NaHCO_3 \xrightarrow{Heat} Na_2CO_3+H_2O+CO_2 \uparrow$$

Uses-

1. As baking powder in food products
2. In making soda water and soda containing cold drink.
3. As antacid to remove acidity of stomach.
4. As mild antiseptic
5. In fire extinguishers
6. As laboratory reagent.

5.4.5 Washing soda ($Na_2CO_3.10H_2O$) -

It is called cloth cleaning soda. Its chemical name is sodium carbonate. In it there are 10 molecules of crystalline water with one molecule of sodium carbonate. It is formed by Solvay's method. In another method, sodium carbonate is obtained on heating baking soda. On its recrystallization, washing soda is obtained.

$$2\ NaHCO_3 \xrightarrow{\Delta} Na_2CO_3+H_2O+CO_2 \uparrow$$

$$Na_2CO_3+10H_2O \xrightarrow{\text{Crystallization}} Na_2CO_3.10H_2O$$

Properties -

1. It is white crystalline solid.
2. Soluble in water.
3. Its solution in water is alkaline.
4. On heating its crystal looses water and get converted into soda ash .

$$Na_2CO_3.10H_2O \xrightarrow{more\ than\ 373K} Na_2CO_3{}^{+}10H_2O$$

Uses -

1. In washing and cleaning
2. In formation of castic soda, baking soda, glass, soap borax.
3. As detergent
4. In paper, paint and textile industry.
5. As laboratory reagent.

5.4.6 Plaster of Paris ($CaSO_4\ ½H_2O$)

Its chemical name is hemihydrate of calcium sulphate. First time it was made in capital of France i.e. Paris, by heating Gypsum so it was named as plaster of Paris. It is also called P.O.P. It is obtained by heating Gypsum at 393 K.

$$2CaSO_4\ 2H_2O \xrightarrow{393K} 2CaSO_4.½H_2O+3H_2O$$

Gypsum — Plaster of Paris

When we heat P.O.P. more than 393K, whole water of crystalline water is removed and dead burnt plaster is obtained.

Properties -

1. It is a while sleek solid substance.
2. On mixing water, in 15 to 20 minutes, it becomes hard and solid.

$$2CaSO_4.½\ H_2O+3H_2O \rightarrow 2CaSO_4.2H_2O$$

P.O.P. — Gypsum

Uses -

1. Its most important use is in making plaster for repairing the cracked bones.
2. In making buildings

3. In dental medicals
4. In making decorative materials like statues.
5. As fire extinguisher substance.

5.5 Soap and detergent

Detergent is a latin word which means" to wipe clean" Soap and detergent are studied in this field.

5.5.1 Soap - The oldest detergent is soap. These are sodium and potassium salts of fatty acids with long carbon chain C_{12} to C_{18} like stearic, palmitic, oleic acid etc. These are made by heating oil or fats with sodium hydroxide or potassium hydroxide. This reaction is called saponification.

$$\begin{array}{l} CH_2\ COOR \\ | \\ CH\ C\ OOR \\ | \\ CH_2COOR \end{array} \quad + 3\ NaOH \longrightarrow \underset{\text{soap}}{3RCOONa} + \quad \begin{array}{l} CH_2\ OH \\ | \\ CH\ OH \\ | \\ CH_2\ OH \end{array}$$

higher fatty acids — glycerol

Soap obtained in this reaction, separates out on mixing sodium chloride. Only those soaps obtained by sodium and potassium salts of higher fatty acids are soluble in water. In these, potassium soaps are more soft. They are used in making shaving soap, shampoo etc. Glycerine is used for making transparent soap.

Soap perform cleaning action in soft water but can not perform it in hard water. In hard water, calcium (Ca^{+2}) and magnesium ions are present, which substitute sodium ion from soap molecule. In this way, calcium and magnesium salts of higher fatty acids are formed. These salts are insoluble in water so they get precipitated. Thus, they can not perform cleaning action. To solve this problem, detergents are used.

5.2.2 Detergent - Detergents are like soap but they work in both soft and hard water. So, generally detergents are used for cleaning.

Detergents are sodium alkyl sulphate and sodium alkyl benzene sulphonate . Apart from these, many types of detergent are found. Here ion of these detergents gets substituted by Ca^{+2} and Mg^{+2} ions and form calcium or magnesium sulphonates. These sulphonates are soluble in water so do not precipitate like soap. So there is no obstacle in cleaning action.

Due to these synthesized detergents, water pollution problem arises because bacteria can not decompose them easily

If R group that is hydrocarbon chain is less branched then they can be decomposed by bacteria easily. So that benzene sulphonate detergents which have long and less hydrocarbon chain are used. At present, to increase ability and productivity of detergents, inorganic phosphate, sodium peroxyborate and some flouroscent compound are also mixed. The cleaning work is done by soap and detergent by micelle formation.

5.2.3 Micelle formation and cleaning action of soap

Soap and detergent perform cleansing action by micelles formation. Firstly, soap molecules like sodium stearate are ionised in water.

$$C_{17}H_{35}COONa \rightarrow C_{17}H_{35}COO^- + Na^+$$

It can also be written as

$$R\ COONa \rightarrow R\ COO^- + Na^+$$

Hydrocarbon part (Hydrophobic) — Polar part (Hydrophillic)

This hydrocarbon tail (R) which is hydrophobic and polar end which is hydrophillic makes such structure. These parts are arranged such that hydrocarbon part is inward and negatively charged polar end is outward.

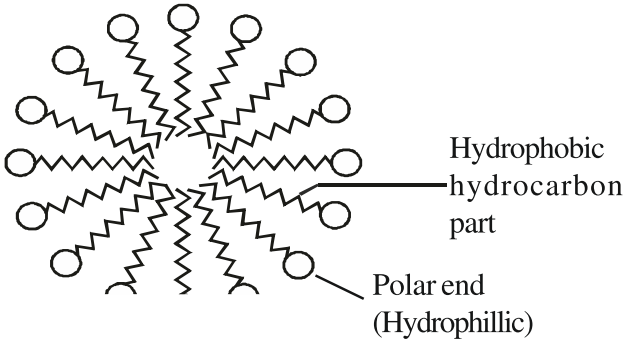


Fig. 5.3 Micelle structure

It is called micelle.

Most of the impurities like oil drop etc are insoluble in water but soluble in hydrocarbon. In cleaning by soap, soap molecules form micelles around impurity. In this, hydrophobic hydrocarbon part attracts impurity and hydrophillic polar part is outward. So, impurity is surrounded and micelle is formed. Polar end present at outer ends are attracted by water and whole impurity is pulled in water.

All micelles are negatively charged (uniformly) so they do not precipitated. Thats why when dirty clothes are treated with soap and then dipped in water, whole impurity of cloth comes out in water.

Important Points

1. According to Arrhenius, those substances which give H^+ ions in aqueous solutions are acid and which give OH^- ions are called base.
2. According to Bronsted and lowry, acids are proton donars and base are proton acceptors.
3. According to Lewis, electron donor are called base and electron accepton are acids.
4. Acid turn blue litmus to red and base turn red litmus to blue.
5. Salt and water are formed by the reaction of acid and base.
6. In crystals of salt, sometimes water of crystallisation is also present.
7. Strength of acid and base is measured by pH.
8. The negative logarithm of concentration of hydrogen ions $[H^+]$ is called pH.
9. If pH of solution = 7, it is neutral, pH < 7 then. acidic and pH > 7 then alkaline.
10. In daily life, many compounds are useful.

    eg. $NaCl, NaHCO_3, Na_2CO_3.10H_2O,$

    $$CaOCl_2, CaSO_4.\frac{1}{2}H_2O$$

11. Soap and detergent are used in cleaning work. These are formed by different types.
12. These do cleaning work by micelle formation.

Practice questions

Objective type questions :

1. Aqueous solution of base
   (a) Turns blue litmus into red
   (b) Turns red litmus into blue
   (c) Turns litmus solution into colourless
   (d) Does not have any effect on litmus solution

2. Solutions of acid and base are, _____ of electricity.
   (a) Insulator (b) Conductor
   (c) Semiconductor (d) No effect

3. pH is negative logarithm of which ions?
   (a) $[H_2O]$ (b) $[OH^-]$
   (c) $[H^+]$ (d) $[Na^+]$

4. Which one is the pH of acidic solution.
   (a) 7 (b) 14
   (c) 11 (d) 4

5. In our stomach, digestion of food occurs in which medium
   (a) Acidic (b) Alkaline
   (c) Neutral (d) Variable

6. In making fire extinguisher, which substance is used-
   (a) Sodium carbonate
   (b) Sodium hydrogen carbonate
   (c) Plaster of paris
   (d) Sodium chloride

7. Washing soda is-
   (a) $NaHCO_3$ (b) $NaCl$
   (c) $CaSO_4.\frac{1}{2}H_2O$ (d) $Na_2CO_3.10H_2O$

8. Which gas is released on keeping bleaching powder open in air-
   (a) H_2 (b) O_2
   (c) Cl_2 (d) CO_2

9. Soap works
   (a) In soft water
   (b) In hard water
   (c) In both soft & hard water

(d) None of these

10. In micelle formation, hydrocarbon tail is
(a) Inward (b) Outward
(c) Variable (d) Towards any side.

11. Compounds which accept proton $[H^+]$
(a) Acid (b) Salt
(c) None of these (d) Base.

Very short type questions

12. Which acid is found in sting of red ant?

13. What are proton donor compounds called?

14. What is neutralisation?

15. How drinking water is made bacteria free?

16. How acid reacts with metallic oxide? Give equation.

17. In pH, what P and H indicates ?

18. Which treatment would we take to get relief from excess acidity produced in stomach?

19. Name two sodium salts.

20. Give definition of base according to Lewis.

21. What is saponification?

22. What is the characteristic of detergents?

23. Which compound is used for plastering cracked bones?

24. In a solution, concentration of hydrogen ion is 1×10^{-4} gm mole L^{-1}. Find pH of solution.

Tell whether solution is acidic or alkaline?

Short type questions

25. Write name and uses of two strong acids and two strong bases.

26. Differentiate soap and detergents?

27. Write definitions of acid and base according to Arrhenius.

28. What is pH? describe pH range of acidic and alkaline solution.

29. What is water of crystallisation? Give example

30. What happens when :

(i) Curd or sour substances are kept in metal utensils.

(ii) Teeth are not cleaned after eating food at night.

31. A compound A reacts with acid H_2SO_4 and release gas B with brisk effervescence. On heating gas B burns with pop sound. Tell names of A and B and give equation of reaction.

Essay type question

32. Explain acid and base according to Bronsted Lowry and Lewis.

33. Write uses of pH in normal life.

34). Write name, method of preparation and uses of-

(i) NaOH
(ii) $NaHCO_3$
(iii) $Na_2CO_3.10H_2O$
(iv) $CaOCl_2$
(v) $CaSO_4.\frac{1}{2}H_2O$

(35) How micelles are formed ? Write mechanism also.

Answer key

(1)	(b)	(2)	(b)	(3)	(c)
(4)	(d)	(5)	(a)	(6)	(b)
(7)	(d)	(8)	(c)	(9)	(a)
(10)	(a)	(11)	(d)		

Chapter-6

Chemical Reaction and Catalyst

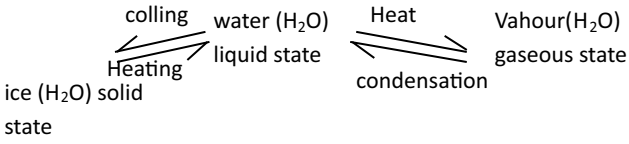
In our life, many chemical incidents happen everyday, in which substances changes their forms. These changes are called physical or chemical changes.

6.1 Physical and chemical change

In some substances, on removing the cause of change, again initial substance is obtained. Whereas on the other side some changes are such in which composition of substances gets changed and new substances are formed, these changes are called chemical changes.

6.1.1 Physical change

These are the changes in which physical properties and state of substance changes but their chemical properties do not change on removing the cause of change, again initial state is obtained like water (H_2O) is in liquid state, on heating gaseous state vapour (H_2O) is formed and on cooling solid state ice (H_2O) is formed.



Magnet formation by iron, sugar dissolving in water etc are other examples.

6.1.2 Properties of physical change :

(1) Only physical properties of substances like state, colour, smell etc changes.

(2) On removing the cause of change, again initial substance is obtained.

(3) This change is temporary.

(4) New substance in not formed.

6.1.3 Chemical Change

These are changes in which chemical properties and composition of substance changes and new substance is formed. When chemical change occurs, it is not necessary that on removing the cause of change again initial substance is obtained Eg- on burning coal, carbon dioxide gas is formed.

C	+	O_2	$\longrightarrow$	CO_2
Coal		Oxygen		Carbon dioxide
(Solid)		(Gas)		(Gas)

Here when carbon and oxygen react then substance with new chemical composition carbone dioxide (CO_2) is formed and in this reaction coal can not be obtained again from (CO_2). Other examples are formation of curd by milk, spoiling of cooked vegetable, rusting of iron etc.

Properties of chemical change :

(1) The substance formed as a result of the chemical change is completely different in chemical proerties and composition from the initial substance.

(2) Generally, initial substances can not be obtained again.

(3) This change is permanent.

(4) New substance is formed.

6.2 Chemical equation

In any chemical reaction, substances are represented by molecular formulas & symbols, then it is called chemical equation. Eg. on heating carbon in presence of oxygen, carbon dioxide is formed.

Carbon + oxygen $\longrightarrow$ Carbon dioxide

$C + O_2 \longrightarrow CO_2$

In this way, chemical reaction can be written in short by chemical equation. In chemical reaction, the

substance that takes part are written on the left hand side of arrow, these are called reactants. Arrow shows the direction of reaction. On the right hand side of arrow are products which are the substances formed during the reaction.

6.2.1 Steps of writing chemical equation -

(1) For writing equation of a chemical reaction, firstly reactants are written, then an arrow is made, then products are written.

(2) When the number of reactants and products are more than one, then plus sign (+) is written between them Eg-

$$C + O_2 \longrightarrow CO_2$$

(3) In a chemical reaction, mass is neither formed nor destroyed. Thus, number of atoms of reactants and products would be same on both sides of arrow.

According to the fundamental law of chemical combination, in a chemical reaction whatever be the mass of reactant, same product of same mass is formed that means mass is conserved in complete reaction. It can also be understood as the total number of atoms of any elements is same on the reactant and on product side So, it is necessary to balance the written equation.

(4) Equation is balanced by increasing and decreasing number of molecules on both sides. Chemical equation is solved by hit and trial method.

(5)To balance chemical equation, firstly the atoms other than oxygen (O) and hydrogen (H) are balanced.

Eg.

$$C_3H_8 + O_2 \longrightarrow CO_2 + H_2O$$

Propane	oxygen	carbon dioxide	water

$$C_3H_8 + O_2 \longrightarrow 3CO_2 + H_2O$$

Number of C is balanced, now balance number of H.

$$C_3H_8 + O_2 \longrightarrow 3CO_2 + 4H_2O$$

Now balance the number of O on both side

$$C_3H_8 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$$

(6) After balancing the equation, we represent physical state of reactants and products, (s) for solid, (l) for liquid and (g) for gas.

$$C_{(S)} + O_{2\ (g)} \rightarrow CO_{2\ (g)}$$

(7) When reactant and product are in aqueous solution form, then (aq) is written.

$$CaO_{(s)} + H_2O_{(l)} \longrightarrow Ca(OH)_{2\ (aq)}$$

(8) When reaction is reversible that is occur in both directions then arrow sign $\rightleftharpoons$ is used.

(9) Temperature and pressure required for completion of reaction are written above the arrow.

$$N_{2\ (g)} + 3H_{2\ (g)} \overset{773k/200atm}{\rightleftharpoons} 2NH_{3\ (g)}$$

(10) For exothermic and endothermic reaction, (+) and (-) sign are applied with amount of heat on the product side. Heat is also written by Δ sign.

$$N_2 + 3H_2 \longrightarrow 2NH_3 + 10.5 \text{ Kcal/mole}$$

$$N_2 + 2O_2 \longrightarrow 2NO_2 - 21.6 \text{ Kcal/mole}$$

(11) Catalyst used in reaction is written above the arrow

$$\begin{array}{l} CH_2 \\ \| \\ CH_2(g) + H_2(g) \end{array} \xrightarrow{Ni} \begin{array}{l} CH_3 \\ | \\ CH_3 \end{array}$$

ethene → ethane

6.2.2 Properties of chemical equation-

A brief information of reaction is obtained through chemical equation. Its properties are :-

(1) Complete information about the reactants and products i.e. number of molecules, mass etc are obtained.

(2) Physical state of substance can be known.

(3) Required conditions for reaction i.e. temperature, pressure, catalyst etc are known by it.

(4) By equation, it is clear whether reaction is exothermic or endothermic.

(5) It gives information about reversibility of reaction.

6.2.3 Limitations of chemical equation-

(1) It does not give information regarding completeness of reaction.

(2) The concentration of reactant and product is not clear through it.

6.3 Chemical reaction

When chemical change occurs in any substance, it differs in chemical composition and properties from main substance, this phenomenon is called chemical reaction i.e. **the chemical change in any substance is called chemical reaction.** During chemical reaction, reactants are converted into products but the total mass is conserved. Chemical reaction is represented by chemical equation. Eg.

$$2Mg(s) + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

On burning magnesium ribbon in oxygen, white coloured powder of magnesium oxide is formed. Here, in reactants, number of atoms of Mg is 2 and number of atoms of oxygen (O_2) is 2 and after product formation also this number remains same. Mass of Mg and O_2 remains same before and after the reaction. Look at another example.

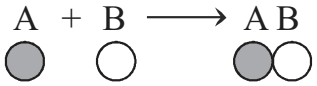
$C_{(s)}$	+	$O_{2(g)}$	$\longrightarrow CO_{2(g)}$
12		(2×16)	$(12+2\times16)$
12	+	32	$12+32$
	44		44

In this reaction, coal is burnt in presence of oxygen. Here coal (C) and oxygen (O_2) are reactants.Gas CO_2 formed as product have completely different properties than these two. Here 12 g Carbon reacts with 32 g oxygen to form 44 g CO_2. Total mass of reactants remain equal to the total mass of products.

In chemical reaction, bonds between atoms of compound break and new bonds are formed. There are many types of reactions on the basis of combination of the reactants, breakdown and formation of bonds, velocity and nature of reaction etc.

6.3.1 Addition reaction :-

The chemical reactions in which two or more reactants combine to form a single product, are called addition reactions. In these reactions, new bonds are formed between the reactants.



As reactants simply add in this reaction, so these are called addition or combination reaction

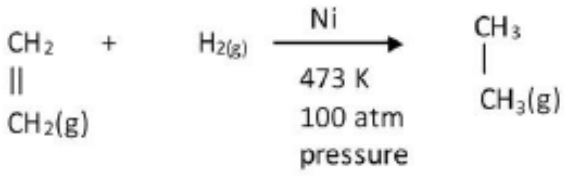
Eg- Burning of coal

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

Burning of magnesium ribbon

$$Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

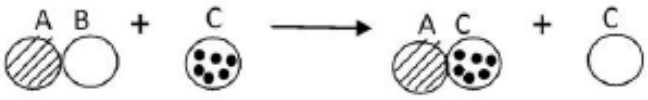
Hydrogenation of ethene



6.3.2 Replacement reaction:-

The chemical reactions in which atom or group of atoms present in reactant displaces atom or group of atoms of other reactant. In these reactions, the bond already present breaks and some new bonds are formed.

Eg.

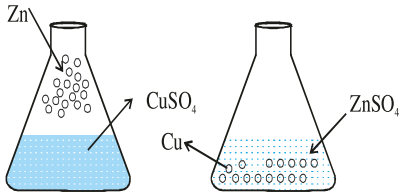


$$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$$

copper sulphate + zinc → zinc sulphate + copper

On mixing zinc pieces in blue coloured solution of copper sulphate, blue colour of $CuSO_4$, solution disappear and Cu is precipitated, and formation of $ZnSO_4$ occurs in solution. In displacement reactions,

more reactive element displaces comparatively less reactive element. Zn is more reactive metal and Cu is less reactive, so Zn displaces Cu from $CuSO_4$.



Blue colour Blue colour disappear

Reactivity of elements can be known by their activity series as-

Table 6.1

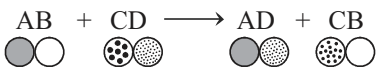
Activity series of some elements

Metals above H are more reactive than H	Potassium	K	More reactive elements
	Sodium	Na	
	Calcium	Ca	
	Magnesium	Mg	
	Zinc	Zn	
	Iron	Fe	
	Lead	Pb	
	Hydrogen	H	
Metals below H less reactive than it	Copper	Cu	
	Mercurry	Hg	
	silver	Ag	Less reactive elements
	Gold	Au	

Decreasing order of reactivity ↓

Double Replacement Reaction:-

In this type of chemical reaction, atoms or group of atoms of both reactants are displaced mutually and new compounds are formed.

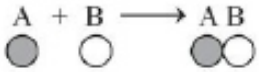


Some part of both reactants are displaced mutually and new products are formed.

Sulphate ions (SO_4^{-2}) of copper sulphate displaces hydroxide ions (OH^-) of sodium hydroxide and as a result ,copper hydroxide $[Cu(OH)_2]$ and formation of bonds, velocity and nature of reaction etc.

6.3.1 Addition reaction :-

The chemical reactions in which two or more reactants combine to form a single product, are called addition reactions. In these reactions, new bonds are formed between the reactants.



As reactants simply add in this reaction, so these are called addition or combination reaction

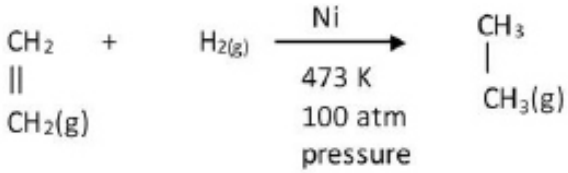
Eg- Burning of coal

$$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$$

Burning of magnesium ribbon

$$Mg_{(s)} + O_{2(g)} \longrightarrow 2MgO_{(s)}$$

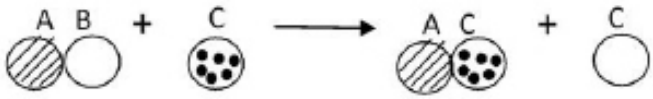
Hydrogenation of ethene



6.3.2 Replacement reaction:-

The chemical reactions in which atom or group of atoms present in reactant displaces atom or group of atoms of other reactant. In these reactions, the bond already present breaks and some new bonds are formed.

Eg.



$$CuSO_4 + Zn \longrightarrow ZnSO_4 + Cu$$

copper sulphate + zinc → zinc sulphate + copper

On mixing zinc pieces in blue coloured solution of copper sulphate, blue colour of $CuSO_4$, solution disappear and Cu is precipitated, and formation of $ZnSO_4$ occurs in solution. In displacement reactions,

dissociates into calcium oxide and CO_2.

(c) Photolytic dissociation - In this type of dissociation reaction, compounds get energy from light and breaks into small molecules. As in these reactions, compounds dissociate in the presence of light, so these are called photolytic dissociation.

$$2HBr \xrightarrow{\text{light (hv)}} H_2 + Br_2$$

Hydrogen Bromide Hydrogen Bromine

6.3.4 Slow and fast reactions -

Chemical reactions are of two types on the basis of velocity i.e. time taken-slow and fast

(a) Fast reactions -

These reactions occur rapidly on mixing the reactants. Generally, such reactions are ionic reactions like the reaction between strong acid and strong base which gets completed in 10^{-10} s.

$$NaOH+HCl \rightarrow NaCl+ \underset{(10^{-10}\,s)}{H_2O}$$

$$AgNO_3+HCl \rightarrow \underset{\text{white ppt}}{AgCl} +HNO_3$$

As soon as we mix silver nitrate and hydrochloric acid, white precipitate of silver chloride (AgCl) is formed. In plants, speed of photosynthesis reaction is also very fast. Half life period of this reaction ($t_{1/2}$) is 10^{-12}sec. (The time taken for half of the reactant to convert into product is called half life period of that reaction)

(b) Slow reaction -

There are many reactions which take hours, days or years to complete, these are called slow chemical reaction. Eg- Reaction of rusting of iron continues till years, which is a good example of slow chemical reaction.

$$4Fe+3O_2+6H_2O \rightarrow \underset{\text{Rust}}{2Fe_2O_3.3H_2O}$$

Another eg.

$$2\ KClO_3 \xrightarrow{\Delta} 2KCl+O_2$$

$$CH_3COOH+C_2H_5OH \rightarrow CH_3COOC_2H_5+H_2O$$

Acetic acid Ethanol Ethyl acetate

6.3.5 Reversible – Irreversible Reaction -

(a) Irreversible reactions - In these reactions reactants react to form products. They only occur in one direction, so they are called irreversible reactions. In these reactions, concentration of reactants decreases slowly and the concentration of products increases. When these chemical reactions are written in form of chemical equation, then it is written as normal arrow sign $(\rightarrow)$ Eg.

Coal burns in air and form carbon dioxide.

$$CH_4+2O_2 \rightarrow CO_2+2H_2O$$

Methane

On burning methane, carbon dioxide and water are formed and are stable also, so methane is not formed again. It means, in these reactions generally chemical change occur and products are formed. Reactants can not be formed again by products.

(b) Reversible Reaction -

The reactions in which reactants react, to form products under same conditions, and at same time products also react to from reactants. These reactions are called reversible reactions. These reactions occur in both directions. In these reactions, amount of reactant is never zero. In reversible reaction, half arrow sign is written in both sides $\rightleftharpoons$.

$$A+B \underset{(2)}{\overset{(1)}{\rightleftharpoons}} C+D$$

Reversible reactions are divided into two reactions which occur simultaneously

(1) $A+B \rightarrow C+D$

It is called forward reaction

(2) $C+D \rightarrow A+B$

It is called backward reaction

In this way, reversible reaction occur on both sides (forward and backward) simultaneously. Firstly, products (C+D) is formed from reactants (A+B). After the products are formed in favourable quantity,

backward reaction starts and reactants start forming. Once the reaction is started, it never completes. Every time reactant and product are present in the reaction mixture. If gases are formed in reaction, then it is required for the reaction to occur in closed container.

$$N_2+3H_2 \rightleftharpoons 2NH_3$$

$$H_2O+H_2CO_3 \rightleftharpoons H_3O^+ +HCO_3^-$$

Example of one such chemical reaction is carrying of CO_2 and O_2 by haemoglobin.

6.4 Oxidation - reduction -

In chemistry, oxidation reduction reactions are very important. Many biological, physical and chemical reactions are related to these. Generally , all the elements react with O_2 and H_2 , so on this basis these are called oxidation reduction reactions. These reactions also define oxidizing and reducing agent. These reactions are explained on following basis.

6.4.1 Oxidation reduction on the basis of combination and dissociation of oxygen -

Addition of oxygen is called **oxidation**. Mainly, oxidation word is used for addition of oxygen

eg - $2Mg+O_2 \rightarrow 2MgO$

$S+O_2 \rightarrow SO_2$

sulphur dioxide

In reaction, removal of oxygen from substance is called **reduction**.

$$2KClO_3 \rightarrow 2KCl+3O_2$$

$$2MgO \rightarrow Mg+O$$

In this reaction, $KClO_3$ is reducing to KCl and MgO to Mg.

6.4.2 Oxidation reduction on the basis of addition and removal of hydrogen -

This definition was famous earlier but now it is also used in organic chemistry. Those chemical reactions in which hydrogen is removed from substances, are called oxidation.

$$2H_2S+O_2 \rightarrow 2H_2O+2S$$

Here, H_2S (Hydrogen sulphide) gas is oxidized to (Sulphur) S.

$$CH_3CH_2OH \xrightarrow{(o)} CH_3CHO+H_2$$

Ethanol Ethanal

In ethanol, number of H_2 atoms are 6 and in product formed ethanal, number of H_2 atoms are 4. So here ethanol is oxidized in ethanal and hydrogen is removed.

Those chemical reactions in which addition of hydrogen takes place are called **reduction**.

$$\underset{\text{Ethene}}{CH_2=CH_2} + H_2 \xrightarrow[\text{473 k/ 100 atm}]{\text{Ni}} \underset{\text{Ethane}}{CH_3-CH_3}$$

$$H_2+Cl_2 \longrightarrow 2HCl$$

Here, Ethene is reduced to Ethane and Chlorine to HCl.

It is not essential that hydrogen and oxygen take part in reactions. So definitions of oxidation and reductions were given in general form.

6.4.3 Oxidation - reduction on the basis of addition and removal of electropositive elements -

Those reaction in which electropositive element is removed, is called **oxidation**.

$$2KI+Cl_2 \rightarrow 2KCl+I_2$$

$$H_2S+Cl_2 \rightarrow 2HCl+S$$

Here Potassium iodide (KI) is oxidized to Iodine (I_2) and H_2S to sulphur (S). Those reactions in which electropositive element is added are called **reduction**.

$$Cl_2+Mg \rightarrow MgCl_2$$

Here Chlorine (Cl_2) is reduced to Magnesium chloride ($MgCl_2$).

6.4.4 Oxidation-reduction on the basis of addition and removal of electronegative element-

Those reactions in which susbtance combines with electronegative element, are called **oxidation**.

$$Mg+Cl_2 \rightarrow MgCl_2$$

Here, Magnesium (Mg) is combining with more electronegative element Chlorine (Cl_2) and so it is oxidizing. Those reactions in which electronegative element is removed, are called **reduction**.

$$2FeCl_3+H_2 \rightarrow 2FeCl_2+2HCl$$

Here $FeCl_3$ is reducing to $FeCl_2$ due to removal of more electronegative element Chlorine. If all these facts are taken in a sequence then it can be said that oxidation are reactions in which oxygen or electronegative element add to a substance or hydrogen or electropositive element is removed.

In the same manner, reduction are those reactions in which hydrogen or electropositive element add to a substance or oxygen or electronegative element is removed. All these are long run concepts of oxidation reduction. At present, these terms are expanded. Oxidation reduction are explained on the basis of addition and removed of electrons.

6.4.5 On the basis of electron -

A. Oxidation-

Those reactions in which atom, ion or molecule donates electron (e^-), are called **oxidation**.

$$Na \rightarrow Na^+ + e^-$$
$$Fe^{2+} \rightarrow Fe^{3+} + e^-$$
$$2Cl^- \rightarrow Cl_2 + 2e^-$$

Here Sodium donates e^- and oxidizes to Na^+ cation. Ferrous (Fe^{2+}) ion donates one more e^- and oxidizes to ferric (Fe^{3+}) ion and chloride (Cl^-) ion donates e^- and oxidizes to neutral molecule. These reactions show that, in oxidation reaction, neutral atom becomes cation or charge on cation (positive ion) increases or charge on negative ion decreases.

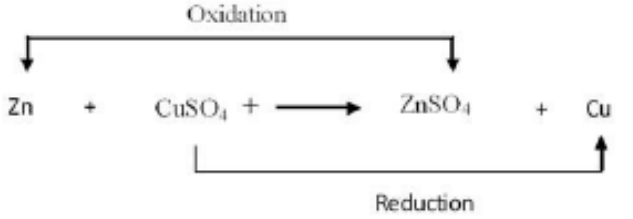
B. Reduction-

Those reactions in which atom, ion or molecule accepts e^-, are called **reduction.**

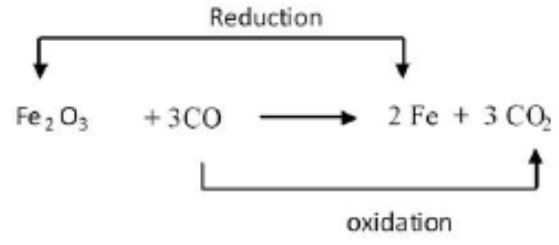
$$Cl+e^- \rightarrow Cl^-$$
$$MnO_4^- + e^- \rightarrow MnO_4^{-2}$$
$$Mg^{+2}+2e^- \rightarrow Mg$$

Here Chlorine accept e^- and reduce to chloride ion (Cl^-), permanganate ion (MnO_4^-) accept e^- and reduce in mangante ion (MnO_4^{2-}) and magnesium cation (Mg^{2+}) accept e^- and reduces to neutral Mg atom. These examples show that in reduction reactions, opposite to oxidation, e^- are accepted through which neutral atom forms anion or charge on anion increases or charge on cation decreases.

From above reactions, we can see that these are oxidation-reduction half reactions. One substance donates electron and another accept e^-. In these reactions, one substance is oxidized and another is reduced. These reactions occur simultaneously. So these are called redox reactions.



In above reaction, Zn is oxidizing to $ZnSO_4$ ($Zn \rightarrow Zn^{2+}+2e^-$) and Copper sulphate is reducing in Cu ($Cu^{2+}+2e^- \rightarrow Cu$)



In this reaction, ferric oxide (Fe_2O_3) is reducing to iron and carbon mono oxide (CO) is oxidizing to CO_2. Here in a reaction , one substance is oxidizing and another is reducing. It is called redox reaction.

In these reactions, substance which oxidize donates e^- and help another substance to reduce, is called reducing agent. The substance which reduces, accept e^- and oxidizes another substance is called oxidizing agent.

It means, reducing agent $\rightarrow$ e^- donor

oxidising agent $\rightarrow$ e^- acceptor

6-5 Neutralization

When acid and base react, then salt and water are formed, this reaction is called neutralization reaction. Here hydrogen ion (H^+) of acid reacts with hydroxyde ion (OH^-) of base and forms water.

Acid + Base $\rightarrow$ salt + water

$HCl + NaOH \rightarrow NaCl + H_2O$

When strong acid and strong base of same concentration react then pH of solution is 7, whereas if strong acid react with weak base, then its pH is less than 7. If strong base react with weak acid then pH of solution is more than 7.

It can be understood as when on mixing acid and base, same amount of acid neutralizes same amount of base and , salt is formed. One mole H^+ ion given by any acid reacts with one mole OH^- ion of base and are neutralised. Strong acid and strong base get completely ionised. So, in neutralization reaction, all H^+ and OH^- ions combine to form water and pH of solution is becomes 7.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

$$H^+ + Cl^- + Na^+ + OH^- \longrightarrow Na^+ + Cl^- + H_2O$$

So, total reaction is

$$H^+ + OH^- \longrightarrow H_2O$$

Whereas in neutralization reaction between weak base and strong acids, weak base do not ionise completely. Some amount of base remains in molecular form. On taking same moles of acid and base, quantity of H^+ ions is more than quantity of OH^- ions , so after neutralization reaction, H^+ ions are present in the solution and pH of solution is less than 7.

$$HCl + NH_4OH \longrightarrow NH_4Cl + H_2O$$

Here, NH_4OH is weak base.

In this way, in neutralization reaction of weak acid and strong base, acid do not completely ionise or dissociate and remains in undissociated form in some amount . On taking equal mole of acid and base in solution , OH^- ions are more in the solution, and pH of solution becomes more than 7.

$CH_3COOH + NaOH \rightarrow CH_3COONa + NaOH$

Acetic acid Sodium acetate

Here, acetic acid is a weak acid.

6.6 Catalyst

Those substance which change the velocity of chemical reaction but themselves remains unchanged, are called catalyst and this phenomenon is called catalysis.

$$2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + 3O_2$$

$$\text{Vegetable oil} + H_2 \xrightarrow{Ni} \text{Vegetable ghee}$$

Thermal dissociation of potassium chlorate occurs at low temperature on mixing MnO_2. In above reaction,

and powdered Ni metal act as catalyst.

These are divided into many types on the basis of action of catalysts, state etc.

6.6.1 Types of catalyst on the basis of physical state -

On the basis of physical state, catalysts are of

two types -

(a) Homogeneous catalyst - When in a chemical reaction, catalyst, reactants and products are in same physical state then catalyst is called homogeneous catalyst and reaction is called homogeneous catalysis.

Eg.

$$CH_3COOCH_{3(i)} + H_2O_{(i)} \xrightarrow{HCl(aq)} CH_3COOH_{(aq)} + CH_3OH_{(aq)}$$

Methyl acetate Acetic acid Methanol

$$2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(q)}$$

Sulphur dioxide Sulphur trioxide

(b) Heterogeneous catalyst - When in a chemical reaction, physical state of reactants and catalyst are different, then catalyst is called heterogeneous catalyst and reaction is called heterogeneous catalysis.

Eg.

$$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe_{(s)}} 2NH_{3(g)}$$

$$\text{Vegetable oil}_{(i)} + H_{2(g)} \xrightarrow{Ni_{(s)}} \text{Vegetable ghee (s)}$$

In the presence of finely divided nickel metal (Ni) catalyst, vegetable oil is hydrogenated to form vegetable ghee. Here, oil is in liquid state, H_2 in gaseous state and Ni and ghee are in solid state.

6.6.2 Types of catalysts on the basis of action -

(a) Positive catalyst - Catalysts which increases the rate of chemical reactions are called positive cata lysts.

eg. $2KClO_3 \xrightarrow[\Delta]{MnO_2} 2KCl + 3O_2$

$$2SO_2 + O_2 \xrightarrow{No} 2SO_3$$

(b) Negative catalyst - Catalysts which decreases the rate (velocity) of chemical reactions are called negative catalyst.

eg. $2H_2O_2 \xrightarrow{glycreol} 2H_2O + O_2$

Hydrogen peroxide

In presence of glycerol, rate of dissociation of H_2O_2 decreases, for accumulating H_2O_2, some amount of glycerol is mixed in it.

$$2CHCl_3 + O_2 \xrightarrow{C_2H_5OH} 2COCl_2 + 2HCl$$

Chloroform Phosgene

Chloroform itself is oxidized by the oxygen in air and form phosgene gas (poisonous) for slowing down the speed of this reaction, some quantity of ethanol (C_2H_5OH) is added to it.

(c) Auto catalyst - When the product formed in a chemical reaction, itself act as catalyst i.e. increases the velocity of reaction, then the product is called auto-catalyst.

eg.

$$CH_3\ COO\ C_2H_5 + H_2O \rightarrow CH_3\ COOH + C_2H_5OH$$

ethyl acetate acetic cid ethanol

Here, initially reaction have slow speed but after the product acetic acid is formed in some amount, velocity of reaction increases. Here, acetic acid act as auto catalyst.

(d) Bio - catalyst - The substances which are used to increase the velocity of biochemical reactions are called bio-catalysts. These are generally called enzymes. Enzymes are complex nitrogenous organic compounds which are specific for different biochemical reactions.

Eg-

$$NH_2CONH_2 + H_2O \xrightarrow{Urease} 2NH_3 + CO_2$$

Urea

$$\text{Maltose} \xrightarrow{Maltase} \text{Glucose} + \text{Glucose}$$

In chemical reactions, some substances are also used, which affect the activity of catalyst-

(i) Catalyst promoter - Those substances which when added with catalyst in the reaction mixture, increases the activity of catalyst, are called catalyst promoters. They only increase the activity of catalyst and are not themselves catalyst.

Eg-

$$N_2 + 3H_2 \xrightarrow{Fe/Mo} 2NH_3$$

Here Mo (Molybdenum powder) increases

rate of reaction by increasing activity of catalyst iron (Fe).

Vegetable oil $+H_2 \xrightarrow{Ni/Cu}$ Vegetable ghee

Here Ni is catalyst and Cu is catalyst promoter.

(ii) Catalyst inhibitor - Those substances which when mixed in reaction mixture, decreases the activity of catalyst , are called catalyst inhibitor.

Eg. $N_2+3H_2 \xrightarrow{Fe} 2NH_3$

If carbon mono oxide (CO) gas is mixed in this reaction, then activity of catalyst iron (Fe) decreases.

6.6.3. Properties of Catalyst -

1. Catalyst are only responsible for the change in velocity of chemical reaction Their chemical composition and amount do not change.

2. Presence of catalyst in small amount in reaction mixture is sufficient.

3. For each reaction, there is a specific catalyst i.e. single catalyst can not catalyse all the reactions.

4. Catalyst do not initiate any reaction, it only increases the velocity.

5. In reversible reactions, catalyst affect rate of both forward and backward reaction in same way.

6. Catalyst are more active at a particular temperature only. With change in temperature, their activity is affected.

Important Points

1. The changes in physical properties of substances are called physical changes. These are temporary.

2. The changes in composition and chemical properties of substances are called chemical changes.These are permanent.

3. Chemical reactions are written in form of chemical equations. Balanced chemical equation give brief information about chemical reaction.

4. In combination reactions, two or more substances combine to form single product.

5. The displacement of an atom or group of atoms of a reactant by atoms or group of atoms of another reactant is called displacement reaction.

6. When a substance dissociate in two or more simple molecules, reaction is called dissociation reaction.

7. Reactions are called slow or fast on the basis of their velocity.

8. Reaction of an acid and base is called neutralization reaction.

9. Those reactions in which addition of oxygen or electronegative element or removal of hydrgoen or electropositive elements occur, are called oxidation reactions.

10. Those reactions in which addition of hydrogen or electropositive element or removal of oxygen or electronegative element take place, are called reduction reactions.

11. Donation of electron is oxidation and acception of electron is reduction.

12. Those reactions which proceeds in one direction only are called irreversible reactions.

13. Those reactions which proceed in both directions, i.e. reactant form product and again product form reactant, are called reversible reactions.

14. Those substance which affect the velocity of chemical reaction without changing themselves are called catalysts.

15. Catalysts are of four types → positive, negative, auto-catalyst and bio-catalyst.

16. Catalysis are of two type → Homogeneous catalysis and heterogeneous catalyst.

17. Catalyst promoter and catalyst inhibitor- affect the activity of catalyst.

Practice Questions

Objective type questions

1. Conversion of in is called-
   (a) Oxidation (b) Reduction
   (c) Dissociation (d) Combination
2. A substance breaks in two simple small molecules then reaction is called-
   (a) Dissociation (b) Displacement
   (c) Oxidation (d) Reduction
3. Substance which donate electron are called-
   (a) Oxidizing agent (b) catalyst
   (c) Reducing agent (d) None of these
4. Reactions which proceed in both directions-

(a) Oxidation (b) Reduction
(c) Irreversible (d) Reversible

5. Those which increase rate of reaction-
(a) Catalyst (b) Oxidizing agent
(c) Reducing agent (d) None of these

6. Enzymes are -
(a) Negative catalyst (b) Positive catalyst
(c) Auto catalyst (d) Bio catalyst

7. $2Mg+O_2 \rightarrow 2MgO$ In this reaction, magnesium metal is-
(a) Oxidized (b) Reduced
(c) Dissociated (d) Displaced

8. Which sign is used for reversible reaction-
(a) $\rightarrow$ (b) $\uparrow$
(c) $\downarrow$ (d) $\rightleftharpoons$

9. The reaction which is catalysed by the product formed-
(a) Bio chemical (b) Reversible
(c) Auto-Catalysed (d) Irreversible

10. In exothermic reaction, heat is
(a) released (b) absorbed
(c) soluble (d) None of these

Very short type questions

11. What is chemical change?
12. Name catalyst which changes vegetable oil in vegetable ghee?
13. How many types of catalyst are there ? Write their name.
14. $Zn+CuSO_4 \rightarrow ZnSO_4+Cu$
This is an example of which type of reaction ?
15. Give an example of redox reaction
16. What are reversible reactions ?
17. What is the work of catalyst promoter and catalyst inhibitor ?
18. What is the reaction between acid and base called?
19. How many types of reactions are there on the basis of velocity ?
20. Write an example of thermal dissociation reaction.
21. What is the work of catalyst in any reaction ?
22. What is the fundamental principle a balancing of chemical reaction ?
23. What is redox reaction ?
24. What type of reaction is burning of coal ?
25. What will be the pH of solution, when strong acid and strong base react ?

Short type questions

26. Write difference between physical and chemical change.
27. Write one example of combination and decomposition reaction.
28. $AgNO_3+KCl \rightarrow AgCl+KNO_3$
Which type of reaction is this ? Write the name and explain.
29. Explain oxidation and reduction on the basis of electronic change.
30. What are the types of catalyst ? Write their name.
31. Explain the types of dissociation reactions?
32. Why some amount of ethyl alcohol is added in chloroform ?
33. Aqueous solution of salt formed by weak acid and strong base is alkaline. Why ?
34. Are these reactions possible ? Write answer with reason.
(i) $Cu+ZnSO_4 \rightarrow CuSO_4+Zn$
(ii) $Fe+CuSO_4 \rightarrow FeSO_4+Cu$
35. Identify oxidation - reduction in following reactions.
(i) $C+O_2 \rightarrow CO_2$
(ii) $Mg+Cl_2 \rightarrow MgCl_2$
(iii) $ZnO+C \rightarrow Zn+CO$
(iv) $Fe_2O_3+3CO \rightarrow 2Fe+3CO_2$

Essay type questions

36. How many types of chemical reactions are there? Explain.

37. What do you mean by oxidation - reduction ? Explain with examples.
38. What do you know about types and properties of catalyst ?
39. Write steps of writing chemical equation and its properties.
40. Write differences-
    (a) Reversible - irreversible reactions.
    (b) Catalyst promoter - Catalyst inhibitor
    (c) Homogeneous - Heterogeneous catalysis
    (d) Oxidation - Reduction inhibitor.

Answer key

1. (b) 2. (a) 3. (c) 4. (d) 5. (a)
6. (d) 7. (a) 8. (d) 9. (c) 10. (a)

Chapter - 7
Atomic Theory, Periodic Classification and Properties of Elements

Man has been trying since ancient times to know about the substance. Ancient Indian and Greek philosophers were collecting information about the microscopic nature of substance since a long time (almost 500B.C.) The ancient Indian philosopher Maharishi Kanad told that when substance is continuously divided in small pieces then at last, smallest particles, atoms are obtained. It is not possible to further divide this smallest particle. An another Indian philosopher Pakudha katyayam told that different forms of substance are obtained from the combination of these particles.

Almost at the same time, Greek philosopher Democritus and Leucippus called these smallest indivisible particles as atoms. It is taken from Greek word atomio which means indivisible. All these ideas about the atom were only philosophical, there was not any scientific or experimental basis.

At the end of 18^{th} century, many important works were done for it and atomic theories were given on the basis of laws and experimental facts.

7.1 Atomic theory of Dalton

In 1808, a British school teacher, **John Dalton** gave a theory to explain atom. This atomic theory was given on the basis of chemical combination, mass conservation and law of constant proportion Its main postulates are :-

1.Each substance is made up of small particles which are called atoms.

Jhon Dalton

2. Atoms are indivisible particles.
3. All the atoms of an elements are same i.e. have same mass, size and chemical properties.
4. Atoms of different elements have different mass, size and chemical properties
5. Atoms of different elements always combine in simple proportions of small whole numbers to form compound.
6. In chemical reactions, atoms only rearrange they can neither be created nor be destroyed by chemical reactions.

Atomic theory of Dalton could not explain many facts but it laid strong foundation of advanced research about the atoms on the basis of scientific and experimental facts. Till the end of 19^{th} century it was known that some more smaller particles are also present in atoms. Due to presence of these subatomic particles, atomic structure was further modified.

7.2 Atomic model of Thomson

Till now, electron and proton were discovered. Models had been developed to understand the internal structure of these electrons and protons in an atom. First model related to atomic structure was given **by Sir J.J. Thomson** in year 1898. According to him, atom is a positively charged sphere of size 10^{-10}m, in which negatively charged electrons are distributed in an equal amount. It is also called Plum Pudding Model. It is a type of Christmas cake in which positive charge is considered as pudding and

J.J. Thomson

electrons are like plum. In Indian perspective they can be considered as Bundi ka Laddu or water melon. Red part of water melon is like positive charge and seeds in between are like electrons. In this model, Thomson cleared that in an atom, amount of positive and negative charge is same and atoms are electrically neutral.

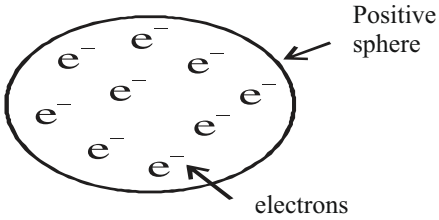


Fig 7.1 Thomson's Atomic Model

By this theory, electrical neutrality of atom was clarified but this model could not explain Rutherford gold foil experiment so this theory was declared invalid and it remained only of historical importance.

7.3 Rutherford's gold foil experiment

Ernest Rutherford and his students in 1911 did the experiment of bombarding particles on very thin gold foil. In this, highly energetic particles (nucleus of He) were bombarded on thin gold foil (thickness 10^{-7}m or 100nm). A zinc sulphide coated circular plate was kept around foil so that after bombardment, particle strike on screen and produce flash. In this way, direction of particle was determined.

Arnest Rutherford

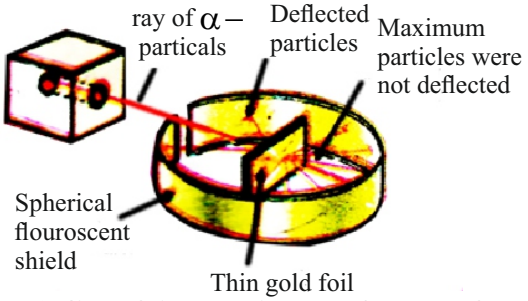


Fig 7.2 Gold foil experiment of Rutherford

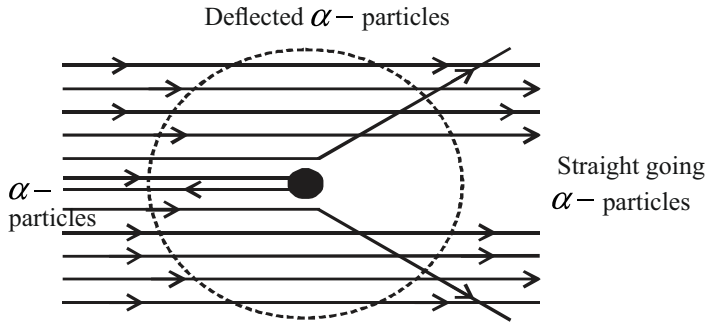


Fig. 7.3 Deflection of α – particles from nucleus of Gold metal

The observation of this experiment were:

1. Most of the particles moved straight through the gold foil without deflection.
2. A very few particles were deflected through small angle.
3. Out of 20,000 particles, one particle was deflected by 180^0 angle.

The observations obtained from this experiment were unexpected. Rutherford himself stated that

"It was almost as incredible as if you fired a 14 inch shell at a piece of tissue paper and it come back and hit you."

1. Most of the part of atom is empty and chargeless so most α- particles pass straight without deflection.
2. Some α- particles get deflected so it is confirmed that strong repulsive force act on them, so entire positive charge should be concentrated at a place in the atom.
3. In an atom volume of positive charge is very less as compared to total volume. This positively charged volume was called nucleus The diameter of atom is almost 10^{-10} m and diameter of nucleus is almost 10^{-15} m.

On the basis of these conclusions, Rutherford represented following model of an atom -

1.The entire positive charge and mass of the atom are concentrated at its centre called nucleus.

2. Most of the part of the atom is empty in which

electron move with high speed in circular path these circular paths are called orbits.

3.Atoms are electrically neutral. So it is confirmed that as many electrons are there in an atom, as the number of protons are present in nucleus.

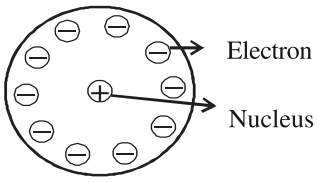


Fig. 7.4 Rutherford Model of Atom

Atomic model of Rutherford can be considered as solar system. In this model, electrons move around nucleus in different orbits in the same way as different planets move in different orbits around the sun. So, this model became fundamental basis for the explanation of atomic structure but could not explain some facts.

Limitations of Rutherford model

1. It could not explain stability of an atom.
2. It could not make clear the electronic structure of an atom.

According to Maxwell's theory, electron moving in a circular path will emit radiation by which its energy will continuously decrease. In this way it will move in spiral motion and at the end it will fall in But actually, it does not happen. It does not explain spectrum of atom and number of electrons and their arrangement in an atom.

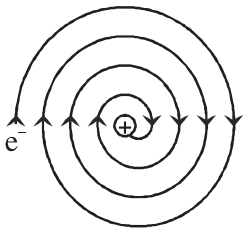


Fig 7.5 Path of e- in an atom

Neil Bohr using quantum theory of physics, tried to remove the drawbacks of Rutherford model.

7.4 Hypothesis of neil's Bohr

In 1913, Neil's Bohr proposed a model to explain structure and spectrum of hydrogen atom logically. Bohr's atomic model is based on following hypothesis :

Neil Bohr

1. In the centre of atom, nucleus is present which contain positively charged particles, protons.
2. The electrons move around nucleus in paths of fixed radius and energy. These paths of fixed energy are called orbits or energy levels.
3. These orbits are arranged concentrically around the nucleus. These are represented by n. Their value is always an integer like 1, 2, 3, 4.....and they are shown by K,L,M,N..... respectively.

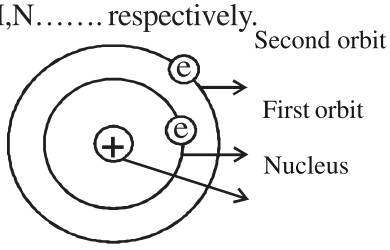


Fig. 7.6 Bohr's Atomic model

4. With increase in value of n, orbits get away from nucleus and their energy increases, The orbit $n = 1$ *or* K has least energy.
5. In these orbits, angular momentum of e^- is $mvr = \frac{h}{2\pi}$ or its multiple. Here h = Planck's constant, m=mass of electron, v=velocity of electron, r = radius of orbit i.e. electron can move only in those orbits whose angular momentum is equal to $\frac{nh}{2\pi}$.

6. According to Bohr, there is no change in energy of electron on revolving in a fixed orbit.
7. When an electron absorbs energy from outside the atom, then it gets excited and move to higher energy level. If electron emits energy then it transit from higher energy level to lower energy level. In an atom, due to absorption and emission of energy by the electron, linear spectrum is formed.

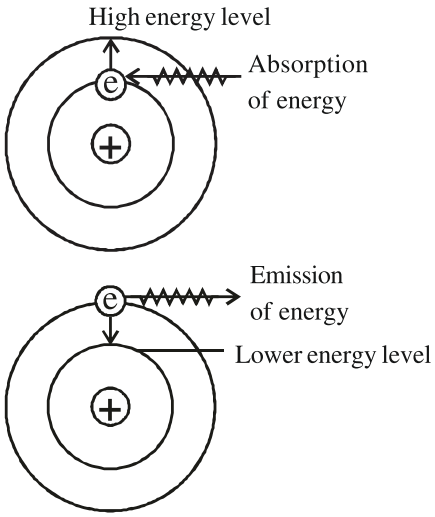


Fig. 7.7 Absorption and emission of energy by an electron

Limitations of Bohr Model -

Bohr's atomic model was more developed. As, linear spectrum of atom and its stability could be explained. Its limitations are as follows -

1. Atoms with large number of electrons could not be explained by this model.
2. Through high resolving power apparatus it was known that linear spectrum of an atom is divided into more than one line. The reason could not be explained by Bohr model.
3. It could not explain process of formation of molecule by atom through chemical bond.

Apart from knowing the structure of an atom, search for different type of elements was also done. The symbol, atomic structure and special properties of these elements were also clearly identified. By now it had been known that all matter was made up of atoms of elements. Attempts were made to organize the information related to these elements.

7.5 Necessity of classification

Till 1800, only 31 elements were known. Till 1865, 63 elements had been discovered and today 118 elements (according to IUPAC) are known, although some of these elements are man-made. It is very difficult to remember all the elements, their physical and chemical properties and properties of the compounds formed by them individually. So the necessity of classification of elements was felt. Scientists tried to arrange these facts in a sequence based on some properties, so that they can be studied in a simple and rational number . By this type of classification, the study of new elements to be discovered in future will also be done in an organized way.

7.6 Classification

The classification of elements is the result of many years of experiments and hypothesis of scientists. Firstly the name of **Dobereiner** comes in this series. In 1829, he made groups of 3-3 elements whose physical and chemical properties were same, these were called **Dobereiner's Triads**. In this group atomic weight of middle element was equal to the average of atomic weights of remaining two elements and properties were also in between their properties.

Dobereiner found only three such triads. After that this law was not useful. Then British chemist **John Alexander Newland** in 1865, gave **Law of octaves**. He arranged the elements in increasing order of their

Table 7.1 Dobereineer's Triads

Element	Atom Weight
Li	7
Na	23
K	39
Ca	40
Sr	88
Ba	137
Cl	35
Br	80
I	127

atomic weights and found that properties of 8th element were similar to first one. Like the notes of music, after seven notes, eighth note is same as first note.

This law was also not proved useful for elements after calcium. After it, many scientists carried forward the work of classification. In it, **Russian scientist Mendeleef and Lother Meyer** developed periodic table independently.

Table 7.2 Newland's Octaves

Element	Li	Be	B	C	N	O	F
Atomic wt.	7	9	11	12	14	16	19
Element	Na	Mg	Al	Si	P	S	Cl
Atomic wt.	23	24	27	28	31	32	35.5
Element	K	Ca					
Atomic wt.	39	40					

7.7 Mendeleef's periodic table

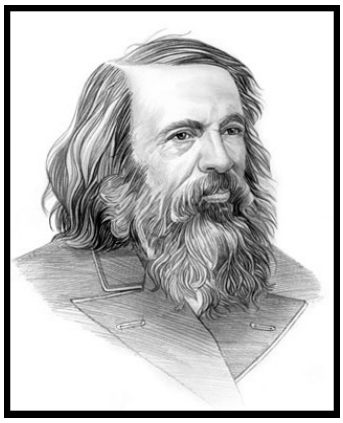
The credit for making periodic table at first goes to Mendeleef. He arranged elements in increasing order of their atomic weight and saw that after a fixed interval same properties of elements repeats. Considering it as basis, he gave periodic law, **''Properties of elements are periodic functions of atomic weight".**

Table 7.3 Mandeleef's Periodic Table

Group	I	II	III	IV	V	VI	VII	VIII
Oxide Hydride	R_2O RH	RO RH_2	R_2O_3 RH_3	RO_2 RH_4	R_2O_5 RH_3	RO_3 RH_2	R_2O_7 RH	RO_4
Periods ↓	A B	A B	A B	A B	A B	A B	A B	Transition series
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 29.98	Si 28.09	P 30.974	S 32.06	Cl 35.453	
4 First series: Second series:	K 39.102 Cu 63.54	Ca 40.08 Zn 65.37	Sc 44.96 Ga 69.72	Ti 47.90 Ge 72.59	V 50.94 As 74.92	Cr 50.20 Se 78.96	Mn 54.94 Br 79.909	Fe Co Ni 55.85 58.93 58.71
5 First series: Second series:	Rb 85.47 Ag 107.87	Sr 87.62 Cd 112.40	Y 88.91 In 114.82	Zr 91.22 Sn 118.69	Nb 92.91 Sb 121.75	Mo 95.94 Te 127.60	Tc 99 I 126.90	Ru Rh Pd 101.07 102.91 106.4
6 First series: Second series:	Cs 132.90 Au 196.97	Ba 137.34 Hg 200.59	La 138.91 Tl 204.37	Hf 178.49 Pb 207.19	Ta 180.95 Bi 208.98	W 183.85		Os Ir Pt 190.2 192.2 195.09

Mendeleef arranged periodic table in horizontal rows and vertical columns. He called the vertical colums as groups and horizontal rows as periods. His table had 8 groups which were divided in two sub groups, A and B. Till that time, noble gases were not known, Later to show them, a new group called zero group was made. Six periods were made, which were again divided in series.

Mendeleef arranged the elements in the table in the increasing order of atomic weight. He confirmed that elements with same type of physical and chemical properties should come in the same group, so that periodicity of elements is maintained. For it, somewhere he had to break the order of atomic weight. Like atomic weight of iodine (I) is 126.9 and tellurium (Te) is 127.6 but I is kept after Te because its properties resembles with properties of elements of VII group. In similar way, he left blank spaces for some elements in periodic table and did future predictions for them. He left gaps for Eka-boron, Eka-aluminum and Eka-silicon and predicted their properties which were proved correct later. Later they were called Scandium, Gallium and Germanium respectively. The formation of this table proved very useful and important in classification and study of elements.



D. Mendeleef's

Still this table could not explain all the facts like :

(i) At some places, increasing order of atomic weight was not followed.

(ii) Some elements with similar properties were kept in different groups and some elements with dissimilar properties in same group.

(iii) Hydrogen was not given fixed position.

(iv) Isotopes were not given any position.

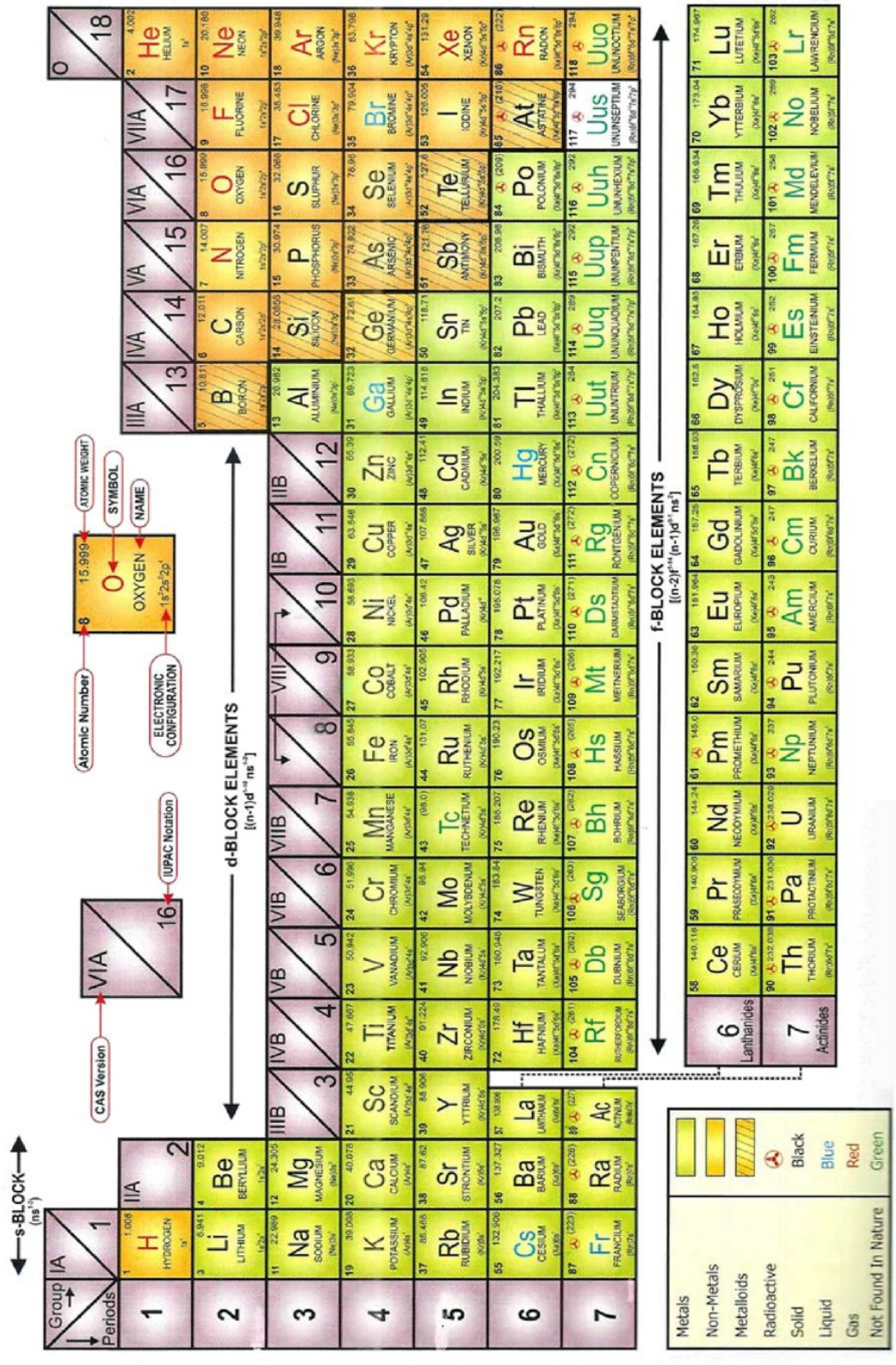
7.8 Modern periodic table

When Mendeleef made periodic table, then there was no information about arrangement of subatomic particles (e,p,n)in an atom, Thus, he considered atomic weight as the main property.

In the beginning of 20th century, after the information about electron, proton and neutron had arrived, **Henry Moseley** (in 1913), rearranged periodic table. He found that atomic number represent the elements in periodic table better than atomic weight. Thus, he gave modified periodic law according to which, **''Physical and chemical properties of elements are periodic function of their atomic number"** It is called Modern Periodic law.

In modern periodic table, elements are kept on the basis of increasing atomic number. In neutral atom, atomic number i.e. number of protons present in nucleus is same as total number of electrons present. So this periodic table itself represent the electronic configuration of elements. This form of periodic table is more simple and better detailed than Mendeleef periodic table. So it is also called extended or long form of periodic table. In this periodic table, horizontal rows are called periods and vertical columns are called groups. Number of groups are 18 and number of periods are from 1 to 7. Periods represent shell that means principle energy level n. First period have two elements. It is called **very short period** Second and third period have 8-8 elements, these are called **short period.** In fourth and fifth period, d-orbitals are also included. Both these periods have 18-18 elements. These are called **long period**. In sixth and seventh period, **f-orbitals** are also placed, so they have 32-32 elements, these are called **very long period.** Although each element of f-block is written in two

Table 7.4 Periodic Table



horizontal rows by 14-14 elements separately. In these, elements of first row are called **lanthanides** and elements of second row are called **actinides.**

From this periodic table, it is clear that in same group or same vertical column, outermost electronic configuration of elements is same. In all these elements of a group, number of valence electrons which means number of electrons in outermost shell are same. In that group, on going down, only number of shells increases. On the basis of last electron filled in outermost shell, these elements can be divided in four blocks. Group 1 and 2 are called s-block elements, group 13 to 18 are p- Block elements, group 3 to 12 are d-block elements and at bottom both horizontal rows are called f-block elements. In horizontal rows, elements of first row (4f series) comes after lanthanum, so these are called lanthanides. Elements of second row (5f series) comes after actinium, so these are called actinides. Elements of s-block are called alkali or alkaline **Earth metal**, p-block are called **principal elements**, d-block are called **transition elements** and elements of f-block are called **inner transition elements.** In periodic table, elements after uranium are called ultra uranium (transuranic) elements.

In this way, in periodic table, electropositive metallic elements are placed at left and electronegative non-metallic elements on the right. The zig-zag ladder like line below B, Si, As, Te and At make boundary between metal and non metals. These elements are called metalloids.

7.9 Periodicity in properties

On the basis of periodic table, many physical and chemical properties of elements can be explained. If in periodic table, we go from left to right in a period or move down in a group then there is a definite order of increase or decrease of physical and chemical properties of elements. This regular change in properties of elements depends on their electronic configuration. In the periodic table, there is gradual change in electronic configuration of elements, with it gradual change in properties of elements can also be seen.This sequential change in properties is called periodicity in properties and properties are called periodic properties. Like atomic radius, melting point, boiling point, ionization enthalpy, valency etc. Periodicity in some important properties are found this way.

7.9.1 Atomic Radius

The distance between nucleus and electron present in outermost shell of atom is called atomic radius. It is a very small unit. In a period, on moving from left to right, atomic number increases, thus number of proton in nucleus increases, so more nuclear attraction force act on electrons present in outermost shell, so the atomic radius decreases.

The force of attraction felt by electons of outermost shell of an atom by nucleus is called effective nuclear charge. Effective nuclear charge is always less than actual nuclear charge because mutual repulsion force between electrons present in outermost shell is balanced in small amount by nuclear attraction force. Effective nuclear charge is an important property by which periodicity of properties in periodic table is affected. On going from left to right in a period, effective nuclear charge increases and on moving down a group, it decreases.

On moving down a group, atomic number increases, number of shells also increases and value of effective nuclear charge decreases. So, atomic

radius increases.

Table 7.5 INCREASING ATOMIC RADIUS IN GROUP

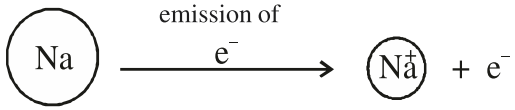
Element (group)	Atomic no.	Atomic radius (in pm)	No. of shells
Li	3	152	2
Na	11	186	3
K	19	231	4
Rb	37	244	5
Cs	55	262	6

Table 7.6 Decreasing Atomic Radius In period

Period II element	Li	Be	B	C	N	O	F
Atomic no.	3	4	5	6	7	8	9
Atomic radius (in pm)	152	111	88	77	74	66	64

7.9.2 IONIC RADIUS

When an atom accepts or donates electron then ion is formed Radius of ion is called ionic radius When an atom donates electron, then positive ion is formed



sodium atom
electronic configuration 2,8, 1
atomic radius 186 pm

sodium cation
electronic configuration 2,8
ionic radius 95 pm

Fig – 7.8 Small size of positive Ion

In formation of positive ion (cation), with removal of electron, outermost shell of electron gets completely over and effective nuclear charge on remaining electrons increases. So size of cation is always less than neutral atom.

When an atom accepts electron, then negative ion (anion) is formed.

chlorine atom
electronic configuration 2,8, 7
atomic radius 99 pm

chlorine anion
electronic configuration 2,8,8
ionic radius 181 pm

Fig – 7.9 Biger size of negative Ion

In formation of anion, number of electrons in outermost shell increases and value of effective nuclear charge decreases. So size of anion is always larger than size of neutral atom.

7.9.3 IONISATION ENTHALPY

The energy given to isolate an electron from a neutral atom of an element in gaseous state is called ionization enhalpy or ionization potential. It is measured in calorie/mole or Kilo Joule/mole or electron volt/mole.

As energy is given in this process so its value is always positive.

$$\text{Neutral atom}_{(g)} + \text{ionization enthalpy} \rightarrow \text{positive ion}_{(g)} + e^-$$

The energy given to separate first electron from neutral atom is called first ionization enthalpy and energy given to isolate one more electron from cation is called second ionization enthalpy. Similarly energy given to isolate third electron is called third ionization inthalpy. Generally, for an element, first ionization enthalpy (IE) < second IE < third IE.

On going from left to right in a period, as atomic size decreases and value of effective nuclear charge increases, so it becomes difficult to isolate electron from the atom. The value of ionization enthalpy increases.

On moving down a group, number of shells increases, so atomic size increases and due to decrease in effective nuclear charge, attraction on outermost electrons becomes less. So it is easy to separate electron from neutral atom. On moving down a group, value of ionization enthalpy of elements decreases.

7.9.4 ELECTRON GAIN ENTHALPY

It is also called electron affinity in gaseous state. When a neutral atom of any element accepts an electron, then negative ion (anion) is formed and the energy released is called electron gain enthalpy or electron affinity. Its value can be positive or negative, it depends on the nature of the element.

$$\text{Neutral atom (g)} + e^- \rightarrow \text{anion (g)} + \text{free energy}$$

(Electron gain enthalpy)

On going from left to right in a period, atomic size decreases and effective nuclear charge increases, so value of electron gain enthalpy increases. On going down in a group, some times irregularity can be found in atomic size.

7.9.5 Electronegativity

In covalent compounds, the property of attracting electron of chemical bond formed between two different atoms by an atom is called electronegativity. This is a relative tendency of elements.

On moving from left to right in a period, due to decrease in atomic size, electronegativity of elements increases. On moving down a group, atomic size increases, so value of electronegativity decreases. The most electronegative element is fluorine (F).

7.10 Valency

The number of electrons present in outermost shell of an element determines valency of that element. This property can be explained by electronic configuration of elements. Generally, the number of hydrogen atoms combining with an atom of an element or half of the number of oxygen atoms combining with an atom is called valency.

Element of same group show same valency because electronic configuration of their outermost shell are same. In members of s-block i.e. group 1 and 2 there are 1 and 2 electrons respectively in the outermost shell and their valency is also 1 and 2 respectively.

The valency of p-block elements or elements of group 13 to 17 is obtained by number of electrons present in its outermost shell or by subtracting the number of electrons present in outermost shell from 8.

Generally, valency of 18^{th} group is zero. On moving from left to right in a period, valency increases from 1 to 4 and then decreases. If element combines with oxygen then valency increases from 1 to 7. A part from this, d-block elements lanthanide and actinide elements show more than one valency, it is called **Variable Valency**. It is characteristic property of elements of this group. Now, oxidation state is used instead of valency. According to electronegativity, number of electrons or charge accepted by atom of an

Table 7.7 Valency of Elements

Group	No. of e^- in valence shell	Valency	Compound with H	Compound with O
1	1	1	NaH	Na_2O
2	2	2	CaH_2	CaO
13	3	3	AlH_3	Al_2O_3
14	4	4	SiH_4	SiO_2
15	5	3,5	PH_3	P_2O_5
16	6	2,6	H_2S	SO_3
17	7	1,7	HCl	Cl_2O_7

element from atom of another element, is called its oxidation state.

7.11 Atomic size

Atomic size is a measurement of distance of nucleus of an independent atom from its outermost shell. It is very difficult to measure size of one atom of any element because these are found as molecule or group of atoms. It is very rare for an isolated atom to exist. Thus, atomic size is determined on the basis of radius of that atom. Radius of an atom can be in any form of the following.

(i) Covalent radius (ii) Vanderwaals radius

7.11.1 COVALENT RADIUS

When two same atoms of an element are covalently bonded, then half of the distance between nuclei of both atoms is called covalent radius.

7.11.2 VANDERWAAL RADIUS

In solid state, half of the distance between atoms of two close non bonded molecules of same substance is called vanderwaal radius.

Thus, value of vanderwaal radius r_w is always greater than covalent radius r_c.

$$r_w > r_c$$

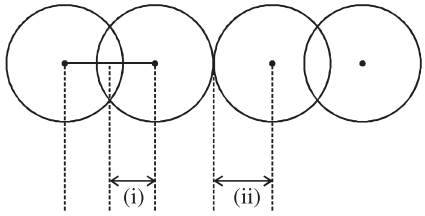


Fig 7.10 (i) covalent radius
(ii) Vanderwaal radius

Apart from it, size of atom can be determined on the basis of metallic radius. In crystal lattice of metal, half the distance between nucleus of two nearby atoms is called metallic radius.

In periodic table, atomic size increases. On moving down a group as number of shells increase on moving from left to right in a period, number of electron in that shell increases and effective nuclear charge also increases, so atomic size decreases.

Metallic and non metallic properties of elements depend on this periodic property of atomic size.

7.12Metallic and non-metallic properties

The tendency of an atom of any element to donate electron and form positive ion is called metallic property. Like alkali metals of group 1 are the most electropositive elements, because they easily donate electron and form positive ion. They possess highest

metallic properties.

The tendency of an atom of any element to accept electron and form negative ion is called non metallic property. Like the halogen group (group 17) elements easily accept an electron to form anion so they have strong non metallic properties.

On moving down a group, size of atoms of element increases and value of effective nuclear charge decreases. Value of ionization enthalpy sequentially decreases and formation of cation occurs easily. On moving from left to right in a period, atomic size of elements decreases and value of effective nuclear charge increases. Value of ionization enthalpy sequentially increases and formation of cation do not occur easily. That menas metallic properties of elements decreases. Metals have electropositive characters.

On moving from left to right in a period, atomic size decreases and due to increase in effective nuclear charge, electron gain enthalpy increases. So tendency to form anion increase and non-metallic properties of elements increases. On going down the group, electron gain enthalpy decreases so the non-metallic properties decreases.

Elements on left part of periodic table are rich in metallic properties, As we move to right, metallic properties decreases and non metallic properties increases Non-metals are electronegative i.e. they have electronegative characters.

In this way, a zigzag line is formed in periodic table which separates metals and non metals. The elements near this line possess both type of properties and are called metalloids. These are Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium and Polonium.

Generally, oxides of metal oxides are basic and non-metals are acidic.

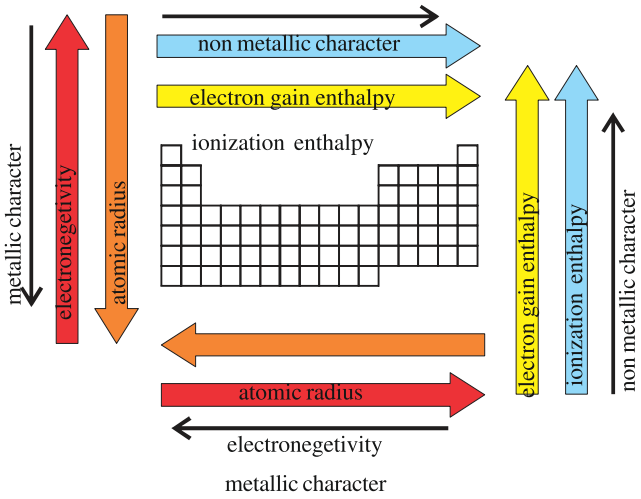


Fig. 7.11 Periodic properties of element in Periodic Table

Important Points

1. At first, Dalton gave atomic theory. He told that every substance is made up of atoms.
2. First atomic model was given by Thomson which is known as Plum Pudding model.
3. According to atomic model of Rutherford, most of the mass and positive charge of an atom is concentrated at its centre called nucleus. Most of the part of atom is empty in which electron revolve around nucleus.
4. Neil's Bohr told that electrons revolve around the nucleus in orbits of fixed energy.
5. The classification of elements was done for systematic study of elements.
6. In initial efforts of classification, Dobereiner's Triad, Newland's octave rule etc. were given.
7. The important effort in the classification of elements was of Mendleef. He gave periodic law, according to which, '' Properties of elements are periodic functions of their atomic weight."
8. Mendeleef created an important periodic table which wasdivided into periods and groups on the basis of increasing order of atomic weight.

9. Moseley further arranged Mendeleef's periodic law and gave modern periodic law. According to it, ''Properties of elements are periodic functions of their atomic number".
10. Modern periodic table is based on increasing order of atomic number. It has 7 periods and 18 groups.
11. Periodicity in physical and chemical properties is found due to their similar electronic configuration of in elements.
12. Atomic radius, ionization enthalpy, electron gain enthalpy, electronegativity etc. are periodic function of elements.
13. The number of electrons present in an outermost orbit of atom determines its valency.
14. Metallic and non-metallic properties of elements depends on their atomic size and other periodic properties.

Practice questions

Objective type questions

1. Which radiations Rutherford used in his experiment?
   (a) α (b) β
   (c) V (d) X
2. Which is the smallest particle of substance?
   (a)Molecule (b)Atom
   (c) Element (d) Compound
3. Who gave first periodic classification of elements?
   (a)Dobereiner (b) Moseley
   (c) Newland (d) Mendeleef
4. On which property modern periodic table is based?
   (a)Atomic structure (b) Atomic weight
   (c) Atomic number (d) Valency
5. Number of periods and groups in modern periodic table are
   (a)7 and 18 (b) 9 and18
   (c) 7 and 20 (d) 9 and 20
6. In periodic table, on moving down a group, atomic size,
   (a)decreases (b) remains constant
   (c) remains irregular (d) increases
7. Vanderwaal radius is .....than Covalent radius
   (a) smaller (b) larger
   (c) same (d) none of these
8. In short period, number of elements are :
   (a) 2 (b) 8 (c) 18 (d) 32
9. Energy given to isolate electron from neutral atom is :
   (a)electron gain enthalpy
   (b) electronegativity
   (c) Ioinization enthalpy
   (d) excitation energy
10. Which element has highest electronegativity
    (a) H (b) Na (c) Ca (d) F
11. Members of which groups have highest metallic properties:
    (a) 1 (b) 2 (c) 5 (d) 6

Very short type questions

12. Write the name of Thomson's model?
13. What are Bohr's orbits called?
14. What is modern periodic law?
15. Write Mendeleef 's periodic law ?
16. On the basis of which property Mendeleef kept elements in periodic order?
17. What name was given to members of 18^{th} group?
18. What are the other names of d-block and f-block elements?

Short type questions

19. Give the position of metals, non-metals and metalloids in the periodic table?

20. Explain periodicity in electron gain enthalpy in a group?
21. What do you understand by Vanderwaal radius and Covalent radius?
22. Cation is smaller than netural atom and anion a bigger than neutral atom. Why?
23. What is effective nuclear charge? How it change in a group and a period?
24. Valency shows which type of periodic property while going from left to right in a period?
25. Write Dalton's theory of atomic structure ?

Essay type questions

26. List merits and demerits of Mendeleef's periodic table?
27. How the following properties of elements show periodicity in periodic table. ?
    (i) Atomic radius
    (ii) Ionization enthalpy
    (iii) Electronegativity
28. Explain classification of elements by modern periodic table.
29. Describe Rutherford's gold foil experiment. Also explain result and conclusions of the experiment.

Answer key

1.(a) 2. (b) 3. (d) 4. (c) 5. (a)

6. (d) 7. (b) 8. (b) 9. (c) 10. (d)

11. (a)

Chapter -8
Carbon and Its Compounds

According to Berzelius (1815), it was believed that organic compounds can be obtained from the living organisms only and can not be synthesized by artificial methods in laboratory. This is known as vital force theory. Later, Substances obtained from living organisms were known as organic compounds and study of carbon compounds or organic compounds was known as organic chemistry.

But in 1828, Wohler synthesized an organic compound urea by heating a mixture of inorganic compounds, ammonium sulphate and potassium cyanate in laboratory

$$\underset{\text{Ammonium Sulphate}}{(NH_4)_2SO_4} + \underset{\text{Potassium cyanate}}{2KCNO} \xrightarrow{\Delta} \underset{\text{Amoniums cyanate}}{2NH_4CNO} + K_2SO_4$$

After this discovery by Wohler, vital force theory was failed and efforts for synthesis of organic compounds started in laboratory. We use many organic compounds in daily life such as in grains, table, chair, petrol, LPG paper, plastic, cloth, oil, soap, detergent, pencil, rubber etc. Carbon element is present in all these substances. Due to the smaller size of carbon atom it forms single, doulbe and triple bonds by making sigma (σ) and (π) bonds. Because of special characteristic properties of carbon atom, the number of compounds formed by carbon atom are greater than the number of compounds formed by other elements.

8.1 Characteristics of carbon atom

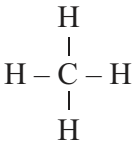
1. The atomic number of carbon atom is Six (6) in periodic table which is denoted as "C" (Symbol)

2. The electronic configuration of carbon atom is $1s^2\ 2s^2\ 2p^2$.

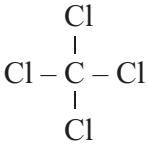
3. The valency of carbon atom is four. Carbon atom can combine with other elements to satisfy its four valencies as follows.

(i) With four monovalent atoms

Example CH_4, CCl_4 etc.



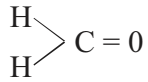
Methane



Carbon tetra chloride

(ii) With two monovalent and one divalent atom

Example- Formaldehyde



(iii) With one monovalent and one trivalent atom. Example - HCN

$H - C \equiv N$ Hydrogen cyanide

(iv) With two divalent atoms

Example CO_2

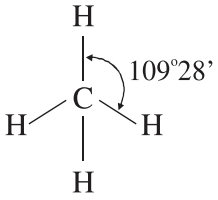
$O = C = O$ carbon dioxide

4. The geometry of carbon atom is tetrahedral in which four valencies of carbon atom are directed towards the four corners of a regular tetrahedron and the carbon atom is situated at the centre of regular tetrahedron. The bond angle between each valency is 109°28'

Regular Tetrahedron: "A tetrahedron has Four triangular faces, one of which is the base and the three corners of the triangular base

are joined to an apex forming the other three triangular faces".

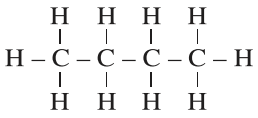
Bond Angle: "The angle in between two adjacent bonds in a molecule is called the bond angle" for example in CH_4 bond angle is $109^0 28'$ with tetrahedral geometry.



Methane (Tetrahedral Geometry)

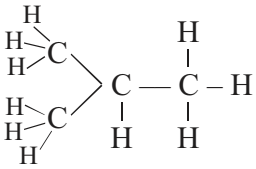
5. Carbon has the special ability to bond to itself, forming branched, unbranched or cyclic chains of carbon to carbon bonds. This property of carbon atom is called "Catenation"

For example Butane



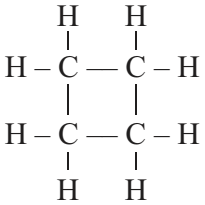
Unbranched chain

Isobutane



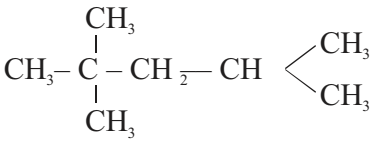
Branched chain

Cyclobutane



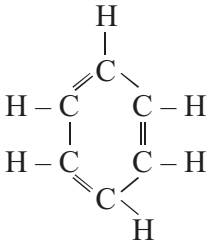
Aliphalic cyclic compound

Isooctane

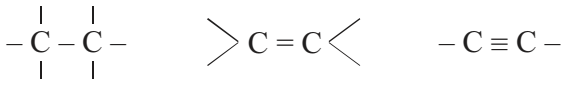


Highly branched

Benzene

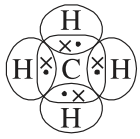


6. Carbon atom can form single, double and triple bond combine with other carbon atom. Example

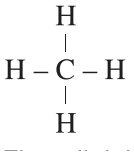


Alkane Alkene Alkyne

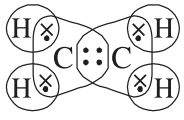
7. Carbon atom and hydrogen atom form covalent bond by equal sharing of electrons due to almost same electronegativities of both. In this process octet of carbon and nearest inert helium gas configuration duet of hydrogen is obtained. Compound so formed by carbon and hydrogen are knwon as hydrocarbons.

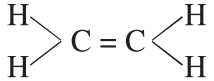


(Electronic formula of methane)

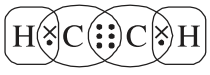


Structural formula of methane





Electron dot strucutre of ethene Structural formula of Ethene



$H - C \equiv C - H$

Ethyne

8.2 Hydrocarbon and its classification

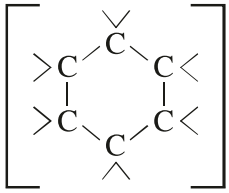
Compounds formed by carbon and hydrogen are known as Hydrocarbons. Example CH_4, C_2H_6, C_2H_4,

8.2.1 Classification of Hydrocarbons

Hydrocarbons

Open chain Hydrocarbons
or
(Acyclic Hydrocarbons)
or
(Aliphatic Compounds)

Closed Chain Hydrocarbons
or
(Cyclic Hydrocarbons)



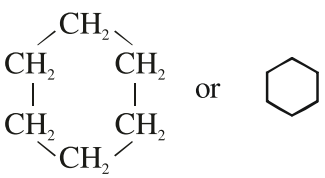
Saturated Hydrocarbons
(Single bond is present in between carbon-carbon atom Example methane, ethane propane etc).

Unsaturated Hydrocarbons

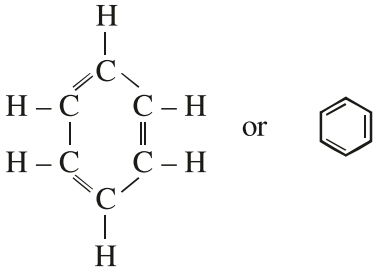
Alkene
(Carbon-carbon double bond is present)
Example: Ethene, propene etc.

Alkyne
(Carbon-carbon triple bond is present)
Example-Acetylene, propyne etc

Alicyclic Hydrocarbons
(Aliphatic compounds)
Burns without smoky flame
Example. Cyclohexane



Aromatic Hydrocarbons
Burns with smoky flame
Example. Benzene



C_2H_2 etc. Generally in nature atoms are not present in free state, they combine with other atoms and form molecule to attain stability. Carbon atom also combines with other atoms like C, H, N, O, S etc and form organic molecules to attain stability.

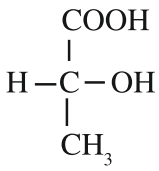
8.3 Nomenclature of organic compounds

To identify and two understand numerous orgnic compounds, naming of these compounds is essential. There are three prevalent systems of naming the organic compounds.

1. Trival System
2. Derived System
3. IUPAC System (International union of pure and applied chemistry)

1. **Trival System:** In this system the compounds are given names which usually refer to the natural source or property of the compuonds.

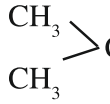
Table 8.1 Nomenclature as per Trival System

Formula	Trival Name	Natural Source
CH_4	Marsh gas	First detected in marshy places
CH_3OH	Wood spirit	First obtainerd by dry distillation of Wood
CH_3COOH	Acetic Acid	Latin: Acetum = Vinegar
HCOOH	Formic acid	Latin: Formica = ants
	Lactic acid	First obtained by distillation of red ants Obtained from lactum (Milk)

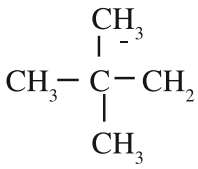
In the trival system, the unbranched hydrocarbons are called normal or n - compounds.

Example- n - pentane

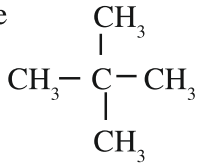
$$CH_3 - CH_2 - CH_2 - CH_2 - CH_3$$

If the compounds have  grouping, it is known as iso-compound

Exmaple isopentane 

If the compound has 

grouping; it is known as Neo-compound

Example- Neopentane 

2. Derived System: In this system of nomenclature the compoounds are named as the derivatives of a simpler compound.

3. **IUPAC System:** International union of pure and applied chemitry adopted a uniform system of naming organic compounds.

Alkane, Alkene and Alkynes (Hydrocarbons) are named as follows-

1. Prefix is used as per number of carbon atoms present in hydrocarbons.
2. Suffix is used as per type of bond present in molecule.
3. Combining prefix and suffix the complete name of hydrcarbon is written.

Table 8.2 Nomenclature as per derived System

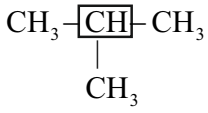
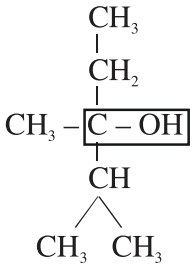
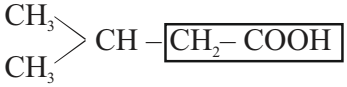
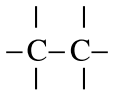
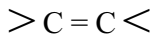
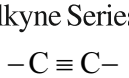
Simple Compound	Derivative of Simple Compound	Name of derivative
CH_4 (Methane)		Trimethyl methane
CH_3OH (Carbinol)		Methyl carbinol
		Methyl Ethyl Isopropyl carbinol
CH_3COOH (Acetic acid)		Isopropyl acetic acid

Table 8.3 Selection fo Prefix.

Number of carbon atoms in molecule	Prefix
C_1	Meth
C_2	Eth
C_3	Prop
C_4	But
C_5	pent
C_6	hex
C_7	hept
C_8	Oct
C_9	Non
C_{10}	Dec

Table 8.4 Selection of Sufix in hydrocarbons

Type of bond in between Carbon-Carbon atom	Suffix
(i) Alkane Series (Single bond) 	– ane
(ii) Alkene Series (double bond) 	– ene
(iii) Alkyne Series (Triple bond) 	– yne

8.3.1: The general formulaof alkane is C_nH_{2n+2}.

These compounds are also known as saturated compounds or paraffins.

Rules for Nomenclature

1. Longest carbon chain is selected for naming. The atom or group which remains out of the chain is denoted as substituent.

2. If two or more than two chains are having same number of carbon atoms then more substituent containing chain is selected.

3. Names of substituents are written first using their prefixes in alphabetical order.

4. If the number of identical substituents are more than one in a molecule, then number of identical substituents are denoted as per the table 8.5

Table. 8.5 The word used for number of identical substituents

Number of Identical Substiuents	Word used
One	Mono
Two	Di
Three	Tri
Four	Tetra
Five	penta
Six	Hexa
Seven	Hepta
Eight	Octa
Nine	Nona
Ten	Deca

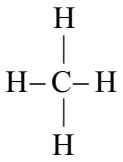
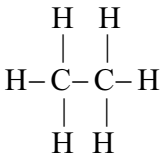
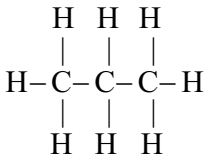
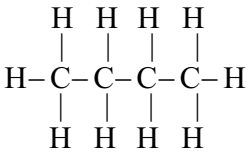
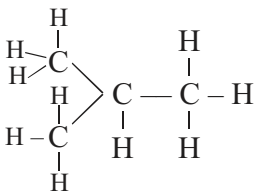
Some important subtituents are as follows

$-CH_3$	methyl
$-CH_2-CH_3$	ethyl
$-CH_2-CH_2-CH_3$	propyl
$-CH<\begin{matrix}CH_3\\CH_3\end{matrix}$	Isopropyl
$-CH_2-CH_2-CH_2-CH_3$	butyl
$-Cl$	Chloro
$-Br$	Bromo
$-I$	Iodo
$-F$	Fluoro
$-NO_2$	Nitro

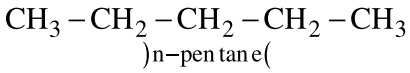
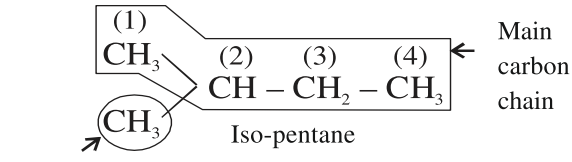
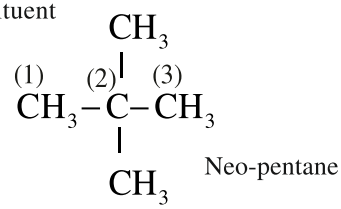
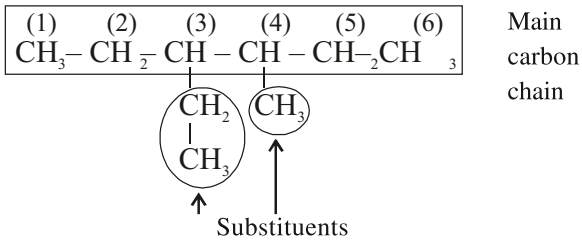
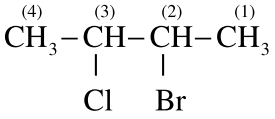
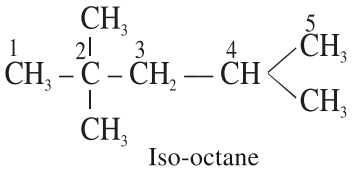
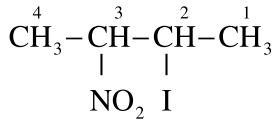
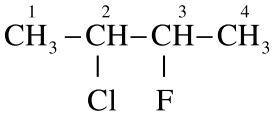
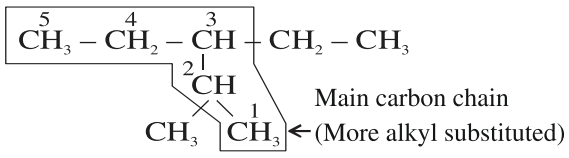
5. **Numbering of substitutents:** Minimum number is given to substituents. If two substituents are symmetrically placed on a carbon chain, the substituent coming first in the alphabetical order is assigned the lower position number.

6. At the time of writing the name of organic compound a comma (,) is written between two numerals and a hyphen (-) between a numeral and the name of the compound.

Table 8.6 Number of carbon atoms, Structural formula and IUPAC Name

Number of carbon	Formula	Structural formula	IUPAC Name
1	CH_4		Meth + ane = Methane
2	C_2H_6		Eth + ane = Ethane
3	C_3H_8		Prop + ane = Propane
4	C_3H_8		But + ane = Butane
5	C_4H_{10}	 (आइसोब्युटेन)	2-Methyl propane

Some other formulae and their IUPAC names

Formula	IUPAC Name
	Pentane
	2-Methyl butane
	2, 2 -Dimethyl propane
	3-Ethyl-4-methyl hexane
	2-Bromo- 3- Chlorobutane
	2, 2, 4 - Trimethyl Pentane
	2-Iodo- 3- nitrobutane
	2-Choloro- 3- fluorobutane
	3-Ethyl-2-methyl pentane

8.3.2 Nomenclature of alkenes

The general formula of alkene is C_nH_{2n}

* In these compounds carbon-carbon double bond is present, hence smallest alkene posses minimum two carbon atoms.

* These compounds are known as unsaturated hydrcarbons.

* These compounds give oily liquid reacting with bromine water, therefore these are also known as olefines.

* Suffix- ene is used for this series.

Rules for Nomenclature

1. Carbon-carbon double bond containing longest chain is selected as a main chain for nomenclature.

2. Minimum number is given to double bond.

3. Other rules are as per nomenclature of alkanes

some examples.

Formula	**IUPAC Name**
$CH_2 = CH_2$ (Ethylene)	Eth+ene=Ethene
$CH_3 - CH = CH_2$	Prop+ene=Propene
$\overset{4}{C}H_3-\overset{3}{C}H_2-\overset{2}{C}H=\overset{1}{C}H_2$	1-Butene
$\overset{1}{C}H_3-\overset{2}{C}H=\overset{3}{C}H-\overset{4}{C}H_3$	2-Butene
$\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{C}H=\overset{2}{C}H-\overset{1}{C}H_3$	2-Pentene
$\overset{5}{C}H_3-\overset{4}{C}H_2-\overset{3}{C}H_2-\overset{2}{C}H=\overset{1}{C}H_2$	1-Pentene
$CH_3-CH_2-\underset{\underset{{}^1CH_2}{\|}}{\overset{2}{C}H}-\overset{3}{C}H_2-\overset{4}{C}H_3$	2-Ethyl-1-Butene

$\overset{3}{C}H_3 \diagdown \overset{2}{C} = \overset{1}{C}H_2$ (CH$_3$ above, CH$_3$ below) — 2-Methyl-1-propene

$\overset{3}{C}H_2(Cl)-\overset{2}{C}H=\overset{1}{C}H_2$ — 3-Chloro-1-propene

$\overset{1}{C}H_2=\overset{2}{C}H-\overset{3}{C}H=\overset{4}{C}H_2$ — 1-Chloro-2-Butene

If number of double bonds are more than one, then, di, tri, tetra etc are used to represent number of double bonds. Example

$\overset{1}{C}H_2=\overset{2}{C}H-\overset{3}{C}H=\overset{4}{C}H_2$ — 1, 3-Butadiene or (Buta -1, 3-diene)

8.3.3. Nomenclature of Alkynes:

* General formula of these compounds is C_nH_{2n-2}.

* These compounds are also known as unsaturated hydrocarbons

In these compunds carbon carbon triple bond is present hence, smallest alkyne posses two carbon atoms.

* Suffix -yne is used for this series.

Rules for nomenclature

1. Carbon-carbon triple bond containing longest chain is selected as a main chain for nomenclature.

2. Minimum number is given to triple bond .

3. If number of triple bonds are more than one, then di, tri tetra etc are used to represent number of triple bonds.

Examples

Formula	IUPAC Names
$HC \equiv CH$ (Acetylene)	Eth + yne = Ethyne
$HC \equiv C - CH_3$	Prop + yne = Propyne
$\overset{4}{C}H_3 - \overset{3}{C}H_2 - \overset{2}{C} \equiv \overset{1}{C}H$	1-Butyne
$\overset{4}{C}H_3 - \overset{3}{C} \equiv \overset{2}{C} - \overset{1}{C}H_3$	2-Butyne
$\overset{5}{C}H_3 - \overset{4}{C}H(\overset{}{CH_3}) - \overset{3}{C} \equiv \overset{2}{C} - \overset{1}{C}H_3$ (CH$_3$: Substituent)	4-methyl-2-pentyne
$\overset{4}{C}H_2(Cl) - \overset{3}{C}H_2 - \overset{2}{C} \equiv \overset{1}{C}H$	4-chloro-1-butyne
$\overset{1}{H}\overset{}{C} \equiv \overset{2}{C} - \overset{3}{C}H_2 - \overset{4}{C} \equiv \overset{5}{C}H$	1, 1, 4-Penta diyne

8.4 Allotropes of carbon

Two or more than two forms of an element which are quite different in properties from each other are known as allotropes and this property is known as allotropy or allotropism".

In nature, carbon elements is present in various forms with different physical properties. For example diamond, graphite, fullerene etc. All these forms are made by carbon atoms and they differ from each other due to difference in bonding of carbon atoms

Crystalline Allotrope: "Allotrope in which carbon atoms are arranged in a definite geometry with definite bond angle is known as crystalline allotrope."

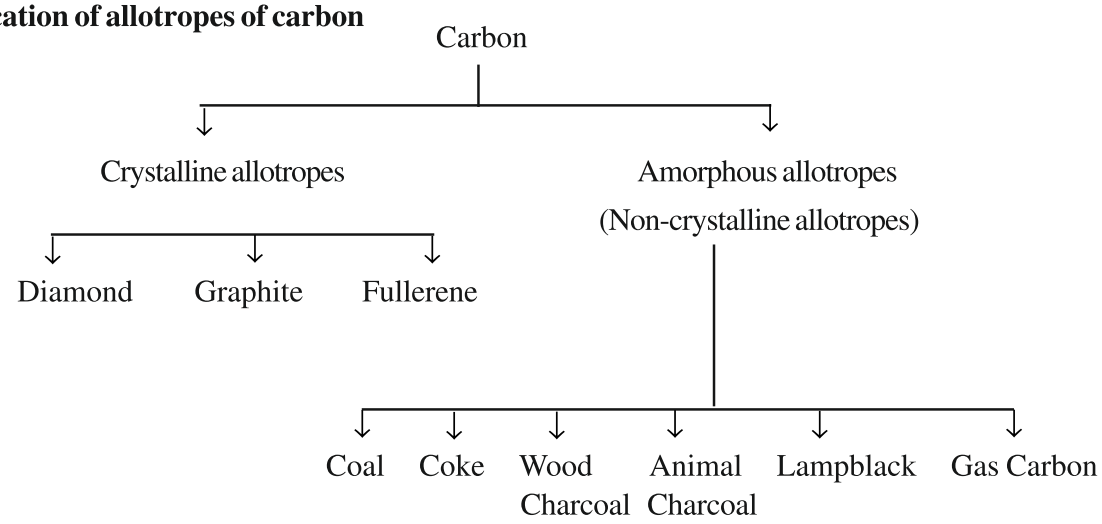
1. **Diamond:** (i) In diamond each carbon atom is bonded with four other carbon atoms in rigid three dimensonal tetrahedral geometry.

(ii) It is the purest from of carbon

(iii) Carbon carbon bond distance in diamond is 1.54 Å.

(iv) Diamond is non-conductor of electricity because all the four valencies of carbon atom are bonded with four other carbon atoms,

Classification of allotropes of carbon



hence, free electrons are not available.

(v) There is a three-dimensinal net work of strong covalent bonds in structure of diamond. It is the cause that diamond is the hardest among the known substances present.

(vi) Melting point of diamond is 3843 K.

(vii) Due to pressure of rocks on layers of coal diamond becomes transparent in nature.

(viii) By subjecting pure carbon at extremely high temperature and pressure, diamond can be synthesized.

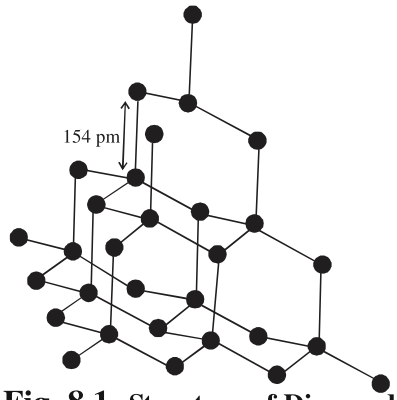


Fig. 8.1 Structure of Diamond

1. Uses of Diamond

(i) It is used as a glass cutter.

(ii) It is used in machines, which are used in cutting rocks and stones.

(iii) It is used in making phonogram needles.

(iv) Diamond is used in manufacturing of gems and jewellery.

2. Graphite

Word graphite is derived from word Grapho, meaning of grapho is "Writing". Graphite is used in our pencils for writing purpose.

(i) In graphite, each carbon atom is bonded with three other carbon atoms in the same plane making hexagonal ring structure. Among these bonds one bond is double bond, hence, valency of carbon atom is satisfied.

(ii) Structure of graphite is two dimensonal structure having regular hexagonal sheets.

(iii) Sheets of graphite slide over one another due to presence of weak bonds and more distance in between them . It is the cause that graphite is used as a dry lubricant..

(iv) Due to presence of free electrons and vacant space in between two layers of graphite it is a good conductor of electricity.

(v) Graphite is a soft and greyish black cloured substance.

(vi) It is a smooth and slippery substance.

Table 8.7 Comparative study of Diamond and Graphite

S.No.	Property	Diamond	Graphite
1.	Structure	Tetrahedral	Hexagonal and arranged in layers
2.	Physical state	Colourless and Transparent	Shiny opaque and Greyish black coloured
3.	Hardness	Hardest substance	soft and smooth
4.	Specific density	3.51	2.25
5.	Electrical Conductivity	Non-conductor of electricity	Good conductor of electricity

(vii) It is a shiny substance.

Uses of Graphite: 1. Graphite is used in pencil

2. It is used as a dry lubricant

3. It is used in making electrodes.

4. It is used to polish the things made up of iron.

5. It is used as a moderator in nuclear atomic reactor.

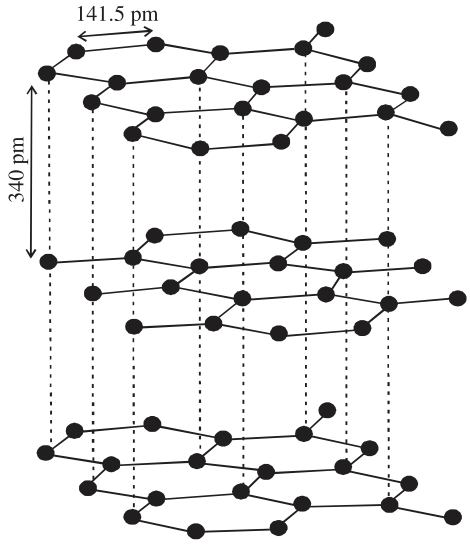


Fig. 8.2 Structure of Graphite

3. Fullerene:

1. The structure of fullerene is similar to foot ball.

2. The name of fullerene is a reference to Buck minister Fuller, a popular American architect.

3. The molecule of fullerene contains C_{60}, C_{70} or more carbon atoms.

4. The most stable fullerene is C_{60} which is known as Buckminister Fullerene.

5. C_{60} contains total 32 faces; out of these 20 are hexagonal and 12 are pentagonal. It has a football like structure, hence, known as "Buckyball".

6. C_{60} is non conductor of electricity and carbon carbon bond distance in C_{60} is 1.40 Å.

7. Fullerene looks like the geodesic dome.

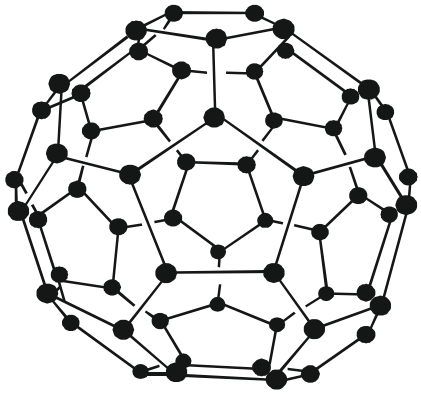


Fig. 8.3 Structure of Fullerene

Uses of Fullerene

1. It is used in purification of natural gas

2. It is used in molecular bearing

3. Technically it is an important allotrope of carbon it behaves like super conductor at higher temperature

8.5 Some Important Organic Compounds Useful in Daily Life

8.5.1 Chloro-Fluoro Carbon or freons: "Freons are polychlorofluoroalkanes". Compounds in which carbon atom is linked with chlorine and fluorine are known as chlorofluorocarbon (CFC) or freons.

Synthesis of Freons: When carbon tetrachloride (CCl_4) is reacted with hydrogen fluoride (HF) in presence of $SbCl_5$, it gives freon-11

$$CCl_4 + HF \xrightarrow{SbCl_5} CCl_3F + HCl$$

Trichloromonofluoro methane
Freon–11

Nomenclature of Freons- The number of carbon, hydrogen and fluorine atoms present in the molecular formula of freon are used for nomenclature of freons as follows.

Freon - XYZ Here

(i) X = One less than the number of carbon atoms in freon molecule (C-1)

(ii) Y = One more than the number of hydrogen atoms in freon molecule (H +1)

(iii) Z = Number of fluorine atoms in freon molecule.

Uses of Freons: 1. Freons are used as inert solvents.

2. Freons are used as refrigerants in refrigerator, airconditioner and cold storages.

Table 8.8 Nomenclature of Some Important freons

Molecular Formula	X	Y	Z	Nomenclature of Froen
$CFCl_3$	0	1	1	Freon -11
CF_2Cl_2	0	1	2	Freon -12
$C_2F_2Cl_4$	1	1	2	Freon -112
$C_2F_3Cl_3$	1	1	3	Freon -113

8.5.2. CNG (Compressed natural gas):

Compressed natural gas is known as CNG. CNG is composed mainly of methane and some other hydrcarbons. CNG has less percentage of carbon, therefore, its combution yields less CO (carbon monoxide) and CO_2 (Carbondioxide). For this reason CNG is less harmful for nature in comparison to other petroleum products. Layers of gases which are found in deep underground above petroleum are known as natural gases. During the extraction of petroleum, natural gases are also obtained. When natural gas is compressed at high temperature it is known as compressed natural gas.

CNG is diffrent from LPG. By fractional distillation of petroleum, the gas which are released along with many other components of petroleum are known as petroleum gases. When these gases are compressed at high pressure and converted into liquid state, then it is known as LPG (Liquid Petroleum Gas)

CNG is more safer than LPG, because it is lighter than LPG. So when there is a CNG leakage then it spreads out in air wheares LPG is heavier so it collects in lower layers which increases the chance of accident.

Uses of CNG:

1. It is used as fuel.

2. CNG is used in place of petrol and diesel in vehicles used for transportion.

8.5.3. **Polymers -** When a number of simple molecules unite with each other to form a long chain molecule with high molecular mass and same emprical formula. This long chain molecule having repeating structural units is called a polymer and the starting simple molecule as monomers. This process in known as polymerisation. Polymers are mainly classified in two categories.

1. Natural Polymers
2. Synthetic Polymers

1. **Natural Polymers**: Polymers which are directly obtained from nature. For example natural rubber, Starch, cellulose, resin etc.

Natural Rubber: It is obtained from rubber free in liquid form. This liquid is known as Latex.

Natural rubber is a polymer of isoprene.

$$n\left[CH_2=CH-\underset{\displaystyle CH_3}{\underset{|}{C}}=CH_2\right] \xrightarrow{\text{Polymerisation}} \left[-CH_2-CH=\underset{\displaystyle CH_3}{\underset{|}{C}}-CH_2\right]_n$$

Isoprene

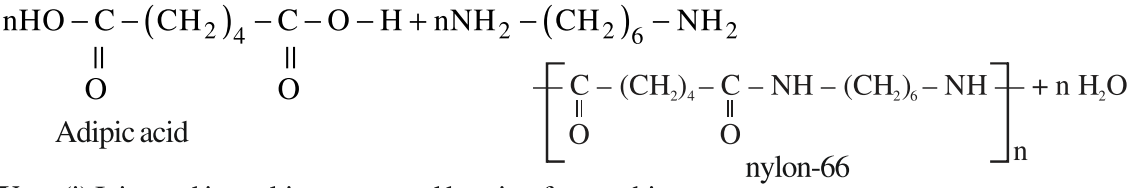
Polyisoprene
(Nautral rubber)

When acetic acid is added in latex, it is converted into solid. The rubber so obtained is soft and has low tensile strength. To improve its tensile strength and elasticity it is heated with sulphur (S). This process is known as vulcanization. Rubber obtained after valcanization is strong, hard, elastic and highly resistant to wear and tear.

2. Synthetic polymers: Man made polymers are known as synthetic polymers or artificial polymers. For example artificial fiber, plastic, synthetic rubber etc.

A. **Artificial fiber**: For example Nylon-66, Terylene, Rayon etc.

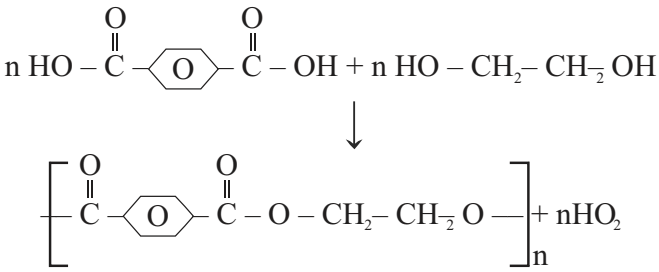
(i) Nylon-66: It is synthesized by condensation of adipic acid (six carbon atoms) and hexamethylene diamine (six carbon atoms) hence, it is knwon as nylon-66.



Uses (i) It is used in making gears and bearing for machines.

(ii) It is used in making tyres, clothes, fibers, ropes, brush etc.

(ii) Terylene: It is synthesized by condensation of ethylene glycol and terephthalic acid. It is also known as "Dacron".

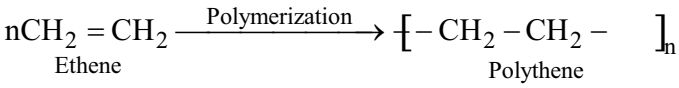


Uses: It is used in making clothes, sail of boats, belts, mangnetic tape, films etc.

(iii) **Rayon**: Initially cellulose is washed by sodium hydroxide solution and then dissolved in carbondisulphide (CS_2). This solution is passed through fine holes and mixed with dilute sulphuric acid. The fine shiny fibers of rayon are formed.

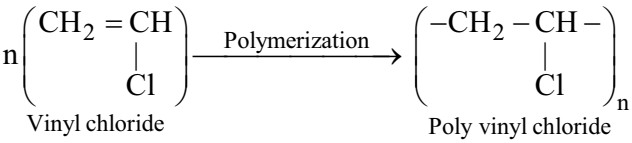
Uses: It is used in making clothes, threads, carpets etc.

(B) **Plastic (i) Polythene:** At high temperature and pressure in presence of catalyst, ethene molecules are polymerized to give polythene. It is flexible and strong plastic.



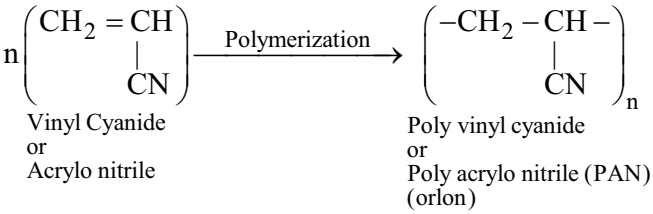
Uses: It is used in making carry bags, pipes, tubes etc.

(ii) Poly vinyl Chloride: It is obtained by polymerization of viny chloride.



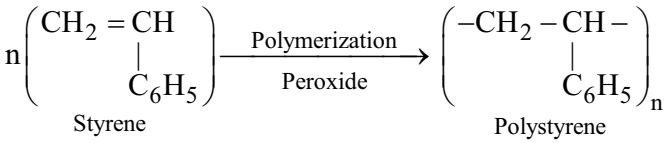
Uses: It is used in making pipes, shoes, sandals, bags, rain coats, toys, phonogram recorder, electric insulator layers. etc

(iii) Poly acrylonitrile or orlon: It is obtained by polymerisation of vinyl cyanide



Uses: It is used in making sweater, pillow, mattresses etc.

(iv) **Poly Styrene**: It is obtained by polymerization of vinyl benzene (styrene)



Uses: It is used in making tea cups, bottle caps, parts of refrigerator, wall tiles, packing material etc.

(c) Synthetic rubber: These are mainly of two types

(i) Buna- S (synthesized by butadiene and styrene)

(ii) Buna-N (Synthesized by butadiene-and acrylonitrile)

In presence of CO_2, 2-3,dimethyl-1,3 - butadiene is catalysed by sodium catalyst to give rubber like product. Which is named as Buna. Here Bu-represents butadiene and Na-represnts sodium catalyst.

Uses Used in making oil containers, Fuel tanks, tyres tubes, medical instruments, petrol tapes shoe soles etc.

Important Points

1. Carbon is tetravalent is nature. these four valencies are oriented towards four corners of a regular tetrahedron.

2. There is an important property in carbon atom by which it forms number of compounds bonding with carbon-carbon. This property is known as "catenation".

3. Covalent bond is present in between carbon and hydrogen. Compounds composed by carbon and hydrogen are known as hydrocarbons.

4. Hydrocarbons are classified into three categories.

(i) Alkane, (ii) Alkene, (iii) Alkyne

5. Carbon-carbon single bond is present in alkane, in alkene it is double bond and in alkyne it is triple bond.

6. There are three methods for nomenclature of organic compounds.

(i) Trival system (ii) Derived system
(iii) IUPAC-System

7. IUPAC system is accepted globally at present.

8. There are two main allotropes of carbon

(i) Crystalline allotropes (ii) Amorphous allotropes

9. Diamond, graphite and fullerene are main crystalline allotropes.

10. Diamond is hardest among the known substances, bright and non conductor of heat and electricity

11. Graphite is soft, smooth and greyish black substance. It is good conductor of heat and electricity.

12. The fullerene molecule posses 60 to 70 carbon atoms. It is denoted as C_{60} or $C_{70.}$. It behaves as super conductor at higher temperature.

13. Polychlorofluoroalkanes are known as freons. These are used a refrigerants.

14. Compressed natural gas is known as CNG. It is used as fuel and an alternative of petrol and diesel for vehicles.

15. When a number of simple molecules unite with each other to form a long chain molecule is knonw as a polymerization. Simple molecules are known as monomers and huge molecule is known as polymer.

16. Polymers are of two types

(i) Natural polymers

(ii) Synthetic polymers

17. Main artifical fibers are Nylon-66, Terylene, Rayon etc.

18. Some important plastics are polythene, polyvinyl chloride, orlon, polystyrene etc.

19. Natural rubber is a polymer of isoprene.

20. To improve the quality and tensile strength of natural rubber it is heated with sulphur., It is known as vulcanization.

21. Buna-S and Buna-N are two types of synthetic rubber.

Practice questions

Objective type questions

1. The value of bond angle in methane is

(a) $109^0 28'$ (b) 120^0

(c) 180^0 (d) 105^0

2. C_5H_{10} hydrocarbon is

(a) Pentane (b) Pentene

(c) Pentyne (d) Pentadiene

3. The molecular formula of Freon -11 is

(a) $CFCl_3$ (b) $C_2F_2Cl_4$

(c) CF_2Cl_2 (d) C_2F_4Cl

4. Natural rubber is polymer of

(a) Neoprene (b) 1, 3-Butadiene
(c) Isoprene (d) Buna-N

5. Which allotrope of carbon is good conductor of electricity.

(a) Diamond (b) Graphite

(c) Fullerene (d) Coke

6. To improve the quality and tensile strength of natural rubber it is heated with sulphur. This process is known as

(a) Polymerization (b) Saponification

(c) Vulcanization (d) Equalization

7. If number of carbon atoms are 3 then prefix used is

(a) Eth- (b) Prop-
(c) But- (d) Pent-

8. The IUPAC name of $CH_2 = CH - CH_2 - Cl$ is

(a) 1-chloro-2-propene

(b) Prop-1-chloro-2-ene

(c) 3-chloro-2-propene

(d) 3-chloro-1-propene

Very short type questions

9. Write the general formula of alkane, alkene and alkynes.

10. Hydrocarbons are made up of which two elements.

11. Write the full name of IUPAC.

12. Give the definition of Vulcanization.

13. How many number of carbon atoms are possible in Fullerene?

14. Which type of geometry is present in carbon atom?

15. Write the definition of Freon.

16. Name the scientist who synthesized first organic compound?

17. Write the full form of CNG.

18. Give the name of monomers by which orlon is formed by polmerization process.

19. Name the allotropes of carbon

20. Write the IUPAC name of Isobutane.

21. Write the full name of PAN

22. By polymerization of which monomer, PVC is formed.

Short type questions

23. Write any three differences between diamond and graphite.

24. What do you understand by catenation tendency of carbon atom?

25. Write the IUPAC name and strucutral formula of the following

(i) C_5H_{12} (ii) C_4H_8

(iii) C_3H_4

26. Write two uses of freon

27. Why CNG is better than LPG as a fuel?

28. Why diamond is hard and graphite is soft.

29. Write any four characteristics of Fullerene.

30. Draw the sketch of clasification of hydrocarbons.

31. Write the uses of graphite

32. Write the main characteristics of carbon atom

33. Write the IUPAC names of following

(i) Iso-octane (ii) $\begin{matrix} CH_3 \\ CH_3 \end{matrix} > C = CH_2$

(iii) Neopentane (iv) $CH_3 - \underset{\underset{Br}{|}}{CH} - \underset{\underset{Cl}{|}}{CH} - CH_3$

34. What is plastic? Write names of main plastic polymers.

35. Write the utilities of diamond and Fullerene.

36. Explain the nomenclature of Freon.

Essay type questions

37. What do you mean by synthetic polymers? Write their process of synthesis and uses.

38. Write a note on following

(i) Freon (ii) CNG

(iii) Natural Rubber

39. (a) Write the main rules applied in nomeclature of alkanes.

(b) Write the formula for the following

(i) Neopentane (ii) Isopentane

(iii) 1, 3-Dichloropropane

(iv) 3-Ethyl-4-methyl hexane

(v) 3-methyl-1-butene

Answer key

1.	(a)	2.	(b)	3.	(a)
4.	(c)	5.	(b)	6.	(c)
7.	(b)	8.	(d)		

Chapter - 9
Light

We see different colourful objects throughout the day but in a dark room or in night our vision and capacity to distinguish colours diminisihes. When we use a bulb then in the light of the bulb we can see even in dark room or in night. Sun is our source of light on earth. When light falls on an object then the object absorbs a few of the colours of light and reflects the rest of the colours. When this reflected light from object reaches our eyes then an image is formed on retina and we can see the object and its colour. An object appears red when it reflects red colour from the light falling on it. If an object transmits all colours through it then we see it as transparent and when object absorbs all colours falling on it then the object appears black. Similarly when an object reflects all colours falling on it then it will appear white to us.

We observe light travelling in straight lines in day to day life but it does not travel in straight line always. When light rays falls on very small obstacles (of the order of the wave length of the light) then light bends around the edges of the object. Wave nature of light is used to understand interference and diffraction phenomena. Interpretation of interaction of light with matter and photo electric effect could not be done with wave nature of light and particle nature of light was used in such explanations. Scientist de Broglie proposed dual nature of light and said that light behaves both as wave and as particle. This dual nature is represented as wavepacket in quantum mechanics. According to this concept the light photons behave some times as wave and some times as particles.

We also observe that when light falls on an opaque object then an image is formed. Image formation is because of linear propagation of light. Light travel in all directions from a light source but in laboratory experiments we restrict light in special direction for the ease of conducting experiments. In figures we usually represent light rays as straight lines but practically isolating a single light ray is almost impossible. In this chapter we shall study phenomena of reflection and refraction using linear propagation of light.

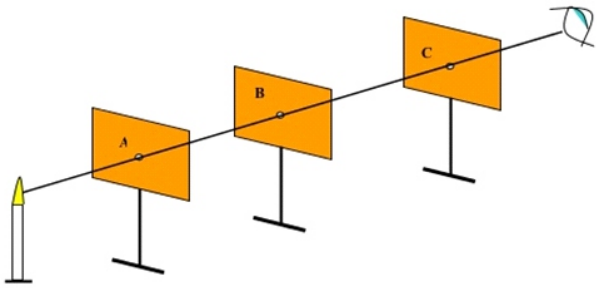


Fig. 9.1 (a) Linear propagation of light

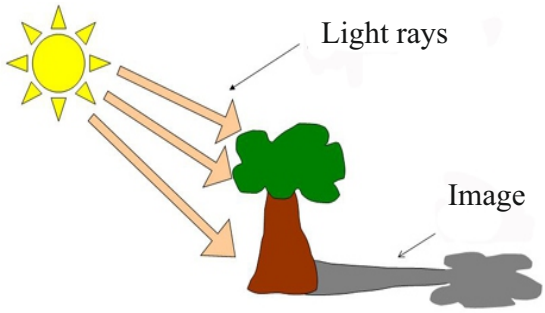


Fig. 9.1 (b) Image of an object

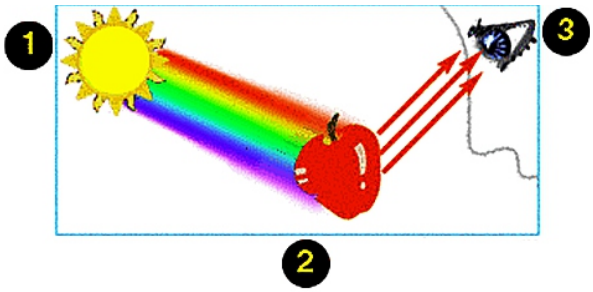


Fig. 9.1 (c) Red colour of an apple

9.1 Reflection of light

Reflection is the change in direction of a wave front at an interface between two different media so that the wavefront returns into the medium from it originated. We encounter two types of reflections in routine : - regular reflection and diffused reflection.

Regular reflection

When light is incident on any smooth plane surface (like mirror) then on looking from a specific direction that plane surface looks shinning while from other direction the surface does not shine. If we change the plane of the mirror then the mirror shines from some other direction. Similarly if the direction of incidence of light is changed then morror gives shining from some other direction decided by the laws of reflection. This deflection of incident light beam by smooth plane surface in the specific direction in the same medium is known as regular reflection.

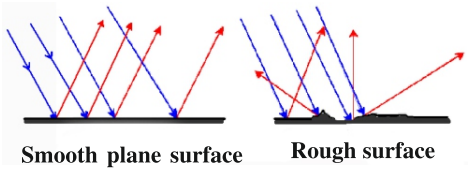


Fig. 9.2 (a) Regular reflection Fig. 9.2 (b) diffused reflection

Diffused Reflection

You might have observed that when light falls on any part of wall from any opening or window then that part of the wall looks bright from every where in the room. This happens because light reflect in all directions after striking the wall. We see almost all objects because of this reason. Rough surfaces, dust particles and microscopic smoke particles diffuse the light in different directions. When sun-light enters the atmosphere then the air molecules scatter blue light more than they scatter red light and thus day time sky is blue. During sunset or sunrise we see red and orange colour because the blue light has been scattered out and away from the line of sight. If we look the outer space from outside our atmosphere then we shall see it black.

Scattering of light in all directions in the same medium by rough surface is known as diffused reflection. Generally, reflecting surface is applied (like silver or aluminum layer) on the back or front of glass or transparent material and then it is used as mirror or reflecting plane.

9.2 Laws of reflection

When light rays propagating through medium-strike at the surface of medium and return back in a particular direction in the medium, then this phenomena is known as reflection of light.

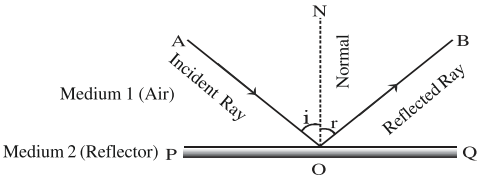


Fig. 9.3 Reflection

Mirrors are often used as reflectors and are made by silvering a surface of a glass. In fig 9.3 PQ is a plane mirror. Light ray AO is incident on the mirror at point O. This ray is reflecting in the direction OB. ON is perpendicular on mirror. Angle AON is known as incident angele 'i' (or angle of incidence) and angle BON is known as angle of reflection 'r'.

By performing a simple activity we can find relation between angle of incidence and angle of reflection.

On a cardboard sheet draw a line PQ and a perpendicular ON from a point O. At any angle 'i' draw a line AB and push two all pins on it. Place a plane mirror upright on line PQ with reflecting surface facing towards line AB and perpendicular ON. View the image of these two all-pins in the mirror and push two more all pins C and D on the card board in such a way that images of A, B and allpins C and D look in straight line. Draw a straight line CD and extend it till mirror. You will see that line CD will meet the line PQ at point O.

You can see that angle AON and DON are

equal. AB is called incident ray and CD is its reflected ray.

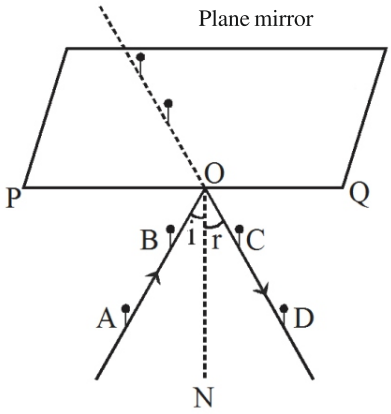


Fig. 9.4 Reflection from plane mirror

Following are rules of reflection

(i) Incident ray, reflected ray and perpendicular on point of incidence are in same plane.

(ii) The angle extended by incident ray with the perpendicular is same as the angle extended by reflected ray with the perpendicular

Angle of incidence i = angle of reflection r

or $\angle i = \angle r$

Image formation in plane mirror

The image formed in a plane mirror is virtual. The image is at the same distance from mirror as the distance of object from mirror though both are in opposite directions. Size of the image is same as that of object. When we look at our image in a mirror then we observe that our left part is right in the image and vice-versa. Similarly if we write letter 'p' on a paper and turn it towards a mirror then we see 'q' in the mirror. This change is known as lateral inversion.

Have you ever pondered why mirror does not invert our image from upside down? If we look carefully and observe then we shall notice that mirror does nothing on its own. To see our image we have to turn towards mirror (left to right) If we place our face and mirror in the same direction then our back will be towards the mirror and we shall not see our image.

Similarly, if we place a mirror in such a way that when we see towards it our face is towards north. In this case when we extend our right hand to point towards east we shall see that our image is also pointing towards east. Now we extednd our hand towards north direction (towards mirror) then our image in mirror will point towards south (towards us). If we cut a cardboard in p shape (or take some toy shaped p) and keep it in our hand while standing in front of mirror then we shall observe that we are holding a p shape in our hand while our left part will be seen right in the mirror . If your analyse these events you shall observe that when you turn the paper (on which p is written) towards the mirror then you are showing q to the mirror as you have rotated the paper by 180^0. In case of a p shaped cardboard you see it as p in image but you may obseve that if one side of this cardboard is red and other is blue then if you are having red facing side of p towards you then the image will be having blue colour.

Example 1 : Prove that image in the mirror is at the same distance from mirror as that of the distance of object from the mirror.

Solution : MM' is a reflecting surface in fig 9.5. P is an object from which rays PO and PO' are incident on MM'. Rays OQ and O'Q' are reflected rays of PO and PO' respectively.

Extending these reflected rays construct a virtual image P' of the object P. ON and O'N' are perpendiculars on mirror.

In triangle POO' and P'OO', line OO' is common therefore from the laws of reflection

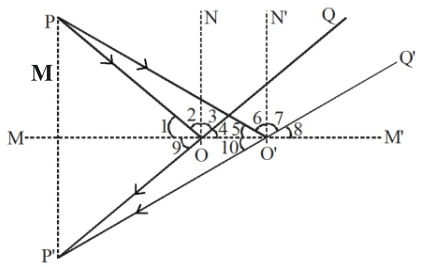


Fig. 9.5 Object- image geometry

$$\angle 2 = \angle 3$$

$$\therefore \quad \angle 1 = \angle 4 = \angle 9$$

or $180° - \angle 1 = 180° - \angle 9$

or $\angle POO' = \angle P'OO'$

similarly $\angle PO'O = \angle P'O'O$

Thus $\Delta POO'$ and $\Delta P'OO'$ are similar triangles

$\therefore PO = P'O$

& $PO' = P'O'$

Similarly in triangles $PO'M$ & $P'O'M$

$\angle PO'M = \angle P'OM$

& $PO' = P'O'$

Arm MO' is commom

Therefore $\Delta PO'M$ & $\Delta P'O'M$ are congruent

hence $PM = P'M$

Thus we see that the distance of object P from the mirror (PM) is same as the distance of image P^1 from the mirror (P^1M) in the opposite direction. From the geometry we see that line PP^1 is perpendicular on the plane of the mirror

9.3 Spherical mirror

There are a few mirrors whose surfaces are curved. Images from such surfaces are different in shapes. Shape and size of the image depends upon the nature of curved surface. Mirrors having spherical reflecting surfaces are called spherical mirrors. Their surfaces are just like a part of hollow spheres. There are two types of spherical mirrors. Spherical mirrors whose curved reflecting surface is curved from inside are known as concave mirrors. For safety purpose the outer surface of (convex back part) of these mirrors are coloured after depositing a layer of aluminum or silver on them. These are back coated mirrors.

Scientific equipments generally have mirrors having front side coated with reflecting layer so that accurate measurements may be made. Such mirrors are known as front coated mirrors. Such spherical surfaces whose outer part is used as mirror surface are known as convex mirrors. To obtain convex mirror the inner side of the spherical surface is coated with reflecting surface and then protective colour is applied on it. These are also back coated convex mirrors. In a front coated convex mirror the reflecting surface is applied directly on convex surface.

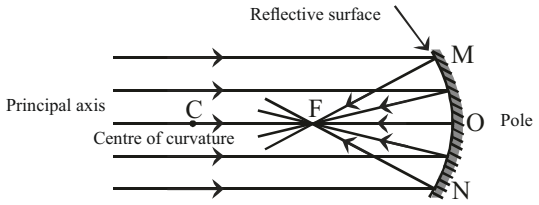


Fig. 9.6 (a) Concave mirror

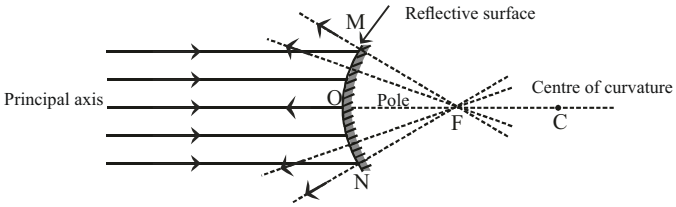


Fig. 9.6 (b) Convex mirror

When paralled ray beam gets reflected from a concave mirror then the reflected rays converge at a point in front of mirror. This point is called focus of a concave mirror. When parallel rays reflect from a convex mirror then they diverge in such a way that when extended backwards these rays meet at a point behind the mirror (fig. 9.6 (b)). It seems that the reflected rays are originating from this point. This point is called the focus (F) of a convex mirror. Centre point (O) of the curved surface of mirror is called pole. Sphereical mirror may be considered as part of a hollow sphere and the centre (C) of that sphere is known as centre of curvature. Distance from pole to centre of curvature (OC)is called radius of curvature and the distance (OF) from pole to focus is known as focal length and is represented as f. In large spherical mirrors the direction of reflected rays changes with distance of point of reflection from pole and thus they do not converge at focus and reflected beam loses the intensity. In this chapter we shall discuss those mirrors only whose aperture (length) is much much smaller than their radius of curvature. In diagram these mirrors are not to the scale and are looking bigger for the sake of understanding. Radius of curvature of these

spherical mirrors is double the focal length.

In real life situations light beams are reflected and converged by a parabolic mirror like in a telescope. In the headlight of an automobile the light is fixed at the focus of a parabolic mirror so that we get parallel light beam when light get reflected from parabolic reflectors. In figure 9.6 we observe that the focus of a concave mirror is towards its reflecting face while for a convex mirror it is at the other side of the reflecting face. Therefore if we consider focal length of one type of mirror as positive then the focal length of other type of mirror will have to be taken as negative. We follow Cartesian sign convention for reflection from spherical mirrors.

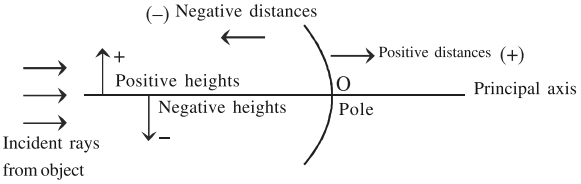


Fig. 9.7 Cartesian sign convention

In Cartesian sign convention all signs are taken from pole of the mirror, also called as origin point and principal axis is considered as x-axis. Rules are as follows.

(i) All distances parallel to principal axis are measured from pole or origin point.

(ii) Object is placed left to the mirror and thus the incidint rays from object are always from the left.

(iii) All distances parallel to principal axis and towards left side of origin point (along-x axis) are taken as negative. For example the distance of object in a convex as well as concave mirror is always negative. Similarly all distances towards right side of the origin point (along + x axis) are taken as positive.

(iv) Heights measured above the principal axis are taken as positive (along + y axis) while heights measured below the principal axis (along - y axis) are taken as negative.

According to Cartesian sign convention the object distance, focal length and radius of curvature are always negative in concave mirror. When image is formed towards left of the origin in a concave mirror then its distance will be taken as negative while the distance will be positive for images formed towards right side of a concave mirror. When image is upright then its height will be taken as positive and when image is below the principal axis and downwards then its height is taken as negative.

For a convex mirror the object distance will be negative as per the sign convention. In convex mirror the focal length and radius of curvature are always towards the right side of the origin point and hence focal length and radius of curvature are always taken positive in a convex mirror. In convex mirror the image is always towards right side of the pole and hence image distance is always positive. Similarly the image is always upright and thus height of image is always positive in this case.

Example 2 : Prove that radius of curvature is double of the focal length for a small aperture concave mirror.

Solution : Reflection from a concave mirror is shown in the figure 9.8. Rules of reflection of plane mirror also applies to spherical mirror.

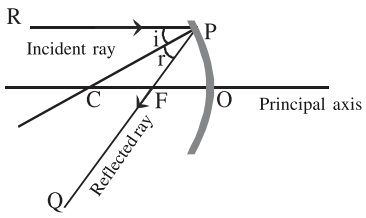


Fig 9.8 Reflection from concave mirror

In the figure RP is incident ray that is parallel to principal axis and after reflecting from concave mirror goes in PQ direction. It passes through point F on the principal axis. Line CP is perpendicular to mirror at point P and hence CP is the radius of curvature of this concave mirror.

From the laws of reflection

Angle of incidence i = angle of reflection r

$$\angle RPC = \angle QPC$$

As incident ray is parallel to principal axis

$$\angle RPC = \angle PCF \quad \text{(Alternate angels)}$$

$$\angle PCF = \angle QPC = \angle FPC$$

Therefore in triangle PCF

$$PF = FC$$

When aperture is small then point P will be near to the pole

$$\therefore \quad PF \simeq OF$$

or $FC \sim OF$

or

$$OF = \frac{1}{2}OC$$

$$OC = 2.OF$$

Thus when aperture is small then radius of curvature OC = R is double the focal length OF = f and focus point F is the middle point of OC.

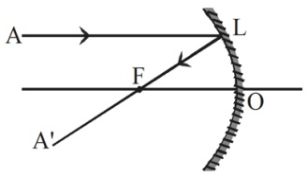
$$\therefore \quad R = 2f$$

9.4 Image formation in spherical mirror

When focal length and radius of curvature of a convex or concave mirror is known then position of image of any object can be ascertained. At least two reflected rays should intersect to get the image. Generally we use specific incident rays to get the position of image in both the concave and convex mirrors.

(i) Incident rays parallel to principal axis

Ray AL parallel to principal axis of a concave mirror gets reflected from point L of mirror and passes through focus in the A' direction (fig 9.9 (a). In a convex mirror the ray AL diverges after reflection and when extended backwards the reflected ray AL' meets at focus. It seems as if the ray is diverging from focus. (fig 9.9(b)).



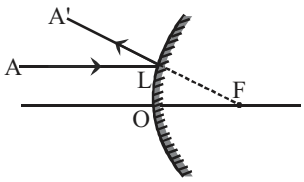
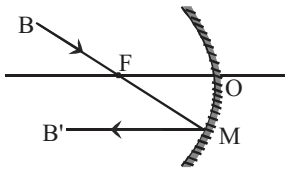


Fig 9.9 (a) **Fig. 9.9 (b)**

(ii) Incident rays towards focus

A ray BM passing through focus of a concave mirror (fig 9.10 (a)) gets reflected from the mirror and becomes parallel to principal axis in MB' direction. Similarly in a convex mirror a ray towards focus strike the mirror at M and gets reflected in MB' direction paralled to principal axis (fig 9.10(b)).



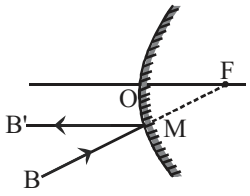
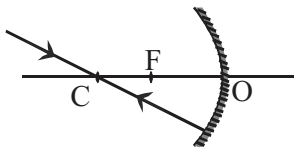


Fig. 9.10 (a) **Fig. 9.10 (b)**

(iii) Incident ray perpendicular to mirror

Ray that passes through radius of curvature in concave mirror and ray that approaches towards centre of curvature in convex mirror get reflected in the same direction from which they are arrived. (fig 9.11(a) & (b)). The reason is that any line joining any point of mirror to the centre of curvature is a perpendicular on that point and hence angle of incidence and angle of reflection in such case is zero.



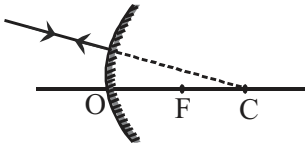
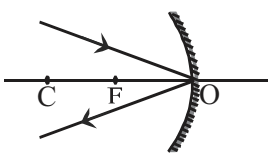


Fig. 9.11 (a) **Fig. 9.11 (b)**

(iv) Oblique rays

All rays that are obliquely incident on convave or a convex mirror will reflect in another oblique direction as per the rules of reflection. It is to be noted that the point, where oblique ray is incident on morror , is joined with centre of curvature and then the angle



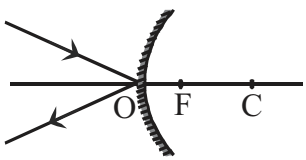


Fig. 9.12 (a) **Fig. 9.12 (b)**

subtended by incident ray with that radius of curvature (at the point where ray is incident) is the angle of

incidence. Now as per rules of reflection, the reflected ray may be drawn. In fig. 9.12 (a) and (b) the point of incidence is O i.e. pole of the mirror.

By keeping in mind the above points we can understand the position and nature of image in concave and convex mirrors. When the reflected rays actually meet at certain point then the image is real. If the reflected rays meet when they are extended backwards (i.e they seems to meet at certain point) then image is virtual. Generally real image is inverted while imaginary image is upright.

Image formation in concave mirror

Ray diagrams of image formation for different position of object for a concave mirror are shown in figure 9.13

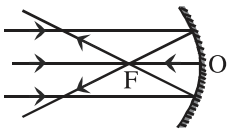


Fig 9.13 (a)
Parallel rays

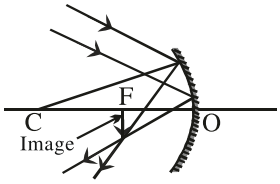


Fig 9.13 (b)
Object at infinity

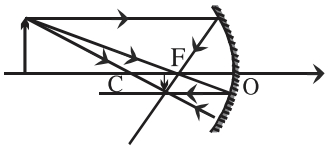


Fig 9.13 (c) Object far from centre of curvature

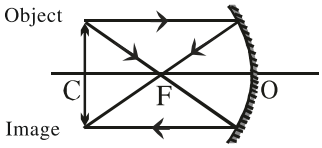


Fig 9.13 (d) Object at cnetre of curvature

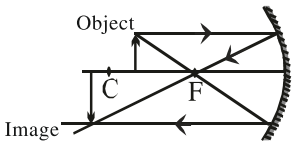


Fig 9.13(e) Object anywhere between centre of curvature & focus

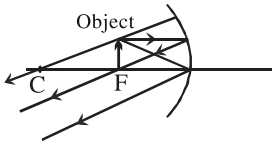


Fig 9.13 (f) Object at focus

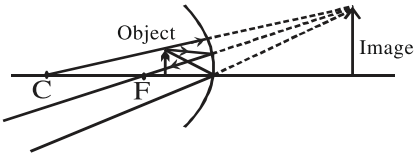


Fig 9.13(g) Object any where between focus and pole

Table 9.1 Nature of image for different positions of object in concave mirror

Sr. No.	Position of object	Position of Image	Image type	Image size
1	At infinity	At focus F	Real and inverted	Very small
2	between centre of curvature and infinity	Between focus F and centre of curvature C	Real and inverted	Small
3	At centre of curvature C	At centre of Curvature C	Real and inverted	Same size
4	Between centre of curvature C and focus F	Away from centre of curvature C	Real and inverted	Magnified
5	At focus F	At infinity	Real and inverted	Very large
6	Between focus F & pole	Behind the mirror	Virtual and upright	Image is large

The table 9.1 represents details of images formed for different object positions. Students can perform simple experiments by taking a wax candle and experimentally observe the image for different positions of candle on a concave mirror.

In routine life you see satellite dish antenna that collect the signals received from satellite through a receiver placed at the focus of concave shaped dish. Similarly, reflecting telescopes also use concave mirror and image of sun, moon or distant object is formed at focus as these rays are parallel. Remember not to look at the image of sun directly otherwise it may damage your eyes. To observe sun, the image is projected on a screen or wall and we observe that projection or special optical filters are used to observe the sun.

Besides the concave mirror is routinely used as shaving mirror (to observe larger image of face). In case of motorcycles etc these mirrors reflect light from powerful bulbs placed at the focus of reflector mirror. The reflected light is in the form of parallel beam. Dentist use concave mirror and light combination to see those parts that are not easily visible because of poor light. In addition it gives larger image of the teeth to a dentist.

Image formation in convex mirror

Light rays diverge after reflection from a convex mirror and we feel as if the light is coming from behind. As focus and centre of curvature of a convex mirror are behind the mirror therefore we can draw image using geometry for object position from infinity to pole. Figure 9.14 shows ray diagrams of images for a few positions of object.

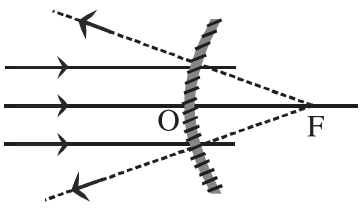


Fig 9.14 (a) Parallel rays

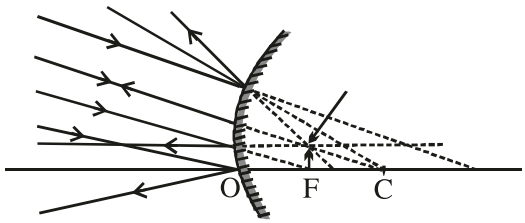


Fig 9.14 (b) object at infinity

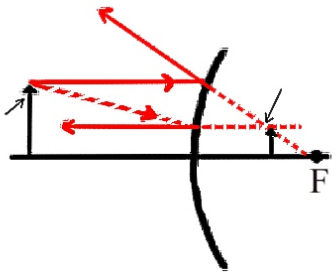


Fig 9.14 (c) object at certain distance

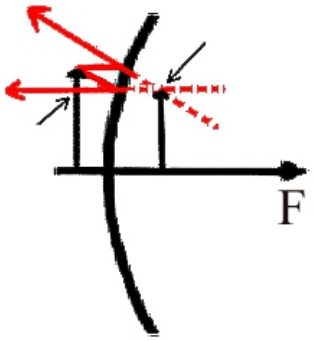


Fig 9.14 (d) object just near the pole

Fig 9.14 Image formation in convex mirror

We observe that the image in a convex mirror is always virtual and upright. As object is brought near the mirror the image increases in size but it is always smaller than the object. Table 9.2 shows details of image for various positions of object.

Convex mirrors make virtual upright image of an object and shows a wide viewing area and thus these are used as rear view mirror and side mirrors in motor vehicles. Drivers thus make an informed guess

about the position of vehicles and the scene behind the drivers. Now -a-days convex mirrors are also used in ATM machines for security reasons so that the person using the ATM can observe the activity behind him.

Table 9.2 Details of image for different positions of object in a convex mirror

Sr. no.	Position of object	Position of image	Image type	Image size
1	At infinity	At focus behind the mirror	Virtual & upright	Point like small
2	Any distance between infinity and pole	Behind the mirror between pole and focus	Virtual & upright	Smaller than object

9.5 Mirror formula

In a spherical mirror

(i) Distance of object from pole is u

(ii) Distance of image from pole is v

(iii) Distance of focus from pole is f

All three are related by an equation known as mirror formula

$$\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

This formula is valid for all spherical mirrors. While solving numerical problems when we put values of u, v, f and R (radius of curvature) then we use proper sign of u, v, f and R as per the Cartesian sign convention. Let us derive it for a concave mirror.

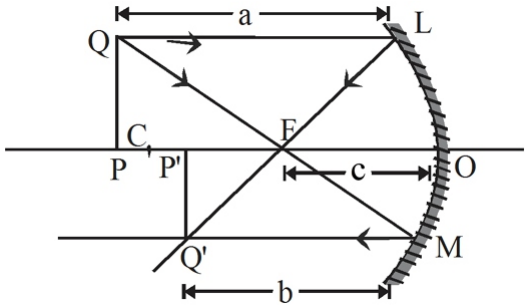


Fig 9.15 Image in a concave mirror

We see that triangle PQF and triangle MOF are similar (here we assume that O and M are so close to each other that distance OM is taken as straight line).

$$\therefore \quad \frac{OM}{PQ}=\frac{OF}{PF}=\frac{c}{a-c}$$

$$\because \quad P'Q' \simeq OM$$

$$\text{so} \quad \frac{P'Q'}{PQ}=\frac{c}{a-c} \qquad .....(1)$$

Similarly in similar triangles OLF and P'Q'F

$$\frac{OL}{P'Q'}=\frac{OF}{P'F}=\frac{c}{b-c}$$

$$\because \quad OL = PQ$$

$$\text{so} \quad \frac{PQ}{P'Q'}\simeq\frac{c}{b-c} \qquad .....(2)$$

$$\text{From (1) \& (2)} \quad \frac{c}{a-c}=\frac{b-c}{c}$$

$$\text{or} \quad ab - ac - bc + c^2 = c^2$$

$$\text{or} \quad bc + ac = ab$$

Dividing both sides by abc

$$\frac{1}{a}+\frac{1}{b}=\frac{1}{c}$$

Acording to Cartesian sign convention a, b & c are all negative here so

Distance of object from pole u = - a

Distance of image from pole v = - b

Distance of focus from pole f = - c

$$\text{So} \quad -\frac{1}{u}-\frac{1}{v}=-\frac{1}{f}$$

$$\text{of} \quad \frac{1}{v}+\frac{1}{u}=\frac{1}{f}$$

This is mirror formula and it is applicable for convex mirror as well.

9.6 Magnification

Ratio of image height to object height is known as magnification It is represented as m. It shows us that how much magnified is the image with respect to the object. The power of a mirror to magnify the object is known as magnifying power.

If object height is h and image height is h' then magnification m from spherical mirror is given as

$$m = \frac{height\ of\ the\ image}{height\ of\ the\ object} = \frac{h'}{h}$$

From the geometry of fig. 9.16 the magnification can be related with image distance v and object distance u for a concave mirror. Triangles PQO and ABO similar so

$$\frac{h'}{h} = \frac{v}{u}$$

or
$$m = \frac{h'}{h} = \frac{v}{u}$$

As object is above the principal axis while image is below it so as per Cartesian sign convention

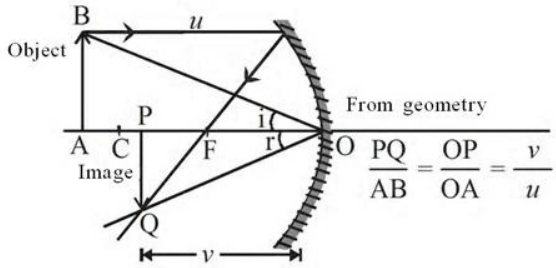


Fig. 9.16 Magnification

$$m = \frac{h'}{h} = -\frac{v}{u}$$

Generally object is placed upright on principal axis so its height is taken as positive. If image is upright, as is in virtual image, then image height is also taken as positive,. If image is real and inverted then image height is taken as negative if

(i) m is negative and v>u then image is real, inverted and magnified.

(ii) m is negative and v=u then image is real, inverted and equal to the object.

(iii) m is negative and v<u then image is real, inverted and smaller than object

(iv) m is positive then image is virtual and upright.

The image will be magnified $(\because\ v > u)$

Magnification formula is same for a convex mirror as well. In a convex mirror m will always be positive for all reals objects as v is positive while u is negative. Also the value of h' and v will always be less than h and u respectively therefore in a convex mirror the image is always virtual, upright and smaller than the object.

Example 3 : A shaving mirror is at 20 cm from the face of a person. If the focal length of a shaving mirror is 80cm then find the distance of image from the mirror and magnification of mirror.

Solution :

focal length f = - 80 cm (concave mirror)

object distance u = - 20 cm

image distance v = ?

magnification m = ?

From mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

or
$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{(-80)} - \frac{1}{(-20)}$$

$$= -\frac{1}{80} + \frac{1}{20} = \frac{-1+4}{80} = \frac{3}{80}$$

$$v = \frac{80}{3} \simeq +26.67\ cm$$

Image will be formed at 26.67 cm behind the mirror

Magnification m

$$m = \frac{h'}{h} = -\frac{v}{u} = -\frac{26.67}{(-20)}$$

$$= +\ 1.33$$

Thus image will be virtual, upright and magnified (1.33 times the object)

Example 4: Focal length of a convex mirror is 30cm. If the virtual image of an object is at 20cm distance then find the distance of object from mirror.

Solution : focal length $f = +30$ cm

Image distance $v = +20$ cm

Object distance $u = ?$

From mirror formula $\frac{1}{v} \frac{1}{u} + \frac{1}{f}$

Or $$\frac{1}{u} = \frac{1}{f} - \frac{1}{v} = \frac{1}{30} - \frac{1}{20}$$

$$= \frac{2-3}{60} = -\frac{1}{60}$$

Or $u = -60$ cm

So the object is 60cm towards left of mirror.

Example 5 : From the side mirror of a motor cycle a car is at 4m distance. If the focal length of side mirror is 1m then find the details of the image in the mirror

Solution : Rear and side mirrors are convex mirrors thus

Focal length of mirror $f = +1$m

Distance of object from mirror $u = -4$m

Distance of image from mirror $v = ?$

Magnification $m = ?$

From mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

Or $$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{1} - \frac{1}{(-4)} = \frac{1}{1} + \frac{1}{4}$$

$$= \frac{4+1}{4} = \frac{5}{4}$$

$$v = \frac{4}{5} = 0.8\,m$$

and magnification $m = -\frac{v}{u} = -\frac{4/5}{(-4)} = +\frac{1}{5}$

therefore image will be at 0.8m from mirror and the image will be virtual, upright and one fifth (0.2times) the object.

9.7 Refraction

You might have observed many times that a scale partly submerged in water is observed as bent inside the water. Similarly a coin or other object inside the watertank is seen at higher level and near our eyes than its actual depth. You might also have observed that when a glass paperweight is palced over a written sheet then the words below the paper weight looks higher in level in comparison to the rest of the words of the sheet when viewed from upside.

When a pen, pencil or rod is obliquely submerged partly in a water container then, just after the interface of air-water medium, that object seems to bend. If you look from the side then you will see that the submerged part is a bit bigger. If the same experiment is performed with a transparent plastic contain or with some other liquid then you may observe that this effect of bending is different for different mediums.

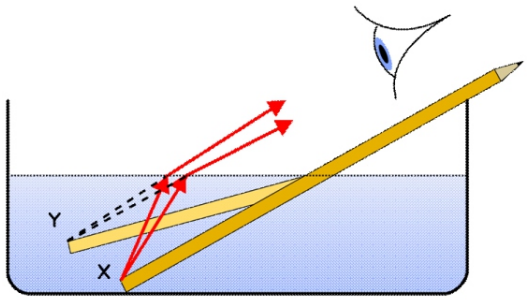


Fig 9.17 (a) Pencil partly submerged in water

The reason for seeing the partly submerged object as bent is that the direction of light rays from the object out of water and from the object submerged in water is different and because of this the submerged part looks a bit higher in level.

Fig 9.17 (b) Straw in a glass

By performing a simple expereiment you can observe the change of direction of light rays. In a beaker or a small container put a coin. Now adjust that container with respect to your eyes such that the coin just becomes invisible to your eyes. Now pour water or ask your friend to pour water into it . You will see that as soon as water is filled in the container the coin will reappear and will be visible to your eyes.

When light travels from one medium to another medium then at the plane of separation of both mediums the direction of light rays changes. This effect is known as refraction.

The incident light should not be perpendicular to the surface of interface of both the mediums otherwise the direction of incident light will not change during refraction though the speed of the refracted light will be different but we shall not be able to view it easily.

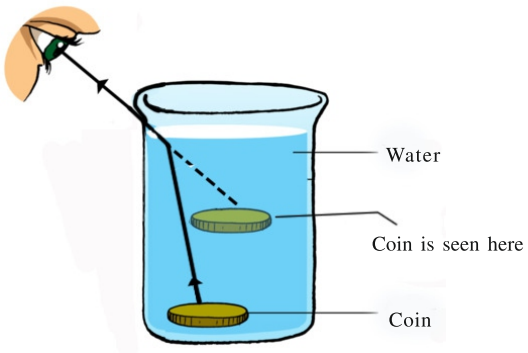


Fig. 9.18 Visibility of coin by Refraction

Velocity of light in vacuum is 3×10^8 m/s. When light refracts from one medium to another medium then its velocity changes. Glycerin, water, glass etc are denser with respect to air. If the second medium is denser releative to the first medium then the velocity of light will be relatively less in denser medium while the frequency does not change. Because of this while going from rarer to denser medium the light rays bend towards the perpendicular. On the contrary when light travels from denser to rarer medium its velocity increases and light rays bend away from the perpendicular. Here density in strict sense is optical density.

With the help of a glass slab the phenomenon of refraction can be understood with a simple experiment. Put a rectangular glass slab on a paper and draw its edges with the pencil. On this rectangular slab ABCD draw a perpendicular ON on face AB at point O. At some angle of incidence 'i' draw a line PQ as incident ray. Place two all-pins on PQ. Now place two more all-pins R & S towards the face CD of the slab in such a way that all the four all-pins look in straight line. Now draw another perpendicular EF (normal) on face AB at some other point F and place all pins on it. Again look from the side CD and put two all-pins G&H corresponding to these two pins. Now remove the slab. This has be shown in fig. 9.19

Now we join the RS line and extend the ray backwards so that it meets the CD face at point O' and then join OO' by a straight line. Similarly join F&G point and draw the line GH. Draw perpendicular on O' as MM' and extend the perpendicular ON to NN'. Now extend the ray PQ straight (dashed line in figure). From the figure it is clear that ray PQ bend towards perpendicular at interface AB and goes towards OO' and again bends away from perpendicular at CD interface and goes towards RS. We also observe that PQ and RS are parallel. This shows that the bending of rays at interface AB and CD are equal and opposite. You will also obseve that EF ray, that is incident perpendicularly on face AB goes undeviated.

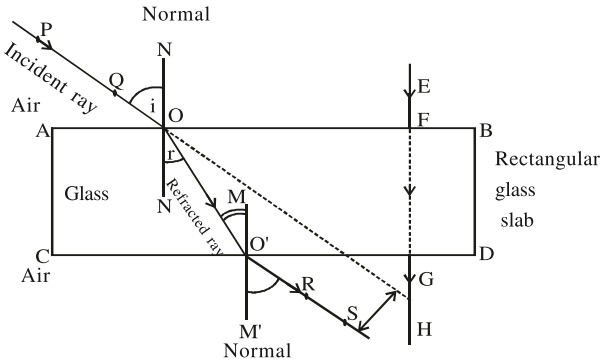


Fig. 9.19 Refraction from glass slab

The refraction is also governed by certain rules. From fig 9.19 we see that incident ray, refracted ray and normal are in the same plane. This is the first to law of refraction.

In refraction the ratio of sine of angle of incidence i and sine of angle of refraction r remains constant

$$\frac{\sin i}{\sin r} = \text{constat}$$

This is second law of refraction that is also known as snell's law. It is also known as refractive index of medium 2 with respect to medium 1 μ_{21} :

$$\mu_{21} = \frac{\sin i}{\sin r}$$

When light travels from vacuum to a medium then refractive index of that medium with respect to vacuum is known as absolute refractive index . Similarly refractive index of a medium with respect to air (or another medium) known as relative refractive index is given as ratio of speed of light in air' to the speed of light in the medium

$$\mu_{21} = \frac{speed\ of\ light\ in\ medium\ 1(air)}{speed\ of\ light\ in\ medium\ 2} = \frac{v_1}{v_2}$$

$$\mu_{wa} = \frac{speed\ of\ light\ in\ air}{speed\ of\ light\ in\ water} = \frac{v_a}{v_w}$$

Refractive index depends upon nature, density of medium and colour (or wavelength) of light. Refractive index is highest for violet colour and lowest for red colour light. A list of refractive indices of a few material are given in table-3.

Table3 : Refractive indices of various materials

Material	Refractive index	Material index	Refractive
Vacuum	1	Glycerive	1.47
Air	1.0003	Turpentine oil	1.47
Water	1.33	Carbon disulphide	1.64
Kerosence	1.44	Diamond	2.42
Glass	1.50		

Examples of Refraction

1.Visibility of the Sun before sunrise and after sunset

We can see the Sun even when it is geometrically just below the horizon during sunrise and sunset. The reason is the refraction of sun-light from different layers of atmosphere. We know that as we go up the atmosphere the air density reduces. Thus rays from sun encounter progressively increasing air density while it enters earth's atmosphere and travels towards earth's surface. This produces deviation of light towards the normal at the interface of different medium of constantly incresing density. Becuase of this reason when the Sun is actually below the horizon Becuase of this reason when sun is actually below the horizon we are able to see the image of sun (fig 9.20) just before the sunrise. This is also the reason that we see the image of sun just after sunset.

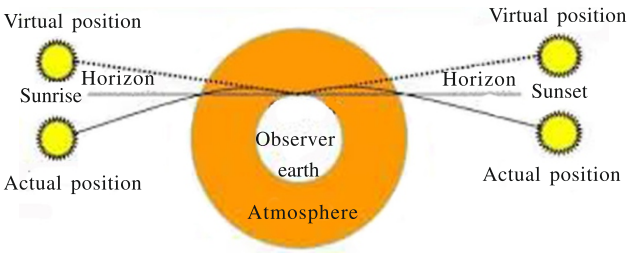


Fig. 9.20 Effect of atmospheric refraction on sunrise and sunset

2. Total internal reflection

When light rays travel through denser medium

to rarer medium then they deviate away from the normal at the interface (r>i). If we keep on increasing the angle of incidence then at specific value of angle of incidence the refracted ray goes in the direction of interface of both the medium and angle of refraction r becomes 90°. This angle of incidence is known as critical angle.

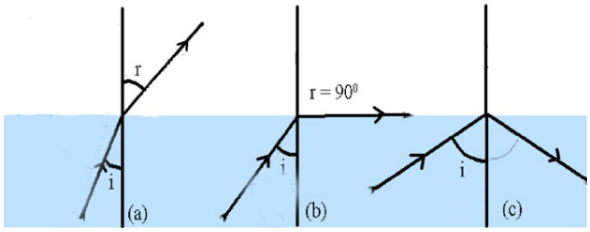


Fig. 9.21 Total internal reflection

If we keep on increasing the angle of incidence beyond critical angle then the light rays reflect back in the denser medium instead of rafracting in the rarer medium. This phenomenon is called total internal reflection. In communication technology the fiber optic cable uses this phenomenon for faster and efficient data transfer.

3. Dispersion of light by prism

When sun light passes through glass prism then the light disperse in seven different colours that can be observed on a screen. In laboratory white light bulb can be used to get chromatic dispersion. We must not see towards the sun or refrated sunlight as it may impair our vision or may cause blindness.

The refracted image at the screen is called spectrum. Newton was the first who proved that white light contains all colours of spectrum. The reason to get this seven colour image is that different colours (having different wavelenghts) travel with different velocities in any medium. In every medium, except vacuum, the speed of red colour is highest and speed of violet colour is minimum. Therefore, after refraction the violet colour bend highest towards the normal. The order of this dispersion is known as VIBGYOR. Yellow is generally considered mean colour of the spectrum.

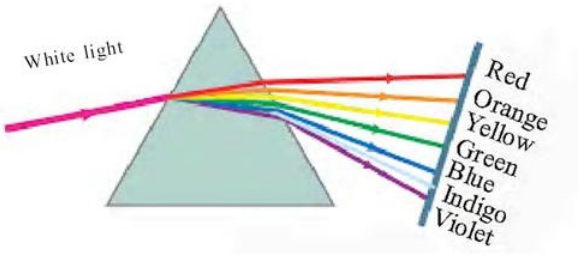


Fig. 9.22 Dispersion of white light

Example 6 : Refractive index of water and glass are 1.33 and 1.5, respectively. Find the refractive index of glass with respect to water.

Solution : μ_w (water) = 1.33

μ_g (glass) = 1.50

Refractive index of glass with respect to water

$$\mu_{gw} = \frac{velocity\ of\ light\ in\ water}{velocity\ of\ light\ in\ glass} = \frac{v_w}{v_g}$$

if velocity of light is c then

$$\mu_w = \frac{velocity\ of\ light\ in\ vacuum}{velocity\ of\ light\ in\ water} = \frac{c}{v_w}$$

Thus $$v_w = \frac{c}{\mu_w}$$

and similarly, velocity of light in glass $v_g = \frac{c}{\mu_g}$

therefore $$\mu_{gw} = \frac{v_w}{v_g} = \frac{c/\mu_w}{c/\mu_g}$$

$$= \frac{\mu_g}{\mu_w} = \frac{1.5}{1.33}$$

$$= 1.12$$

(Note : Refractive index of water is 1.33 that means the velocity of light in water is 1.33 times slower than its velocity in vacuum i.e. its velocity will be c/1.33).

9.8 Refraction through spherical lens

Generally we use such transparent material for focusing light that has cuved surfaces either on one

9.6 Magnification

Ratio of image height to object height is known as magnification It is represented as m. It shows us that how much magnified is the image with respect to the object. The power of a mirror to magnify the object is known as magnifying power.

If object height is h and image height is h' then magnification m from spherical mirror is given as

$$m = \frac{height\ of\ the\ image}{height\ of\ the\ object} = \frac{h'}{h}$$

From the geometry of fig. 9.16 the magnification can be related with image distance v and object distance u for a concave mirror. Triangles PQO and ABO similar so

$$\frac{h'}{h} = \frac{v}{u}$$

or
$$m = \frac{h'}{h} = \frac{v}{u}$$

As object is above the principal axis while image is below it so as per Cartesian sign convention

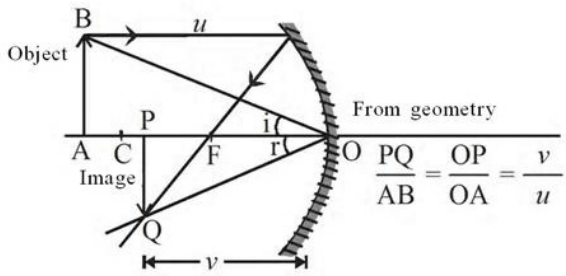


Fig. 9.16 Magnification

$$m = \frac{h'}{h} = -\frac{v}{u}$$

Generally object is placed upright on principal axis so its height is taken as positive. If image is upright, as is in virtual image, then image height is also taken as positive,. If image is real and inverted then image height is taken as negative if

(i) m is negative and v>u then image is real, inverted and magnified.

(ii) m is negative and v=u then image is real, inverted and equal to the object.

(iii) m is negative and v<u then image is real, inverted and smaller than object

(iv) m is positive then image is virtual and upright.

The image will be magnified $(\because\ v > u)$

Magnification formula is same for a convex mirror as well. In a convex mirror m will always be positive for all reals objects as v is positive while u is negative. Also the value of h' and v will always be less than h and u respectively therefore in a convex mirror the image is always virtual, upright and smaller than the object.

Example 3 : A shaving mirror is at 20 cm from the face of a person. If the focal length of a shaving mirror is 80cm then find the distance of image from the mirror and magnification of mirror.

Solution :

focal length f = - 80 cm (concave mirror)

object distance u = - 20 cm

image distance v = ?

magnification m = ?

From mirror formula $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

or
$$\frac{1}{v} = \frac{1}{f} - \frac{1}{u} = \frac{1}{(-80)} - \frac{1}{(-20)}$$

$$= -\frac{1}{80} + \frac{1}{20} = \frac{-1+4}{80} = \frac{3}{80}$$

$$v = \frac{80}{3} \simeq +26.67\ cm$$

Image will be formed at 26.67 cm behind the mirror

Magnification m

$$m = \frac{h'}{h} = -\frac{v}{u} = -\frac{26.67}{(-20)}$$

$$= +\ 1.33$$

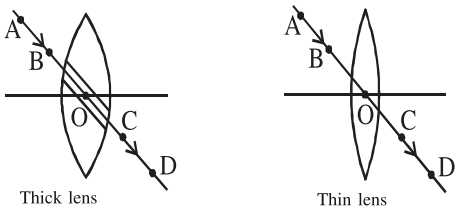


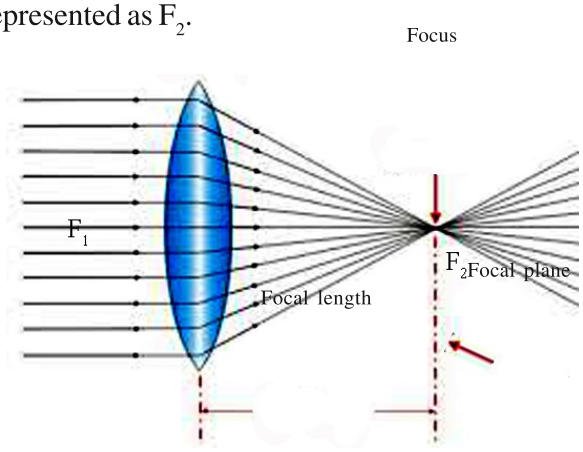
Fig 9.26 Propagation of light through optical centre

Any ray passing trough the optical centre will emerge as parallel to the incoming ray as it will be refracted twice by two surfaces of lens having opposite curvatures. When the lens is not thick (ratio of its thickness with radius of curvature r_1 & r_2 is very small) then the incident and emerging light will be in a straight line.

Optical centre is used in determining position of image by geometrical method. Distance of object and image for a lens system are taken from optical centre. For thin lenses this distance may be measured from their corresponding curved surfaces for ease of experiments.

(v) Principal focus

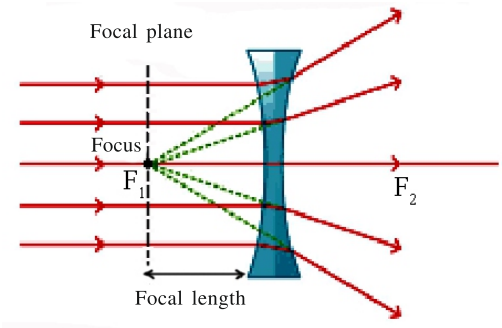
Incident rays parallel to principal axis refract from the lens and converge at a point (or seems to meet at a point) known as focus. There are two foci for lens one on each side. According to conventions the incident light comes from left side and thus left side focus represented is as F_1 and right focus is represented as F_2.



(a) Convex Lens

(vi) Focal Length

Distance between the optical centre and principal focus of a lens is known as focal length



(b) Concave lens

Fig 9.27 Principal focus, focal length & focal plane

(vii) Focal Plane

A plane passing through focus and perpendicular to the principal axis is known as focal plane.

Laws of refraction from a spherical lens

(a) Incident rays parallel to principal axis of a convex lens converge at focus after refraction (fig 9.27(a)). When such parallel rays are incident on a concave lens then they diverge and when extended backwards they meet at focus (fig 9.27(b)) or we may say that they seem to emerge from the focal point.

(b) When light rays pass through focus before their incidence on curved surface of a convex lens then such rays become parallel to principal axis after refraction. When light rays are incident on a concave lens in such direction that they seem like they are going towards focus then after refraction such rays become parallel to principal axis (fig 9.28(a) and (b).

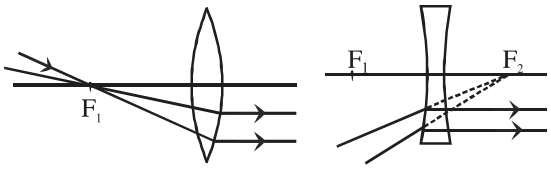
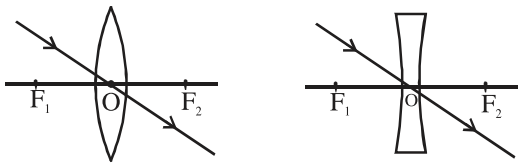


Fig. 9.28 Refraction of rays passing through focus

(c) When light rays pass through optical centre of a

lens then the rays remain undeviated after refraction (fig 9.29(a) &(b)).



(a) Convex Lens **(b) Concave Lens**

Fig. 9.29 Path of ray passinng through optical centre

9.9 Formation of image by lens

Object kept at different distances from lens form images at different distances. We select at least two such refracted rays that intersect to find the position and shape of image geometrically. In case of virtual image we extend the rays backward to find point of intersection.

Image formation by convex lens

(i) When object is at infinity - Rays from infinity are parallel and thus they converge at focus and image is formed. When rays from infinity are parallel but slanted with respect to principal axis then they form image at a point on focal plane. (Fig. 9.30)

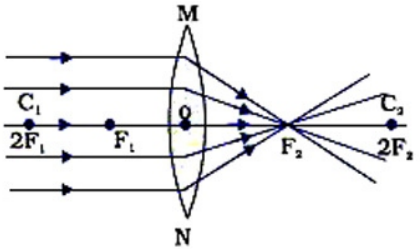


Fig 9.30 Rays parallel to principal axis

(ii) When object is at finite distance - fig 9.31 shows positions of image for different positions of object.

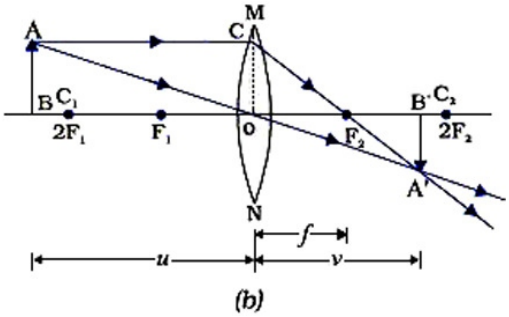


Fig 9.31 (a) Object between infinity and $2F_1$

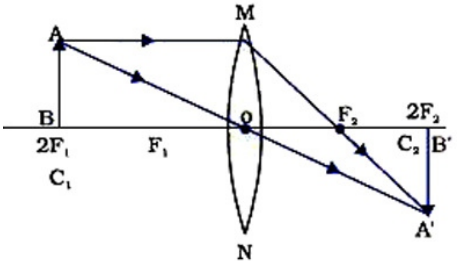


Fig 9.31 (b) Object at $2F_1$

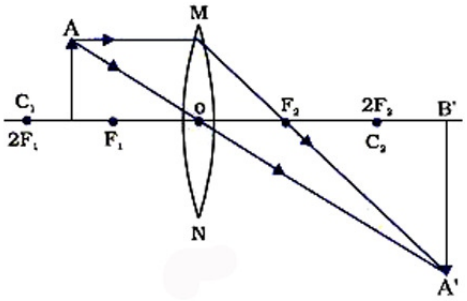


Fig 9.31 (c) Object between $2F_1$ & F_1

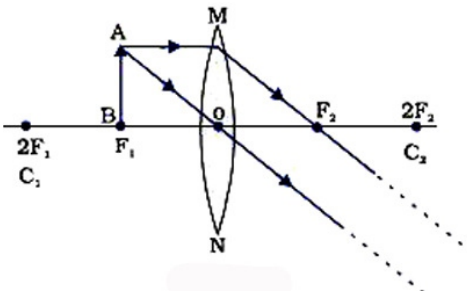


Fig 9.31 (d) Object at F_1

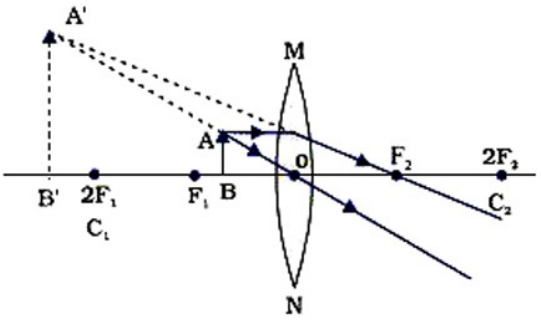


Fig 9.31 (e) Object between F_1 & optical centre

Fig. 9.31 Image formation for different positions of object by convex lens

You may observe that nature of image depends upon the position of object. Starting form infinity as object comes nearer to focus the image size incrases and image remains real and inverted. When object is between focus and optical centre then image is virtual and bigger then object and upright. If object is placed adjacent to lens such that u=0 then the image will be virtual, upright and of same size as object. Image will be formed at optical centre. Table 9.4 shows nature of image for different object positions.

Table 9.4 Nature of image for different object positions for a convex lens

Sr. no.	Position of object	Position of image	Nature of image	Size of image
1.	At infinity	At focus F_2	Real and inverted	point like
2.	Between infinity and $2F_1$	Between F_2 and $2F_2$	Real and inverted	Small
3.	At $2F_1$	At $2F_2$	Real and inverted	same size
4.	Between $2F_1$ and F_1	Between $2F_2$ and infinity	Real and inverted	enlarged
5.	At F_1	At infinity	Real and inverted	very large
6.	Between F_1 & Optical centre	At the same side of the lens and behind the object	Virtual & upright	enlarged

Image formation by concave lens

(i) Object is at infinity

Parallel rays from infinity and parallel to principal axis diverge after refraction from a concave lens and when we extend these diverging rays backwards then a virtual image is formed at focus. This image is very small and upright. If the parallel rays are incident on a concave lens obliquely then the image is formed at focal plane. (Fig. 9.32)

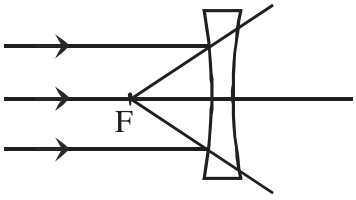


Fig. 9.32 (a) Object at infinity

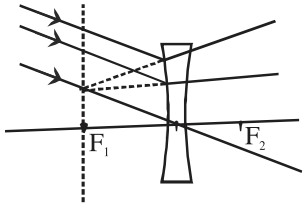


Fig 9.32 (b) Object at infinity

(ii) Object is at finite distance

When object is at a finite distance from a concave lens (anywhere between infinity and optical centre) then a virtual, upright image is formed that is smaller than the object. As object is brought near to the lens, the size of image increases but it always remains smaller then the object. (Fig. 9.33)

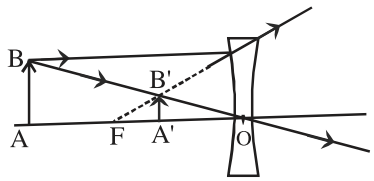


Fig. 9.33 Object at finite distance

inverted then image height is taken as negative.

Magnification can also be represented as ratio of image distance v and object distance u.

$$m = \frac{h'}{h} = \frac{v}{u}$$

Magnification for a real and inverted image will be

Table 9.5 Nature of image for different object positions for a concave lens

Sr. no.	Position of object	Position of image	Nature of image	Size of image
1	At infinity	At focus F_1	Virtual and upright	very small
2	Between infinity and optical axis	Between focus and optical centre	virtual and upright	smaller than object

Lens formula

Just like spherical mirror, in a lens system we have relation between object distance u, image distance v and focal length f and is given as

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$

u, v and f are measured from optical centre of lens.

Cartesian sign convention is used similar to spherical mirrors. Accordingly the focal length of a convex lens is taken as positive and focal length of a concave lens is taken as negative. Object is always placed towards the left of the lens and thus incident rays are always from the left. Therefore object distance is taken as negative. While solving numerical problems appropriate sign is chosen for u,v and f while substituting them in the lens formula.

Magnification

Magnification is defined as increase in the size of image with respect to object and is represented as a ratio of image height h' to object height h. Capacity of lens to magnify an image is known as magnifying power.

Generally, object height is taken as positive as it is placed upright at principal axis. When image is negative while for virtual and upright image it will be positive.

Example 7. A 3.0 cm long object is placed upright on principal axis of a convex lens of focal length 20cm. If real image is at 60cm from lens then find the distance of object from lens and magnification.

Solution : height of object h = +3.0cm

image distance v = +60cm

focal length f = +20cm

object distance u = ?

magnification m = ?

from lens formula $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

or $\frac{1}{u} = \frac{1}{v} - \frac{1}{f} = \frac{1}{60} - \frac{1}{20} = \frac{1-3}{60}$

$= -\frac{2}{60} = -\frac{1}{30}$

or u = – 30 cm

So the object is at 30cm towards left of lens

magnification $m = \frac{h'}{h} = \frac{v}{u} = \frac{+60}{-30} = -2$

or $h' = \frac{v}{u} \cdot h = \frac{60}{(-30)} \times (3) = -6\,cm$

Thus the image is real and inverted and the size of image is double the size of object.

Example 8 : Focal length of a concave lens is 30cm. If object is placed at 15cm from lens then find the image position and magnification by lens.

Solution : object distance u = -15cm

focal length f = -30cm

image distance v = ?

magnification m = ?

from lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

or $\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{(-30)}+\frac{1}{(-15)}=-\frac{1}{30}-\frac{1}{15}$

$=\frac{-1-2}{30}=-\frac{3}{30}=-\frac{1}{10}$

or v = –10 cm

The image is at 10cm distance and is towards left of lens.

magnification $m=\frac{v}{u}=\frac{-10}{-15}=\frac{2}{3}=0.66$

Image is 0.66 or two third of the object and the positive sign of m shows that image is virtual and upright.

Example 9 : Focal length of a convex lens is 50cm. If object is placed at 30cm then find nature and size of image

Solution : focal length f = 50cm

object distance u = -30 cm

image distance v = ?

from lens formula $\frac{1}{v}-\frac{1}{u}=\frac{1}{f}$

or $\frac{1}{v}=\frac{1}{f}+\frac{1}{u}=\frac{1}{50}+\frac{1}{(-30)}=\frac{1}{50}-\frac{1}{30}$

$=\frac{3-5}{150}=-\frac{2}{150}$

or v = – 75 cm

Image will be formed at 75cm towards left of the lens.

Now $m=\frac{v}{u}=\frac{-75}{-30}=\frac{5}{2}=2.5$

Thus image will be 2.5 times the object. Image will be virtual and upright.

9.10 Power of lens

Power fo a lens is defined as its capacity to diverge or converge light rays. A low focal length convex lens will converge the rays nearer to it and thus rays will bend more. On the contrary for a convex lens of larger focal length the rays will bend less and will converge at larger distance. When light rays are incident on a concave lens then depending upon its focal length they will diverge to different degree. A concave lens of low focal length will diverge the rays more and rays will bend more.

We see that the capacity of diverging or converging is inverse to the focal length of lens

Hence power of a lens is defined as $P=\frac{1}{f}$

If f is in meter then P is in dioptre. Power of a convex lens is positive and power of a concave lens is negative. We generally, call this the number of eye lenses. If focal length of a lens is 2m then its power will be p=0.5 dioptre.

If we combine two or more lenses then the resultant power of that combination of lenses is given as

$P = P_1 + P_2 + P_3 + ...$

Where P_1, P_2, P_3 etc are power of individual lenses.

Example 10 : An eye -lens projects the light from infinity on a wall at 25 cm. Find the power of lens.

Solution : focal length of lens f = +25cm = 0.25m

Power $P=\frac{1}{f}=\frac{1}{0.25}=+4$ dioptre

Hence the lens is convex lens.

9.11 Defects in eye vision and their corrections

Eyes are one of the most important organ of our body. We experience many things around the world by seeing through our eyes. When we are not able to see clearly then we consult an ophthalmologist (or an eye-specialist) to rectify the defect in our eyes. Let us first try to understand the structure of eye before studying the types of defects and their remedies in eyes.

Structure of eyes

Working of a human eye resembles to an autofocus camera. It is an organ around 2.5 cm and is almost round. Its components are shown in figure 9.34 The eye is made up of three layers, out of which the outer most part is cornea and sclera, the middle layer consist of choroid, ciliary body and iris and the inner most layer is retina

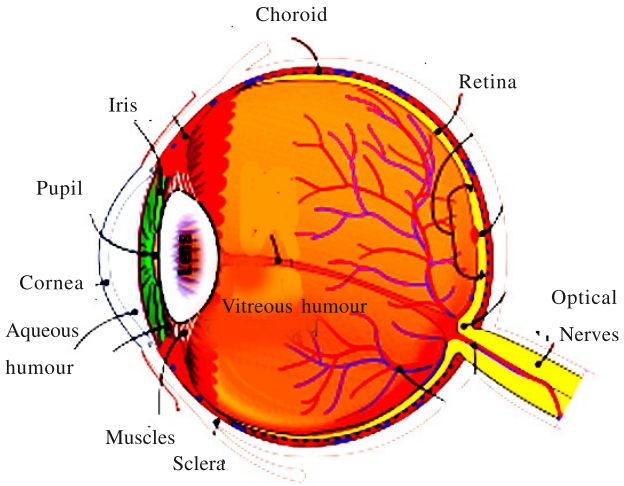


Fig. 9.34 Structure of an eye

1. **Sclera -** It is also known as the white of the eye. It is an opaque, fibrous protective outer layer of the eye. It contains collagen and elastic fiber.

2. **Cornea -** It is the front part of the eye and it covers iris, pupil and interior chamber of eye. It is transparent and refracts the light entering to eye It accounts for around two third of our eye's total optical power. Its focus is fixed.

3. **Iris-** It is fibrous structure behind the cornea having a hole in the middle. Generally it is dark in colour having brown or blue area. Iris can contract or expand.

4. **Pupil -** The hole at the centre of the iris is called pupil. Its size changes depending upon the available light. Fibrous muscles of iris expand or contract to allow different amount of light through pupil. In intense light pupil size reduces while in low light condition the size of pupil increases. Because of this reason we do not see properly when we suddenly move from an intense light region to low light region. After some time the pupil dilates and again we get the ability to see properly.

During total solar eclipse the pupil dilates and then when suddenly the sun light reappearss our eyes may get damaged becuase pupil wouldn't adjust to this sudden change of light. Therefore, it is advised not to see solar eclipse through naked eyes.

5. **Eye lens –** Lens is a flexible transparent structure behind iris and is suspended in place by a ring of suspensory fibrous tissue around the lens. The pressure from these muscles change the shape of the lens and thereby change the focal length of lens or eye. To focus refracted light from cornea the radius of curvature of eye lens is adjusted or accomodated by appropriate pressure on it by fibrous tissue surrounding it. In that way we focus object at various distances. The image formed by lens is real, inverted and small.

6. **Aqueous humour –**In between eye lens and cornea a transparent water fluid is filled. It contains low protein concentrations. It maintains the intraocular pressure and helps in keeping the eye ball in a roughly spherical shape. It also provides nutrition to cornea, lens and other surrounding parts.

7. **Choroid–** It is a vascular layer of eye that has connective tissues. The choroid provides oxygen and nourishment to the outer layer of retina. It is between sclera and retina. It also absorbs the light entering the eye and thereby stops uncontrolled reflections of light from inner layers of eye.

8. **Retina-** Retina is a light sensitive layer of tissue and is below the choroid. Light coming from the object

refracts through cornea and eye lens and gets focussed at retina. Light sensitive tissues of retina get activated on receiving the light. In a complex process they produce electrical signals. Optic nerve send this electrical signal of image to the visual centres of brain. This image received by brain is inverted and the brain now performs a set of processes to give us the final upright image.

9. **Vitreous humour –** The space between eye lens and retina is filled with a transparent gel like matter known as vitreous humour.

Under normal conditions the image of an object kept at infinity from our eyes is clearly formed at retina. When object is near, the tissues of eye lens produce appropriate pressure so that eye lens becomes thick from middle. This process reduces the focal length of the lens and the imge of a nearby object is formed at retina. Capacity of eye lens to change the focal length is known as accomodation power of eyes.

When we try to see an object from very near to our eyes then we find it difficult to get a clear image and the reason is that the eye lens has limit to accomodate the focal length. The least distance from which an object is clearly seen is known as near point of the eye. For a normal eye this distance is 25cm. Similarly, the farthest point from which on object is clearly visible is known as far point of the eye. For normal eyes this is infinity. Distance between near point to the far point is known as range of the vision.

Defects of vision and their corrections

With age the eye loses its power of accomodation. Sometimes because of stress, injury or other reasons the eye can not accomodate for near object or far object or both. Sometimes the eye lens loses its transparency. Because of such varied reasons the eye is not fully able to see objects and we call it defect in vision. A few of the major vision defects and their probable corrections are as follows.

Myopia or short sightedness

Myopia is also known as short sightedness or near sightedness. A person suffering from myopia can see the nearby objects clearly but distant objects are not very clear or distinct. One of the main reason for this defect is the increase in the curvature of eye lens. Therefore, the image of a far obejct is formed infront of the retina while the image of nearby objects is formed at retina. We can say that far point of such persons is not infinity but nearer.

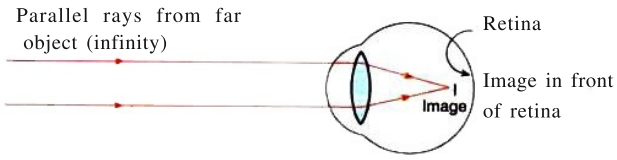


Fig 9.35(a) Short sightedness

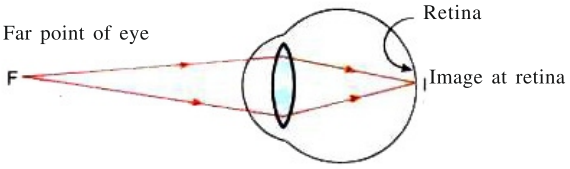


Fig 9.35(b) Far point of a myopic eye

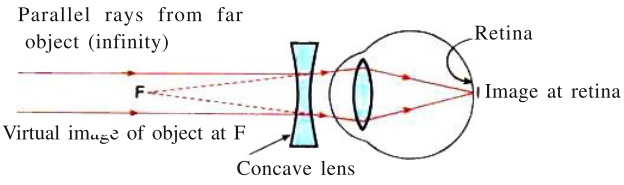


Fig 9.35(c) Correction of myopic eye

To correct the defects of short sightedness a concave lens of apporpriate power is placed before the eye. The concave lens diverge parallel rays from infinity and when extended backwards they seem to originate from the focus of concave lens. When this focal length is equal to the far point of a person suffering from myopia then the person will see clearly. Nowadays laser technique is used to correct short-sightedness.

Hypermetropia or long sightedness

Hypermetropia is also known as long sightedness or far sightedness. A person suffering from hypermetropia is able to see distant objects clearly. Such persons connot see the nearby objects clearly. So an object placed at near point (25cm) is not clearly visible but as we move it away from eyes the obejct

gradually becomes clearer. So we can say that the near point of a person with hypermetropia is not at 25cm but at some longer distance.

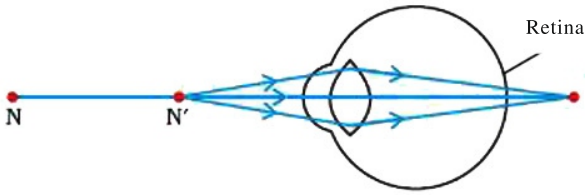


Fig.9.36 (a) Long sightedness

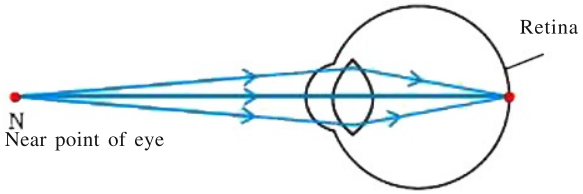


Fig 9.36 (b) Near point of an eye with hypermetropia

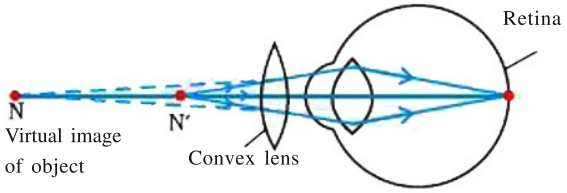


Fig. 9.36 (c) Correction for hypermetropic eye

To correct the defect of long sigthedness a convex lens of appropriate power is placed before the eye. The convex lens makes virtual image of a nearby obejct at such long distance, that is the near point of hypermetropic eye. The eye will then see that nearby object at a distance, away from eye and at the near point of that eye with defect. In that way the eye will see the object clearly

Presbyopia

The flexibility of eye lens and its surrounding fibrous structure decreases with age and thereby the accomdation power of eye reduces. This makes it difficult for people to clearly see the nearby objects. Sometimes with age people can not clearly see the distant objects either. The problem of eye in which person cannot see nearby as well as distant object clearly is known as presbyopia and it generally occur with age. To correct this defect a bifocal lens is used. The upper portion of these lenses is concave and lower portion is convex.

Astigmatism

Astigmatism is beacuse of irregular curvature of the cornea and people of all ages can be affected by this problem. A person with astigmatism cannot clearly see horizontal and vertical lines at the same distance simultaneouly. Cylindrical lenses are used to correct this defect of eye.

Cataract

With aging the transperancy and flexibility of eye lens reduces. The eye starts reflecting light because of this reduction in transperancy and the object is not clearly visible to such an eye. This defect is known as cataract (fig 9.37). The eyelens is removed to improve vision. Earlier a person had to use a very high powered and dark colured lens and still the vision recovery was not proper. Now -a-days becuase of advancement of technology the eye lens is replaced with an artificial lens to correct the vision. These lenses are known as interaocular lenses. It is also possible to use lens such that either long sigthness or short sighedness of the vision is corrected in that lens.

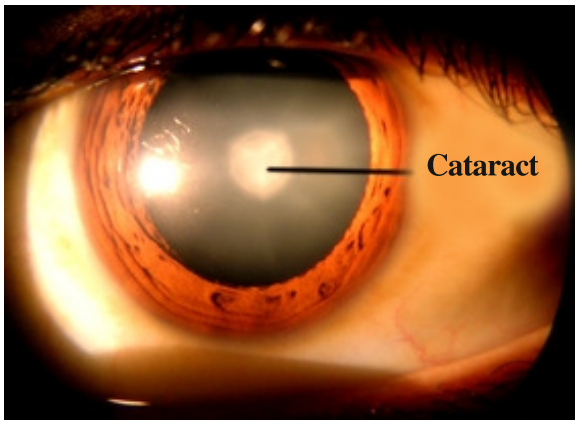


Fig 9.37 Cataract

Important Points

1. When light is incident on an obejct then the object reflects a few colours of light and absorbs others. We see the object and its colour because of this reflected light.
2. Rules of reflection of light :
   (i) incident light, reflected light and perpendicular on the plane of reflection are in the same plane.
   (ii) Angle of incidence 'i' is equal to the angle of reflection 'r'
3. Image in a plane mirror is virtual and is at the same distance behind the mirror as that of the distance of object in front of mirror.
4. Cartesian sign conventions are used for spherical mirror and lens. According to this convention the object is always towards left. Distances of the left of the mirror or lens are taken as negative and distances towards the right are taken as positive. Focal length and radius of curvature of a concave mirror are always negative while they are always positive for convex mirror. Similarly, the focal length of a concave lens is always taken as negative and focal length of convex lens is taken as positive.
5. In convex mirror, the image is always virtual, upright and simaller than the object. For a concave mirror the nature of image depends upon distance of object from the mirror.
6. If object distance for a mirror is u, image distance is v and focal length is f then the morror formula is given as

$$\frac{1}{v} \quad \frac{1}{u} + \quad \frac{1}{f}$$

7. Radius of curvature of a spherical mirror is double of the focal length of the mirror.
8. Ratio of height of image to the height of an object is called magnification.
9. Rules of refraction
   (i) Incident ray, refracted ray and the perpendicular on the plane of refraction are in the same plane.
   (ii) For a refracting medium the ratio of sine of angle of incidence 'i' and sine of angle of refraction 'r' is constant.
10. When light rays travel through rarer medium to denser medium then at the plane of separation of both the mediums the rays bend towards the perpendicular after refraction. On the contrary when rays go from denser to rarer medium then after refraction the rays bend away from the perpendicular
11. Ratio of speed of light in vacuum to the speed of light in a transparent medium is called refractive index of the transparent material.
12. A refracting medium of two curved surfaces or one curved surface and one plane surface is called a lens. Lens are of two types.
    (i) Convex lens or converging lens
    (ii) Concave lens or diverging lens
13. Image from a concave lens is always virtual, upright and smaller than the object. Image in a convex lens depends upon the distance of object from the lens.
14. If an object is at a distance u from a lens, image is at distance v and focal length of lens is f then lens formula is given as

$$\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$$

15. Reciprocal of the focal length of a lens is known as the power of the lens. Its unit is diopter.
16. Eye forms an image of an object at the retina. For a normal eye the near point is 25cm and far point is at infinity
17. Following defects are commonly observed in eyes
    (i) Myopia
    (ii) Hypermetropia
    (iii) Presbyopia
    (iv) Astigmatism
    (v) Cataraet

Practice questions

Objective type questions

1. Which mirror will show a wide area view
   (a) plane mirror (b) convex mirror
   (c) concave mirror (d) parabolic mirror
2. Speed of light will be maximum in
   (a) water (b) glass (c) vacuum (d) glycerin
3. A coin at the bottom of a water tank appears to be raised because of the phenomenon of
   (a) refraction
   (b) reflection
   (c) total internal reflection
   (d) None of these
4. If focal length of a mirror is + 60cm then the mirror is a
   (a) concave mirror (b) parabolic mirror
   (c) plane mirror (d) convex mirror
5. Focal length of a plane mirror is
   (a) 0 (b) 1 (c) Infinity (d) None of these
6. Image in a convex mirror will always be
   (a) real and upright
   (b) real and inverted
   (c) virtual and inverted
   (d) virtual and upright
7. The power of a lens is +2 diopter. What will be its focal length?
   (a) 2m (b) 1m (c) 0.5m (d) 0.2m
8. In hypermetropia a person
   (a) can see nearby objects
   (b) can see far objects clearly
   (c) Neither nearby obejcts nor far objects are clearly visible
   (d) None of these
9. To get a real image of the same size of object, where shall the object be placed before a convex lens of focal length 15cm?
   (a) 30cm (b) 15cm
   (c) 60cm (d) None of these
10. An object is placed at infinity with respect to a concave lens of focal length 20cm. Distance of virtual image from lens will be
    (a) 10cm (b) 15cm
    (c) 20 cm (d) at infinity

Very short type questions

1. When an object absorbs all colours of light then which colour of the object will be seen by us ?
2. To see our full image in a plane mirror what should be the lowest height of the mirror?
3. A light ray is incident on a plane mirror at an angle of 30^0. What will be the angle between the reflected and incident ray?
4. Write two uses of a convex mirror.
5. Write two uses of a concave mirror.
6. Write mirror formula.
7. Write the relation between radius of curvature and focal length of a spherical mirror.
8. Give the magnification formula.
9. Give snell's law.
10. Write lens formula
11. Parallel rays from an object are incident on a convex lens. Where will the image be formed?
12. What is the unit of power of lens?
13. In which conditions a person with myopia cannot dearly see the object?
14. Which defect of eye can be rectified with the help of a convex lens of appropriate power.
15. What is cataract?
16. What will be the nature of our image in a shaving mirror?

Short type questions

1. What do you mean by regular reflection and diffused reflection?
2. Explain lateral inversion.
3. An object is placed between radius of curvature and focus of a concave lens. Show

the image formation by ray diagram.

4. Explain Cartesian sign convention for spherical mirrors.

5. Discuss refraction of light and write the laws of refraction .

6. What are the different types of convex lenses & concave lenses?

7. Define principal focus and optical centre of a spherical lens.

8. What do you mean by radius of curvature and centre of curvature of a spherical lens?

9. Write the laws of refraction for spherical lens.

10. Explain the image formation by a concave lens with ray diagram.

11. What do you mean by power of a lens?

12. What do you mean by myopia? How it is corrected?

13. What is hypermetropia? How this defect is corrected?

14. What do you mean by presbyopia and astigmatism?

15. What is the power of accomodation of an eye and what is the range of the vision?

16. An object is placed on principal axis between infinity and $2F_1$ of a convex lens. Show the image formation with ray diagram.

Essay type questions

1. With the help of ray diagram explain the position and nature of image for following positions of object for a concave mirror.

(i) When object is between infinity and centre of curvature

(ii) When object is at the centre of curvature

(iii) When object is between centre of curvature and focus

(iv) When object is at focus

(v) When object is between focus and pole

2. What do you mean by refraction? write laws of refraction and explain the refraction of light rays with the help of a glass slab.

3. With the help of ray diagram explain the nature and position of image for following positions of object for convex mirror

(i) When object is at infinity

(ii) When object is at certain distance

4. Explain the nature and position of image with the help of ray diagram for a concave lens when object is placed

(i) at focus point of lens

(ii) between focus F_1 and $2F_1$

(iii) Between $2F_1$ and infinity

5. For a convex lens explain the formation of image and nature of image with ray diagram when object is placed.

(i) between focus and optical centre

(ii) at focus F_1

(iii) between focus F_1 and $2F_1$

(iv) at $2F_1$

6. Discuss in detail different types of defects in vision and methods to correct the defects of vision.

Numerical questions

1. Focal length of a concave mirror is 30cm. If an object is placed at 40cm then find the position of image and also get the magnification (-120cm, 3 times & real)

2. An image of an object is seen at 8cm from the convex mirror . If focal length of convex mirror is 16cm then find the position of the object (-16cm)

3. An object is placed at a distance of 60cm from the convex lens of focal length 30cm. If object height is 3cm then find the position and nature of the image (60cm, 3cm real and inverted)

4. An object is placed at 10cm from a convex lens. If focal length of convex lens is 40cm then find the position and nature of the image (-13.33cm, 1.33 times, virtual & upright)

5. Focal length of a concave mirror is 30cm. If an object is placed at 20cm from the mirror then find the image position and its nature (+60cm, 3times & virtual)

6. Image of an object placed in front of a concave lens is at 10cm. If focal length of concave lens is 15cm then find the distance of object from the lens. (-30cm)

7. Find the magnification of a convex lens of focal length 10cm when the upright image of the lens is formed at distance of near point of eye. (3.5)

Answer keys

1. (b)	2. (c)	3. (a)	4. (d)	5. (c)
6. (d)	7. (c)	8. (b)	9. (a)	10. (c)

Chapter - 10
Electric Current

We know that heat flows from higher temperature to lower tempferature and the rate of flow of heat is called heat current. Similarly charge flows in a conducting wire from high potential to low potential and the rate of flow of charges is called the electric current. The direction of current is given from positive charge to negative charge as per convention i.e. the direction is opposite to the direction of motion of electrons.

10.1 Electric current

In any electric circuit the amount of charge passed from a point per unit time is called electric current. If charge Q passes through a point in time t then

$$\text{electric current} = \frac{\text{Charge}}{\text{time}} \quad \text{or} \quad I = \frac{Q}{t}$$

If n electrons pass from a point in t time then a total of ne charge will pass in t time from that point. Hence ne

$$\text{electric current (I)} = \frac{ne}{t}$$

Where e is the charge on electron whose value is 1.6×10^{-19} Coulomb.

10.2 Unit of electric current

From the formula of electric current

$$I = \frac{Q}{t} \qquad Unit\ of\ I = \frac{Columb}{second} = Ampere$$

Electric current is also given as

1 milli Ampere = 10^{-3} Ampere

1 micro Ampere= 10^{-6} Ampere

Definition of one ampere

When Q = 1 Coulomb and t = 1 second then

$$I = \frac{1}{1} = 1 \text{ Ampere}$$

If one coulomb charge passes from any point in one second time then the current in the circuit will be one Ampere.

We use an ammeter in series of the circuit to measure electric current

Example 1 : Find the number of electrons in 1 coulomb of charge

Solution :

$$Q = ne$$

$$1 = n \times 1.6 \times 10^{-19}$$

$$n = \frac{1}{1.6\times10^{-19}}$$

$$n = \frac{10^{19}}{1.6} = \frac{10\times10^{18}}{1.6} = 6.25\times10^{18}$$

10.3 Potential and potential difference

Electric potential is responsible for flow of electricity in a charged object. When two charged objects are placed in contact of each other then positive charge always flows from an object of high potential to the object of low potential. If both the objects are at same potential i.e. the potential difference is zero and if two are in contact with each other then no charge or current will flow between the two objects.

The potential difference between two points of an electric circuit is defined by work. Work done in taking unit positive charge from one point to another point in an electric circuit is equal to the potential difference between the two points.

Potential difference between points A and B is

$$(V_A - V_B) = \frac{\text{Work done (W)}}{\text{Charge (Q)}}$$

$V_A - V_B = \frac{W}{Q}$ Its unit is Joule/Coulomb (Volt)

Electric potential

If point B is at ∞ then

$$V_A - V_\infty = \frac{W}{Q}$$

potential at infinity is considered zero

$$\therefore V_A = \frac{W}{Q} \qquad (\because V_\infty = 0)$$

if $Q = 1$ unit charge then $V_A = W$

Electric potential at any point is equal to the work done in bringing a unit charge from infinity to that point.

Equipment used to measure the potential difference is called Voltmeter. It is placed parallel to two points where potential difference is to be measured.

Example : 2 How much work is required to be done to transfer a charge of 3 coulomb between two points with potential difference of 10 volts.

Solution : $V_A - V_B = 10$ V Given W=?

$V_A - V_B = 10$ V and $Q = 3$ coulomb

$$V_A - V_B = \frac{W}{Q}$$

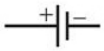
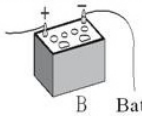
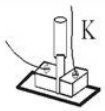
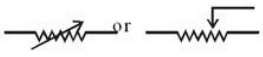
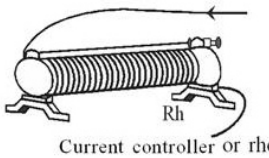
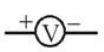
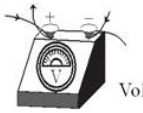
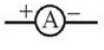
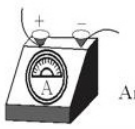
$$\therefore W = (V_A - V_B) \times Q$$

$W = 10 \times 3$ $W = 30$ Joule

10.4 Prevailing symbols of useful equipments in electrical circuits

While drawing electrical circuits different parts are reprsented by symbols for ease. Following table 10.1 shows a few of them -

Table 10.1 Symbols of common component and equipments used in different circuits

S.no.	Component	Symbol	Figure of equipment
1	Electric cell (Battery)		 B Battery
2	Key or switch		 K Key
3	Variable resistance or rheostat or current controller		 Rh Current controller or rheostat
4	Voltmeter		 Voltmeter
5	Ammeter		 Ammeter
6	Electric bulb		 Bulb

10.5 Ohm's law

German scientist Gerog Simon Ohm in 1826 observed a relation between the potential difference between two terminals of a conductor and the current flowing through the conductor. This rule is called Ohm's law and accroding to this law :

The potential difference between the terminals of a conductor is proportional to the current flowing through the conductor when physical states of the conductor like temperature, pressure, length and area etc remain constant

$$V \propto I, \quad V = RI$$

Where R is a constant and is called resistance of the conductor.

Unit of resistance

$$R = \frac{V}{I} \text{ Unit } \rightarrow \frac{\text{Volt}}{\text{Ampere}} = \text{Ohm}(\Omega)$$

Definition of 1 ohm

When a current of 1 amp is passed through a conductor and the developed potential difference is 1 volt then the resistance of that conductor will be 1 ohm.

Experimental verification of Ohm's law

Join a battery (B), a rheostat or current controller (R_h), an ammeter (A), a voltmeter (V) and a key (K) in series and a conducting wire PQ is joined parallel to a voltmeter as shown in the figure 10.1

By adjusting the current contraller (R_h) we change the current in the circuit and in conductor PQ. We note the current as well as corresponding voltage across PQ. Now we draw a graph between potential difference V and current I. We see that the graph is a straight line.

This proves that the potential difference across the terminals of conductor is proportional to the current flowing through it. This is ohm's law.

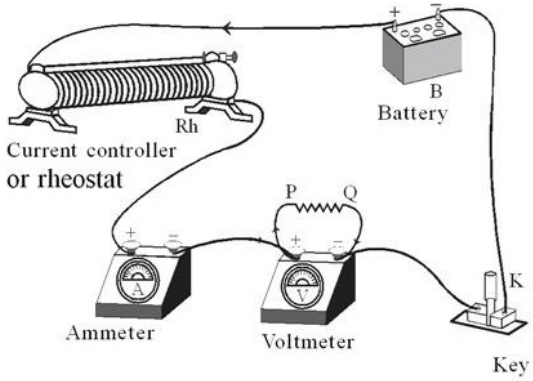


Fig. 10.1 Diagram for experimental verification of Ohm's law

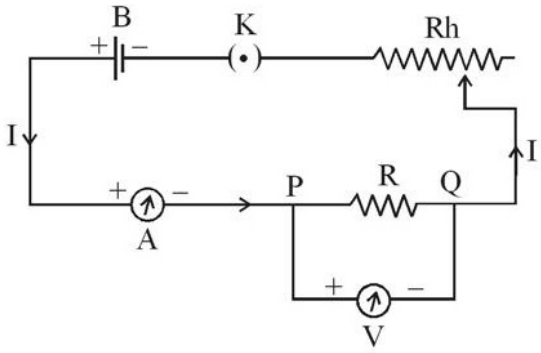


Fig 10.2 Circuit diagram to experimentally verify Ohm's law

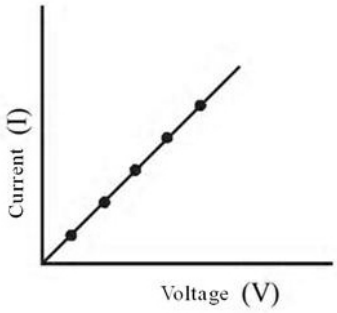


Fig 10.3 Graph between measured voltage and current

Example 3 : Find the resistance of a conducting wire in which potential difference of 2 volts is produced when 0.5 ampere current flows through it?

Solution :

Given I = 0.5 ampere

$V = 2\ V$

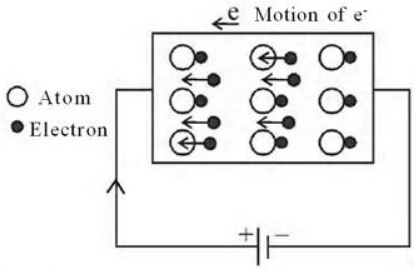
$R = ?$

$$R = \frac{V}{I}$$

$$R = \frac{2}{0.5} = 4\ \Omega$$

10.6 Resistance

Every conducting material is made of many molecules and these molecules are made of atoms. Electrons encircle around the nucleus in atoms. Electrons of the outermost orbit are relatvely loosely bound by the nucleus. These electrons move around freely in a conductor. When these conductors are connected to the battery then these free electons move towards the positive terminal of the battery. Atoms, molecules and ions in the conductor porvide hinderance to the movement of these electrons. This hinderrance is called resistance.



"The Restriction to the movement of charges in conductors is called Resistance".

As resistance is inversely proportional to the conductivity therefore when resistance of a conductor is low then its conductivity will be high.

10.6.1 Dependence of resistance

Resistance depends upon following factors

(a) On length - We take conducting wire of different lengths having same material and same diameter (cross-section) and find the resistances of these wires. Now we draw a graph between length of wire and its resistance. We find that the graph is a straight line. i.e. as the length of the conducting wire increases its resistance also increases or we can say that resistance (R) is proportional to its length

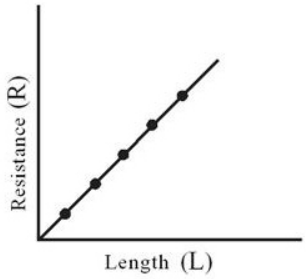


Fig. 10.4 Graph between R & L

$$R \propto L \qquad .....(10.1)$$

(b) On cross sectional area - Let us take different wires of the same material and same lenght but having different cross-sectional area and find their resistances. Now we draw a graph between the resistance and cross-sectional area A and between the resistance and inverse of cross-sectional are a $\left(\frac{1}{A}\right)$. We find that the graph is a strainght line i.e. as corss sectional area (A) or thickness of the wire is increased its resistance decreases.

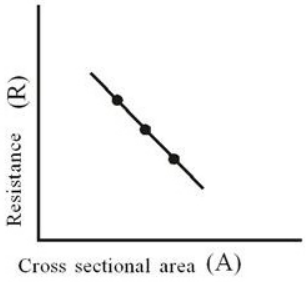


Fig. 10.5 Graph between R & A

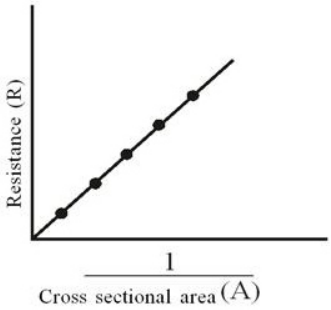


Fig. 10.6 Graph between R & 1/A

$$R \propto \frac{1}{A} \qquad .....(10.2)$$

From equation (10.1) and (10.2)

$$R \propto \frac{L}{A}$$

or $$R = K\frac{L}{A} \qquad \text{.....(10.3)}$$

Where K is a constant that is known as specific resistance of the conducting material or resistivity.

Unit of resistivity :

Solving equation (10.3) for K we get

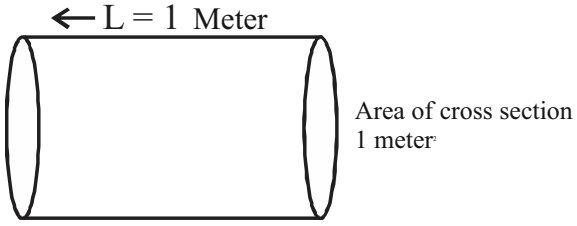
$$K = \frac{RA}{L}$$

$$\text{Unit of } K = \frac{\text{Ohm} \times \text{meter}^2}{\text{Meter}} = \text{Ohm} \times \text{Meter}$$

10.7 Resistivity

Assume a conducting wire with unit lenght and unit cross sectional area.

Thus resistance of wire of unit length and unit cross sectional area is known as specific resistance or resistivity, of the material.



Resistivity does not depend upon the lenght or cross sectional area of a conductor. It depends on the material of the conductor.

10.7.1 Dependence of resistance on temperature

As temperature is increased the resistance increases for metals like silver, copper and gold while for alloys like manganin and constantan the resistance very slightly with change in temperature. On the contrary for materials like silicon (Si) and germanium (Ge) the resistance decreases with increase in temperature. These are called semi-conductors.

L= 1 Meter A= 1 m^2

$$K = \frac{R \times 1}{1} \quad \text{or} \quad K = R \text{ Ohm x Meter}$$

Table 10.2 Specifice resistance of a few materials

Category	Material	Specific resistance (Ohm x meter)
Conductor	Silver	1.60×10^{-8}
	Copper	1.62×10^{-8}
	Aluminium	2.63×10^{-8}
	Tungsten	5.20×10^{-8}
	Nickel	6.84×10^{-8}
	Iron	10.0×10^{-8}
Alloys	Constantan [Cu & Ni Alloys]	49×10^{-8}
	Manganin [Cu, Mn, Cl or Ni Alloys]	44×10^{-8}
	Nichrome [Ni, Cr, Mn Fe Alloys]	100×10^{-8}
Insulators	Glass	$10^{10} - 10^{14}$
	Ebonite	$10^{15} - 10^{17}$
	Diamond	$10^{12} - 10^{13}$

When temperature is decreased in certain materials the resistance drops to zero at a certain temperature. These are called superconductors. For example at 4.2 K temperature the resistance of mercury suddenly drops to zero.

10.7.2 Dependence of resistance on material

If we take wire of four different conductors say silver, copper, gold and aluminum such that the length and cross sectional area of all of them is same. Now we find the resistances of all these wires. We find that the resistance of aluminum is highest and the resistance of silver is lowest.

$R_{,Yewfu;e} > R_{lksuk} > R_{rkack} > R_{pkanh}$

This silver is the best conductor and is followed by copper, gold and aluminium.

From the point of view of conductivity, the four metals are in the sequence

Silver > Copper> Gold>Aluminium

10.8 Combination of resistances

By combining known resistances in two different ways we obtain resistances of different values.

(a) Series combination

In this type of combination second end of the first wire is combined with the first end of the second wire and second end of the second wire is combined with the first end of the third wire etc. In figure 10.7 series combination of three conducting wires AB, BC & CD is shown. Lets R_1, R_2 and R_3 are their resistances. In series combination the same current flows from all resistances while the potential difference across their ends is different.

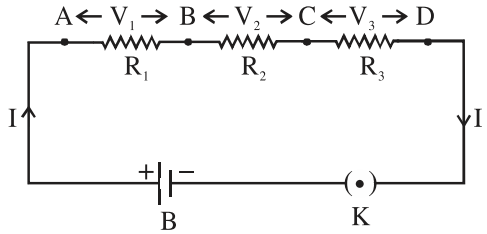


Fig 10.7 Series combination of resistance

Assume that a current I flows from the resistances R_1, R_2 and R_3 and the developed potential difference across the ends of resistances are V_1, V_2 and V_3

According to Ohm's law

Potential difference across the wire AB

$R_1 \quad V_1 = IR_1$

Potential difference across the wire BC

$R_2 \quad V_2 = IR_2$

Potential difference across the wire CD.

$R_3 \quad V_3 = IR_3$

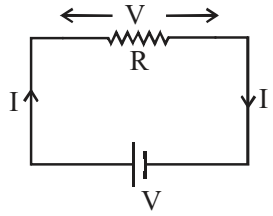
If the potential difference across the battery is V volt then

$$V = V_1 + V_2 + V_3$$

$$V = IR_1 + IR_2 + IR_3$$

$$V = I(R_1 + R_2 + R_3) \qquad .....(10.4)$$

If R is the effective resistance of the series combination of R_1, R_2 & R_3 then potential



Equivalent circuit of fig 10.7

difference across the equivalent resistance is

$V = IR$

Putting this value in equation 10.4 we get

$$IR = I(R_1 + R_2 + R_3)$$

or $$R = R_1 + R_2 + R_3$$

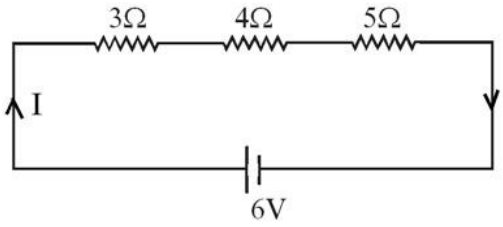
Thus we can say that total resistance of a series combination of a number of resistances is equal to the sum of resistatnces of that combination.

Example 4 : Resistanaces of $3\Omega, 4\Omega$ & 5Ω are connected in series in a circuit in which a battery of 6 V is also connected. Find the following :

(a) current in each resistance

(b) Potential difference across each of the

resistance



Solution

Equivalent resistance of three reistances in series is

$$R = R_1 + R_2 + R_3$$

$$R = 3 + 4 + 5 = 12\,\Omega$$

current will remain the same through all the resistances

$$I = \frac{V}{R} = \frac{6}{12} = 0.5 \text{ ampere}$$

Potential difference (P.D.) across all the three resistances can be found by equation V = IR

P.D. across $3\,\Omega$ resistance

$$V_1 = IR_1 = 0.5 \times 3 = 1.5 \text{ V}$$

P.D. across $4\,\Omega$ resistance

$$V_2 = IR_2 = 0.5 \times 4 = 2.0 \text{ V}$$

P.D. across $5\,\Omega$ resistance

$$V_3 = IR_3 = 0.5 \times 5 = 2.5 \text{ V}$$

(b) Parallel combination

In parallel combination, all the resistances are connected in such a way that the one end of each of them is connected to one point, say C, and the other end of each of them is connected to another point, say D, in the circuit. In figure 10.8 three conductors having resistances R_1, R_2 and R_3 are connected in parallel. In parallel combination the protendtial difference across all the resistances is same but current in each of the resistance is different. Let I_1, I_2 and I_3 are the currents flowing through R_1, R_2 and R_3 respectively then

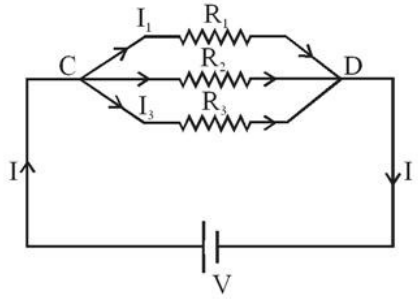


Fig 10.8 Parallel combination of resistances

According to Ohm's law

$$\text{current in } R_1 \quad \Rightarrow \quad I_1 = \frac{V}{R_1}$$

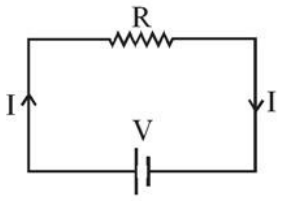
$$\text{current in } R_2 \quad \Rightarrow \quad I_2 = \frac{V}{R_2}$$

$$\text{current in } R_3 \quad \Rightarrow \quad I_3 = \frac{V}{R_3}$$

$$\because \quad I = I_1 + I_2 + I_3$$

$$I = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

$$\text{or} \quad I = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right) \qquad .....(10.5)$$



Equivalent circuit of figure 10.8

If equivalent resistance of R_1, R_2 व R_3 in parallel combination is given by R then the current flowing in the equivalent circuit is $I = \frac{V}{R}$

Putting $I = \frac{V}{R}$ in equation 10.5

$$\frac{V}{R} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

or $$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

Thus the inverse of the equivalent resistance of a parallel combination is equal to the sum of the inverse of each of the resistance in parallel combination. If there are two resistances in a parallel combination, say R_1 and R_2 then

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \quad \text{Or} \quad \frac{1}{R} = \frac{R_1 + R_2}{R_1 R_2}$$

or $$R = \frac{R_1 R_2}{R_1 + R_2}$$

Example 5 : Three resistances of $1\Omega, 2\Omega$ & 3Ω are connected in parallel in an electrical circuit. If this circuit is connected with a battery of 6V then find the follwoing -

(a) Equivalent resistance of the combination

(b) current in the circuit

(c) current in each resistance

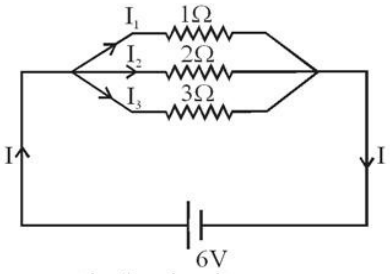
Solution (a) equivalent resistance

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \quad \begin{cases} R_1 = 1\Omega \\ R_2 = 2\Omega \\ R_3 = 3\Omega \\ R = ? \end{cases}$$

$$\frac{1}{R} = \frac{1}{1} + \frac{1}{2} + \frac{1}{3}$$

$$\frac{1}{R} = \frac{6+3+2}{6}$$

$$\frac{1}{R} = \frac{11}{6} \quad \text{Or} \quad R = \frac{6}{11}\Omega$$



(b) current in the circuit

$$I = \frac{V}{R} \begin{cases} V = 6 \text{ volt} \\ R = \frac{6}{11}\Omega \\ I = ? \end{cases}$$

$$I = \frac{6}{6/11}$$

$$= 6 \times \frac{11}{6} = 11 \text{ ampere}$$

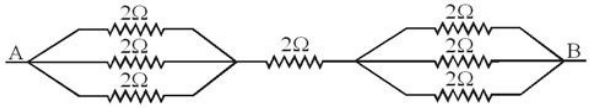
(c) current in each resistance

current in $R_1 = 1\Omega \Rightarrow I_1 = \frac{V}{R_1} = \frac{6}{1} = 6$ ampere

current in $R_2 = 2\Omega \Rightarrow I_2 = \frac{6}{2} = 3$ ampere

current in $R_3 = 3\Omega \Rightarrow I_3 = \frac{6}{3} = 2$ ampere

Example 6: Find the equivalent resistance between A and B in the given circuit.



Solution : In the given circuit three resistances of 2Ω are connected in parallel at two places. The equivalent resistance of each of them will be

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \Rightarrow \frac{1}{R} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$$

$$\Rightarrow \frac{1}{R} = \frac{1+1+1}{2} \quad \text{or} \quad \frac{1}{R} = \frac{3}{2} \text{ or } R = \frac{2}{3}\Omega$$

Thus equivalent circuit may be drawn as

We see that resistances and $\frac{2}{3}\Omega$ are connected in series between point A&B. Hence the equivalent resistance is given as

$$R = R_1 + R_2 + R_3$$

$$R = \frac{2}{3} + 2 + \frac{2}{3} = \frac{2+6+2}{3} = \frac{10}{3}\Omega$$

10.9 Thermal effect of current

When a battery is connected to a circuit and current flows through a conducting wire then the chemical energy stored in the battery is converted continuously into kinetic energy of free electrons. These free electrons collide with the atoms of conductor and in the process the kinetic energy of these electrons decreases and temperature of the conductor increases. Thus chemical energy of the battery changes into thermal energy of conductor. For example, when an electric fan runs continously then it becomes hot.

If we consider an electric circuit in which only a pure resistance is connected then all of the energy of the source decays in the form of thermal energy of conductor. This is known as thermal effect of current. It is used in electric heater, electric press and electric geyser.

To find the heat generated from thermal effect in a pure resistor let us assume a pure reistance wire connected to a battery. Let R is the reistance of the wire and I is current flowing through the circuit and the potential difference across the terminals of resistance is V.

If charge Q passes through the resistance in time t and the potential difference developed is V then the work done = charge x potential difference.

$$W = QV$$

$$W = I\,t\,V$$

In time t the energy given (VI t) by the source is converted to thermal energy and thus the heat developed in time t will be H = VI t

$$H = IR \times It \qquad \left[\begin{array}{c}\text{From Ohm's law}\\ V = IR\end{array}\right]$$

$$H = I^2Rt$$

From the above equation we see that the heat generated in the resisance wire is

(a) proportianl to the square of the current flowing in the wire

$$H \alpha I^2$$

(b) proportional to the reistance

$$H \alpha R$$

(c) proportional to the time t of flow of current

$$H \alpha t$$

All the three rules are called Joule's law of heating.

Electric power

Work done per second when current flows through an electrical circuit is called electric power

$$\text{Electric power (P)} = \frac{\text{Work done (W)}}{\text{Total Time (t)}}$$

As we know that energy given to a pure resistor = VI t

Thus the power given to the resistor

$$P = \frac{W}{t} = \frac{VIt}{t}$$

$$P = VI$$

$$P = IR \times I \qquad [\ V = IR]$$

$$P = I^2R$$

Unit of Power is Joule/second . This is also called Watt.

Watt is a small unit to measure power. Other units to measure power are

1 kilowatt (1 kW) = 1000 Watt = 10^3 Watt

1 megawatt (1 MW) = 1000000Watt = 10^6 Watt

1 horse power (1 hp) = 746 Watt

Electrical energy is given as mulltiplication of electric power and time in hour.

Electrical energy = Electrical power (P) x time (t)

Therefore unit of electrical energy is Watt hour (Wh). When one Watt power is used for one hour then used energy is one Watt hour. The commercial unit of electrical energy is kilo Watt hour (kWh) and is generaly called a 'unit' :

Relation in 1 kWh and Joule

1 kiloWatt hour = $10^3 \times 60 \times 60$ Watt $\times$ second

$$= 36 \times 10^5 = \frac{\text{Joule}}{\text{Second}} \times \text{Second}$$

$$= 36 \times 10^5 \text{ Joule}$$

To calculate consumed electrical energy in 'unit' we use following relation

Electrical energy consumed =

$$\frac{\text{Electrical Power P (Watt)} \times \text{time (hour)}}{1000}$$

For example when two bulbs of 100 watt each are used 8 hours per day then energy consumed in a month (30 days) will be

$$= \frac{\text{p (watt)} \times \text{time(hour)}}{1000} = \frac{(100 \times 2) \times (30 \times 8)}{1000}$$

$= 48$ unit

Example 7 : A 10 volt storage cell is connected to a nicrome resistance coil of 50 ohm so that current flows for one hour. Calculate the heat generated in resistance coil.

Solution : current in the circuit

$$I = \frac{V}{R} = \frac{10}{50} = 0.2 \text{ ampere}$$

$V = 10$ Volt

$R = 50\,\Omega$

$t = 1$ hour

$= 60 \times 60$ second

$= 3600$ second

$H = ?$

$H = I^2 R\, t$

$H = (0.2)^2 \times 50 \times 3600 \qquad = 7200$ Joule

Example 8 : An electric bulb is connected to a source of 220 volt and the current flowing through the circuit is 0.5 ampere. What will be the power of the bulb?

Solution : Given

$P = VI$	$V = 220$ volt
$P = 220 \times 0.5$	$I = 0.5$ ampere
$P = 110$ watt	$P = ?$

10.10 Magnetic effect of current

In 1820 Orsted performed an experiment in which he observed that when electric current passes through a conducting wire then magnetic field is produced around the conducting wire and thus the magnetic needle placed near the wire is deflected. Experiment performed by Orsted can be understood by following way

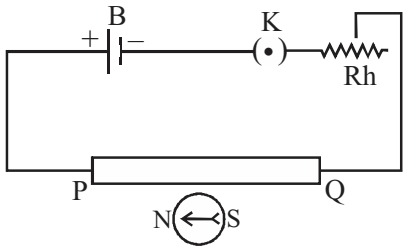


Fig. 10.9 (a)

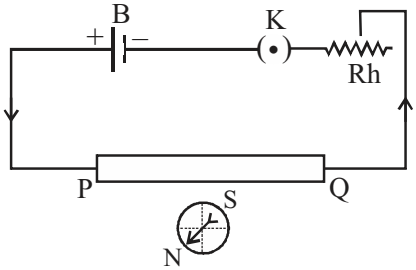


Fig. 10.9 (b)

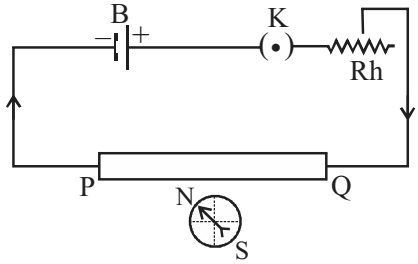


Fig. 10.9 (c)

Fig 10.9 Experiment of Orsted

(i) When there is no current flowing through the conductor then magnetic field is not produced around the conductor and the magnetic needle does not deflect [fig 10.9 (a)]

(ii) When current flows through the conductor then magnetic field is produced around the conductor and deflects the magnetic needle [fig 10.9(b)]

(iii) If we change the direction of the current

through the conductor then the direction of deflection of magnetic needle also changes [fig 10.9(c)]

Deflection of magnetic needle during current flow in the conductor shows that magnetic field is produced around the conductor. If we increase the current in the conductor or if we take the needle near to the conductor then the deflection in the needle increases.

10.11 Direction of magnetic field

Two laws are used to find the direction of the produced magnetic field during current flow in a conductor :

(a) Right handed cork-screw law :- According to this law when a right handed screw is rotated circularly and the point of the screw goes towards direction of electic current then the direction of rotation of screw will show the direction of magnetic field.

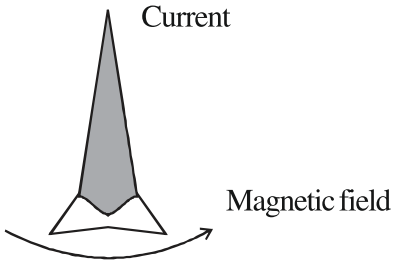


Fig 10.10(a) Right handed screw law

(b) Right hand law

According to this law if conductor wire is held by the right hand such that the thumb is in the direction of the flow of current then the curved fingers will represent the direction of magnetic field.

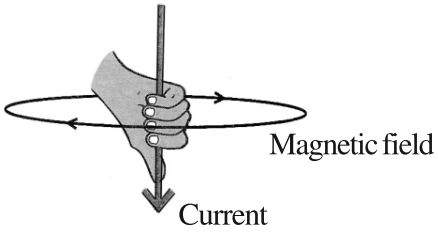


Fig 10.10(b) Right hand law

10.12 Magnetic field and field lines

In Orsted's experiment we observed that a conductor rod behaves like a magnet when current flows through it and compass needle is deflected when brought near to this conductor rod. Actually, the compass needle is also a small magnetic rod . When no outside magnetic field is near this compass needle then it rests in north-south direction The point of the needle directed towards the north is called north facing pole and the end point of the compass needle directed towards the south is called south facing pole.

To represent the magnetic field around a magnet, imaginary lines are drawn around the magnet. These lines are called field lines.

Area around the magnet where we can feel the effect of magnet is known as magnetic field.

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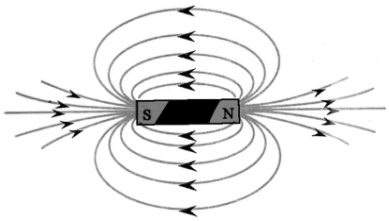


Fig 10.11

Magnetic field has both the direction and the magnitude and the direction of magnetic field is always from north pole to south pole. Figure 10.11 represents magnetic field lines.

10.13 Electromagnetic induction

A coil is connected to a galvanometer as shown in the figure 10.12 and a bar magnet is brought near the coil. We observe that galvanometer gives deflection i.e. current flows through the coil. The value of current depends upon the relative speed of magnet and coil.

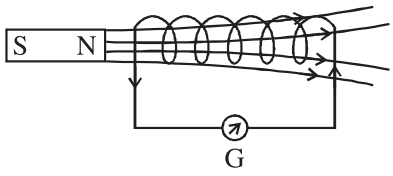


Fig 10.12

Production of electric effect (or electromotive force) in the coil (or an electrical conductor) because

of relative motion of a coil and magnet (or changing magnatic field) is called electromagnetic induction.

Explanation

When coil and magnet are in relative motion then the field lines passing through the cross section of the coil changes continously and thus magnetic flux changes. According to Faraday, when magnetic flux associated with the coil changes then induced current is produced.

10.13.1 Magnetic flux

The number of field lines passing through a cross section area placed in a magnetic field is called magnetic flux associated to that cross-sectional area. Unit of magnetic flux is Weber.

10.14 Electric current generator

Generator is a device in which mechanical energy is given to a coil placed in a magnetic field and electrical energy is obtained. It works on elctromagnetic induction.

Current generators are of two types :

(a) Alternating Current generator

Different appliances at our home like bulb, fan, elctric iron, toaster, refrigerator etc operate with alternating source. During marriages you might have seen that when electricity is stopped beacuse of fault then light decorations are operated with a diesel based alternating current generators usually placed outside the hall or garden.

Thus alternating current generator is a device that transforms mechaincal energy to alternating electric energy.

It has four inportant components

(a) Field magnet (b) Armature or coil

(c) Slip rings (d) Brushes

(a) Field magnet - Generallly it is powerful magnet in horseshoe shape. In figure, it is shown as NS.

(b) Armature or coil - It is a copper coil ABCD wound around a structrue of cast iron.

c) Slip ring - End A & D of the armature coil are connected separately to two slip rings S_1 & S_2. These slip rings, insulated from each other,. rotate along with the coil.

(d) Brushes - Brushes are made of graphite or carbon and one end of them is in contact with slip rings and the other end is connected to outer circuit. They rotate with the armature coil.

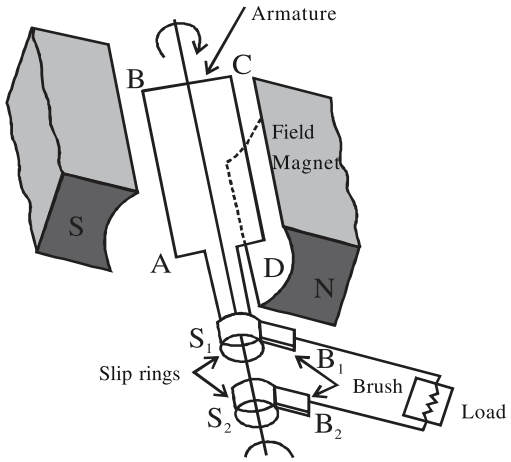


Fig 10.13 Alternating current generator

Working

When armature is rotated by providing mechanical energy then the magnetic flux through the coil ABCD continuously changes and current flows through the coil.

When the coil is rotated clockwise then the plane of the coil alternately become parallel and perpendicular to the magnetic field. In the first half cycle the flux decreases and thus in first half rotation the direction of current in the outer circuit is clockwise and it is anticlockwise in the next half rotation. So in the first half cycle the current flows from B_1 to B_2 in outer circuit and in the next half cycle the current flows from B_2 to B_1. In this way during the full rotation of armature the direction of current changes after a fixed phase difference. During the full rotation, magnitude of current also changes continuously. Such current is called alternating current.

In India, the frequency of alternating current through home elecrtricity is 50 hertz and therefore to

obtain alternating current of 50 hertz from the generator the coil is rotated 50 times in a second. Magnitude of the current produced through alternating current generator depends upon the number of turns in the coil, area of the coil, rotation, velocity and intensity of magnetic field .

(b) Direct current generator

This device also converts mechanical energy to electrical energy but the direction of the current obtained from electrical energy remains constant

Construction:- It is also similar to alternating current generator. The only difference is that instead of two slip rings it has a single split ring commutator

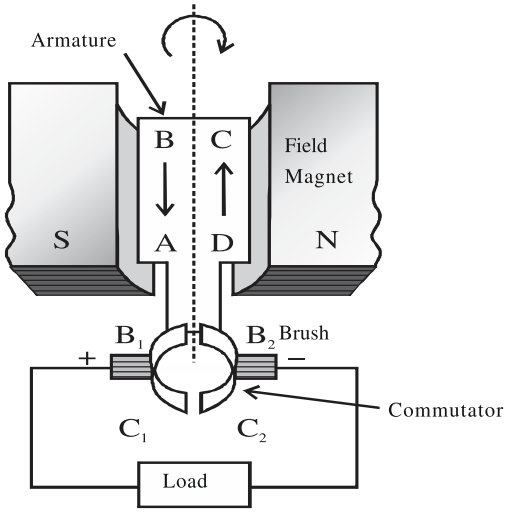


Fig 10.14 Direct current generator

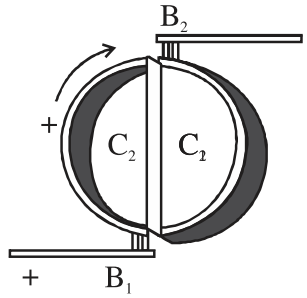


Fig 10.15 Position of commutator after half rotation

Split ring commutator is a metal ring having two halves C_1 and C_2 . One end of the armature is connected to C_1 and the other end is connected to C_2 . Two carbon brushes touch these two split rings. Commutator ring rotates with the armature.

Working

When armnature is rotated in the magnetic field then the magnetic flux through the coil continously changes and induced currrent flows through it. Brushes B_1 & B_2 are adjusted such that when the direction of current changes in the coil the contact of the brushes also changes from one part of commulator C_1 to other part of commulator C_2 and thus the direction of current in the outer circuit remains constant.

Let us assume that during the first half cycle the direction of induced current is such that the end of the coil connected to C_1 is positive and the end connected to C_2 is negative. Let B_1 is connected to C_1 and B_2 is connected to C_2 during this cycle. Thus B_1 will be positive & B_2 will be negative. Now when the direction of current changes at the begining of next half cycle then C_1 becomes negative and C_2 becomes positve. At the same time because of rotation of the coil the C_1 reaches to the place of C_2 and C_2 reaches at the place of C_1. Now the C_1 comes in contact with B_2 while the C_2 comes in contact with B_1. Thus B_1 always remains positive and B_2 remains negative. In this way the curent flows from B_1 to B_2 in outer circuit.

Important Points

1. Rate of flow of charge is called current. Its direction is always taken from positive to negative and it is measured in amperes.
2. Restriction in the flow of charge is called resistance. It depends upon lenght, cross section area, temperature and the material.
3. When physical states of a conductor are constant then the potential difference produced across the conductor is proportional to the current flowing through it. It is called Ohm's law.

   V = IR Where R is a constant and is known as resistance of conductor
4. Ammeter measures current in the circuit and is used in series in the circuit.

5. Voltmeter measures the potential difference across the conductor and is placed parallel to it in a circuit.

6. Resistance of a conducting wire of 1 meter length and 1 square meter cross sectional area is called specific resistance of the material of the wire. Its unit is ohm x meter. It does not depend on length or cross-sectional area of the wire but depends on the material of the wire.

7. Equivalent resistance in series combination

$$R = R_1 + R_2 + R_3 .....$$

8. Equivalent resistance in parallel combination

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

9. A pure resistor is connected to an electric source. The energy given to the pure resistor by electric source (W = VIt) fully transforms into heat energy.

10. When electric current is passed through a conductor then magnetic field is produced around the conductor. This effect is called magnetic effect of currrent

11. Number of magnetic lines of force passing through a surface, kept in a magentic field, is called magnetic flux associated with that surface.

12. Electric generator is a device that transforms mechanical energy to electrical energy. It is based on the concept of electromagenetic induction. Generators are of two types.

(i) Alternating current generator

(ii) Direct current generator

Practice questions

Objective type questions

1. 2 ampere current flows in a conductor connected with a 5V battery. Find the resistance of the conductor

(a) 3Ω (b) $2.5\ \Omega$

(c) 10Ω (d) $2\ \Omega$

2. Resistivity depends on which of the following?

(a) Length of the conductor

(b) Cross section area of the conductor

(c) Material of the conductor

(d) None of these

3. Volt is a unit of

(a) current (b) potential difference

(c) charge (d) work

4. Three conducting wires of $1\Omega, 2\Omega$ & 3Ω are connected in series in an electrical circuit. What will be the equivalent resistance?

(a) Less than 1 Ohm (b) Less than 3 Ohm

(c) More than 1 Ohm (d) More than 3 Ohm

5. The frequency of alternating current in India is

(a) 45 Hertz (b) 50 Hertz

(c) 55 Hertz (d) 60 Hertz

6. Resistances of different values are connected in parallel and connected with an electrical source. In each of the resistor -

(a) current and potential difference will be differenct

(b) current and potential difference will be same

(c) current will be different but potential difference will be same

(d) current will be same but potential difference will be different

7. 2 coulomb charge passes through an electrical circuit in 0.5 second. Find the value of electric current in ampere.

(a) 1 ampere (b) 4 ampere

(c) 1.5 ampere (d) 10 ampere

8. Which of the device does not depend on thermal effect of current

(a) Heater (b) Electic iron

(c) Toaster (d) Refrigerator

Very short type questions

9. What is the unit of specific resistance or resistivity?

10. Define the electric current

11. What is potential difference?
12. What is 1 ohm resistance?
13. How resistance depends upon cross section area?
14. Define resistivity.
15. What do you mean by electric power?
16. 100W – 220V is written on an electric bulb what does it means?
17. How electrical combination is made at home?

Short type questions

18. What is the difference between series combination and parallel combination of resistances?
19. What is electic power? Write the necessary formula for it.
20. Two resistances are of same material and are having same length. If the ratio of their cross-sectional area is 2 :11 then what will be the ratio of their resistances?
21. Define electric potential and potential difference.
22. What is the difference between alternating current generatior and direct current generator?
23. Write the right hand rule.
24. Find number of Joules in 1 kilowatt hour.
25. Write Joule's law of heating.
26. Give circuit diagram of experimental verification of ohm's law.

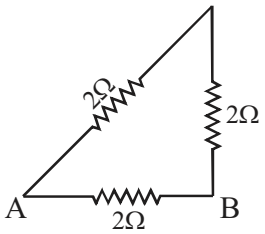
Essay type questions

27. Explain construction and working of alternating current generator. Draw necessary diagram.
28. Derive necessary formula for equivalent resistance of a series combination of resistances giving proper circuit diagram
29. Derive necessary formula for equivalent resistance of a parallel combination of resistances along with proper circuit diagram.

Numerical questions

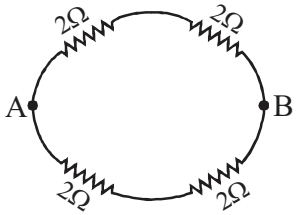
30. Find the highest and lowest resistance from combination of resistances of 1Ω, 2Ω and 3Ω [6Ω, $\frac{6}{11}$Ω]
31. What will be resistance of a conductor wire when the potential difference across its terminals is 2.5 volt when 10 milliampere current flows through it? [250Ω]
32. Find equivalent resistance between A& B in the following circuits

(a)



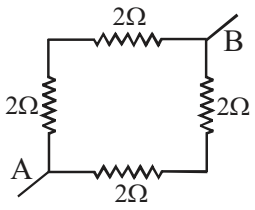
(Ans. $\frac{4}{3}$Ω)

(b)



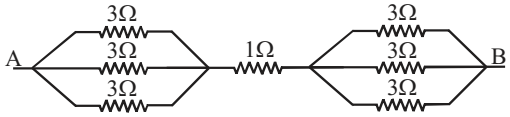
(Ans. 2Ω)

(c)



(Ans. 2Ω)

(d)



(Ans. 3Ω)

33. An electric rod of 1500 watt is used 3 hours daily to heat water. If the rate of consuming one electrical unit energy is Rs. 5.00 then how much be the value of consumed electrial energy in 30 days (Rs. 675)

Answer key

1. (b) 2. (c) 3. (b) 4. (d) 5. (b)
6. (c) 7. (b) 8. (d)

Chapter -11
Work, Energy and Power

In routine life, while performing many activities, we do work by using force e.g.displace an object from one place and put it at another place, push a vehicle, walking, running etc. We need energy to perform work. We and animals get energy from food that we eat while machines gets energy from fuel.Power is also an important concept associated with work. We consider a person (or engine etc) more powerful than the other if that person (or engine) could perform the work faster than the other. In this chapter we shall study work, energy and power.

11.1 Work

When by the application of force the position of an object at rest is changed or velocity of a moving object is changed then it is said that work is done.

Scientifically, work is defined as multiplication of force and displacement of the object in the direction of force.

Work =Force × Displacement in the direction of force

$W = F \times S$

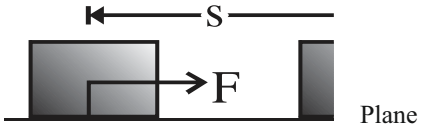


Fig 11.1 Work

If the direction of force is different than the direction of displacement of the object then the component of force along the direction of the displacement is used to calculate work.

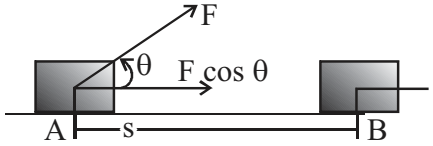


Fig. 11.2 Work when force and displacement are at an angle θ

Let force F is acting at point A in such a way that during the displacement of object till point B the direction of force is making an angle θ with respect to the direction of displacemet. The component of force along the direction of displacement

$= F.\cos\theta$

Thus the work done

W = (Component of force along the direction of displacement) × displacement

$= F\cos\theta \times s$

$= FS\cos\theta$

or $W = \bar{F}.\bar{S}$

Work is a scalar quantity and its value can be positive or negative. If force or component of force is along the direction of displacement then performed work is positive. On the contrary, if force or component of force is opposite to the direction of displacement then the work done is negative.

We shall try to understand this with the help of a few simple examples. For work to be done the force must produce displacement. Let us assume that you try to displace a drum filled with wheat or an almirah filled with books and you apply full force but you could not move them. This means that you did not perform any work even though you got tired because of the labour. Similarly, if you keep standing for some time with weight in your hand and in the process you get tired even then scientifically you did not do any work. When you displace a book kept on a table or you lift pen or you carry a trolley in a mall then you do work. During these activities the object is diplaced because of the force applied by you.

When applied force and resultant displacement are in the same direction then the work done is equal

to the mutliplication of force and displacement. Here the displacement 's' is that displacement during which force is acting on the object. The moment force is not in contact with the object there will be no work even if object keep moving. For example, if you pull trolley along the surface (or horizontal) then object is displaced along the direction of displacement. Thus work done is equal to the multiplication of the force applied to pull the trolley and the resultant displacement.

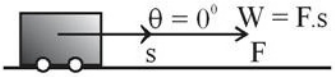


Fig 11.3 (a)

Now we think of a condition where an object with engine is moving with uniform speed.

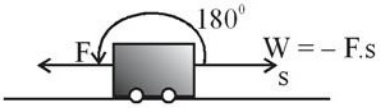


Fig 11.3 (b)

If we apply a force along the direction opposite to the direction of movement of trolley then the trolley shall stop after a certain distance. In this condition the applied force and displacement are opposite to each other making an angle 180°.

Thus work done $W = F.s\cos\theta$

$= -F.s.$ $(\because \cos\theta = \cos 180^\circ = -1)$

When driver applies break to reduce the speed of a moving car or to stop a moving car then force and displacement are opposite to each other.

If an object of mass m falls towards earth from height of 'h' then because of gravitational acceleration 'g' the force acting on the object will be

$F = mg$

and displacement will be $= h$

As the object is falling downwards and the force is also vertically downwards thus, $\theta = 0$

Hence work done by gravitational force $= mgh$

If the force acting an object is at an angle of 90° from its displacement then $\theta = 90^\circ$ and work done will be zero $(\because \cos\theta = 90^\circ)$. When an object is pulled from point A to point B on a plane surface then no work is done by the gravitational force mg $(\because \theta = 90^\circ)$. In this case we have to work against the friction to displace the object (Fig. 11.4 (a))

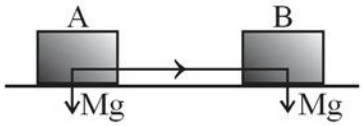


Fig 11.4(a) Work against the friction

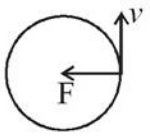


Fig 11.4 (b) Circular motion

Fig 11 Force perpendicular to displacement

Similarly in uniform circular motion the centripetal force on moving object acts perpendicularly and hence no work is done (Fig. 11.1(b)).

11.2. Unit of Work

If force is in Newton and displacement in meters then the unit of work is Joule.

Work = Newton × meter = Joule

Thus if an object is displaced 1 meter by applying a force of 1 Newton then the work done shall be 1 Joule.

$J = N \times m$

If force is in dyne and displacement in centimeters then the work done is in erg.

Work = dyne × cm = erg

1 Joule = 1 Newton × 1 meter

$= 10^5$ dyne $\times$ 10^2 cm

$= 10^7$ erg

Example 1 : During a tour you put a bag of 12 kg from ground to your back at 1.5 meter height. Calculate the work done assuming $g = 10\ m\ s^{-2}$)

Solution: Mass of bag m = 12 kg

displacement h = 1.5 m

work $W = F\,s = mgh = 12\ kg \times 10\ m\ s^{-2} \times 1.5\ m$

$= 180\ Nm$

$= 180\ J$

Work done on bag = 180 Joule

Example 2 . A person is pullig an object with a rope and exerting 5 N force such that the rope is making an angle 30° from the horizontal. Calculate the work done in displacing this object to 20 m ($\cos 30° = 0.866$ or $\cos 30^{o} = \frac{\sqrt{3}}{2}$)

Solution: Force F = 5 N

Displacement s = 20 m

Angle of displacement & force = 30°

Work $= Fs\cos\theta$

$= 5\ N \times 20\ m \times \cos 30°$

$= 100 \times 0.866\ J$

$= 86.6\ J$

Thus work done by the person = 86.6 Joule

11.3 Energy

You might have observed that running water carry away with it wooden logs and trees are uprooted in cyclonic wind. When you hammer a nail placed perpendicularly on wooden surface then the nail goes inside the wood. Wind turbine rotates because of wind.

These observations lead us to think that moving objects have the capacity to do work. When we lift an object to a particular height then the object gains capacity to work. When a child wind the key of a toy and put it on a plane surface then the toy starts moving. In that way different objects gain capacity to work by different means.

When work is done by capable object then the object looses its energy and the object on which work is done gains energy. Any object having energy can apply force on other objects and can transfer some or all of its energy to other objects. The other object gains the energy and develops capacity to work and can even move. In that way a part of the energy of the first object is transferred to the other object.

An object's capacity to work is called energy. Energy of an object is measured by the work that the object is capable to do. Energy is required to do any work. Thus the work done is a measure of energy and hence the unit of energy is same as the unit of work. Energy is also a scalar quntity. If 1 Joule of work is done then the energy required will be 1 joule.

Types of energy

Energy is available in different forms like mechanical energy, light energy, electric energy, thermal energy, nuclear energy, chemical energy etc. Sun is the largest source of natural energy for us. Energy can also be obtained from various natural incidences like tides, flow of rivers, wind etc. A few of the forces of energy are as follows.

Mechanical energy - Energy of an object because of its motion, position or both is called mechanical energy.

Heat energy - Heat energy is because of movement of tiny particles because of heat like in fire chimney. These tiny particles, mostly atoms, molecules or ions in gases, liquid or solids, transfer energy from high temperature to low temperature.

Chemical energy - Energy received through chemical reactions is known as chemical energy. Battery, food, coal, LPG etc have chemical energy.

Electrical energy - Energy produced by electrical charges is called electrical energy. We use electrical appliances at home that are operated with the help of electrical energy.

Gravitational energy - Objects get attracted towards earth because of its gravitational force. Energy produced in objects because of this is called gravitational energy. Generally it is the potential energy held by an object because of its high position compared to a lower position. Water flow from higher level to lower level in waterfalls and rivers because of gravitatioal

energy.

Nuclear Energy - Energy released during nuclear fission and nuclear fusion reactions are called nuclear energy.

All types of energies are mostly in two forms-kinetic energy and potential energy.

In this chapter we shall study mehcanical energy, kinetic energy, potential energy and electrical energy.

11.4 Mechanical energy

Mehanical energy of an object is equal to the sum of its kinetic energy and potential energy. For example when we hammer a nail on a wooden object then following actions take place.

1. Hammer has potential energy because of its weight.
2. When we lift the hammer we work on the hammer and thus the potential energy of hammer is increased.
3. When we pound the hammer on nail then because of movement it acquires kinetic energy and helps in driving the nail into the wooden object.

In this process of driving the nail into the wooden object the sum of kinetic energy and potential energy acquired by the hammer is known as mechanical energy. It helped in doing work.

Fig 11.5 (a) Pounding a nail by hammer

Fig 11.5 (b) Mechanical energy in a bow

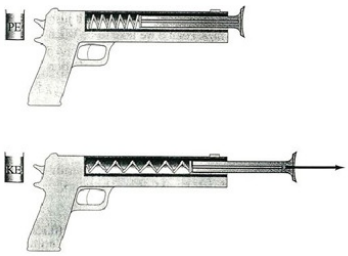


Fig 11.5 (c) Dart out of a toy pistol

Fig 11.5 Mechanical energy

Mechanical energy in a stretched bow is because of its elastic potential energy. Arrow, when released from bow, travels distance because of this energy. A moving car has mechanical energy because of its motion (kinetic energy). Similarly when a dart is pressed in a toy pistol then the spring inside the pistol is compressed and acquires potential energy. When trigger is pressed the spring is released from compression and the dart travels a long distance.

11.5 Kinetic energy

The energy associated with an object because of its motion is known as kinetic energy. A fruit falling from a tree, water flowing in a river, a flying plane, moving car, flying bird, wind etc are able to do work because of the kinetic energy associated with them.

Fig. 11.6 (a) Running Children

Fig 11.6 (b) Galloping horse

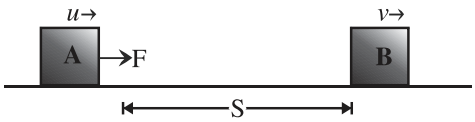


Fig 11.7 Kinetic energy

In order to measure the energy associated with a moving object we calculate the magnitude of the work done to bring that object to rest. Similarly the work done on a body to bring it from rest to a certain speed v is equal to the kinetic energy at speed v.

If an object of mass m is moving with a uniform velocity u and a force F is applied on it in the direction of motion in such a way that the object has displacement 's'. If the velocity of the object changes to v because of the work done and the acceleration is 'a' then from the third law of motion

$$v^2 + u^2 = 2as$$

or acceleration $a = \dfrac{v^2 - u^2}{2s}$

From the second law of Newton

$$F = m a$$

or $$F = m.\left(\frac{v^2 - u^2}{2s}\right)$$

so $$F.s. = \frac{1}{2}m\left(v^2 - u^2\right)$$

$$W = F.s.$$

So $$W = \frac{1}{2}m(v^2 - u^2)$$

So the work done by the object

$$W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

Thus we see that the work done is equal to the change in kinetic energy of the object.

If the inital velocity of the object is zero i.e. if the object starts from rest and attains velocity v then

(Initial kinetic ennergy is zero)

Hence the work done $W = \dfrac{1}{2}mv^2$

We can say that kinetic energy of an object of mass m moving with uniform velocity v is

$$E_k = \frac{1}{2}mv^2$$

Kinetic energy is always positive and depends upon the mass and the velocity of the object. It does not depend upon the direction of movement of object.

Example 3 An object moving with a uniform velocity and is having kinetic energy 2500 J. If the mass of the object is 50 kg then find the velocity of moving object.

Solution: Kinetic energy of the object $E_k = 2500$ (J)

Mass of the object $m = 50kg$

Velocity of the boject $v = ?$

The Kinetic energy $E_k = \dfrac{1}{2}mv^2$

or $$v^2 = \frac{2E_k}{m} = \frac{2 \times 2500\ \text{J}}{50\ Kg} = 100$$

$\therefore$ $v = \pm 10\ m/s$

As kinetic energy does not depend upon the direction of motion of the object and thus velocity of the object is $10\ m/s$

Example 4. A bullet fired from a gun is having a velocity of 500 m/s. If the mass of the bullet is 100 gm then what will be its kinetic energy?

Solution: Mass of the bullet m=100 gm=0.1 kg

Velocity $v = 500\ m/s$

Thus kinetic energy $E_k = \dfrac{1}{2}mv^2 = \dfrac{1}{2} \times 0.1kg \times (500\ m/s)^2$

$$= \frac{25000}{2} J$$

$$= 12500\ J$$

$= 12.5$ K J

The kinetic energy of the bullet will be 12.5 KJ.

Example 5. A motorcycle of mass 100 *kg* is running with a velocity of 20 km/h. How much work will have to be done to increase the velocity of the motor cycle to 40 km/h?

Solution: Mass of the motorcycle $m = 100\ kg$

Initial velocity $u = 20\ km/h = \dfrac{20 \times 1000}{60 \times 60} m/s$

$= 5.56\ m/s$

Final velocity $v = 40\ km/h = \dfrac{40 \times 1000}{60 \times 60} m/s$

$= 11.11\ m/s$

Work done=Final kinetic energy - initial kinetic energy

$$= \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$= \frac{1}{2}m(v^2 - u^2)$$

$$= \frac{1}{2} \times 100\ kg \times \left[(11.11\ m/s)^2 - (5.56\ m/s)^2\right]$$

$$= \frac{1}{2} \times 100 \times (123.43 - 30.91)\ \text{J}$$

$$= \frac{1}{2} \times 100 \times 92.52\ \text{J}$$

$$= 4626\ \text{J}$$

$$= 4.63\ k\ \text{J}$$

11.6 Potential energy

We all have experience that when any object is released from any height the object starts falling towards the earth. Similarly, when a spring is released after compressig it then the spring regains its initial state and if we release the spring after stretching it then again it regains its initial state.

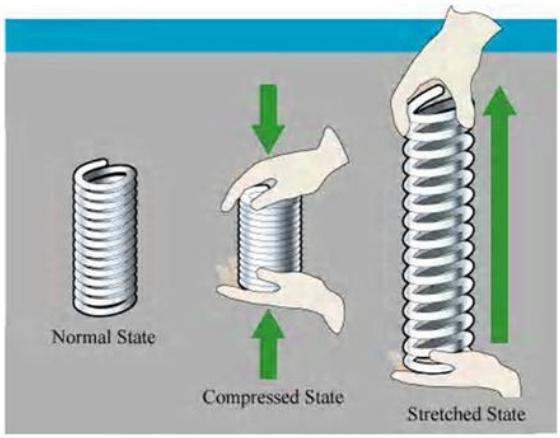


Fig 11.8 Potential Energy

In these examples we observe that some work is done by the object while falling towards earth or by the spring while regaining its initial state. This state is possible only if the object is capable of doing work when it is relesed from one state. When an arrow is released from a stretched bow, the arrow travels a long distannce before coming to rest. Obviously, the stretched bow has sufficient energy to do the work.

Potential energy is that energy of an object that is because of its position. Because of this energy the object attains capability to do the work. Work done to bring object from initial state to new state is a measure of potential energy of the object in new state.

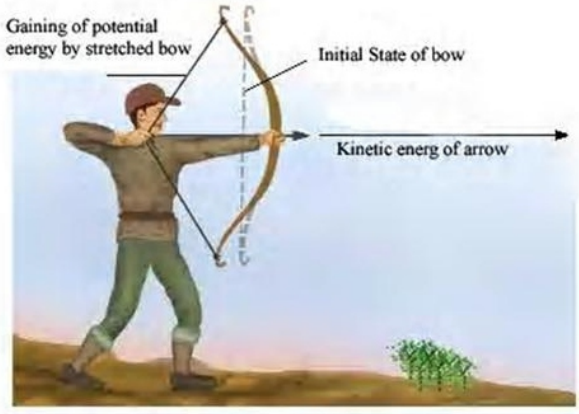


Fig. 11.9 Potetial Energy

We do work to stretch the bow and the corresponding energy will be the potential energy of the stretched bow. In the same manner we do work in stretching a rubber band, compressing or stretching a spring and lifting an object to height. The energy

transferred to the object because of this work is stored in the object as potential energy.

Potential energy in gravitational field

When we uplift any object from the surface of the earth then we have to do work against the gravitational acceleration. This work done on the body increases the energy of the object and part of the potential energy of that object.

Maximum force required to uplift the object from the surface of the earth is equal to the weight of the object. If an object of mass m is lifted to a height of h from the surface of the earth then minimum force required is equal to its weight mg.

Potentil energy of the object at height h = work done against the gravitational force

= Force × displacement

= $mg\ h$

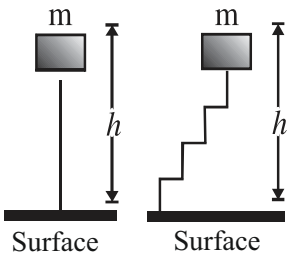


Fig. 11.10 Potential energy

Therefore potential energy of an object of mass m at a height h from the surface of the earth will be mgh. Potetial energy depends upon the height of the object from the earth and does not depend upon the path to reach to that height.

Potential energy of a simple pedulum

When the bob of a simple pedulum is displaced to one side of its equilibrium position then its centre of gravity is lifted up. The work done in the process is stored as potential energy of the pedulum. When bob is released from this position (B in fig 11.11) then it returns towards equilibrium (A in fig. 11.11). Its potential energy decreases during this movement from B to A. At A its potential energy is lowest and because of speed of bob it has highest kinetic energy at point A.

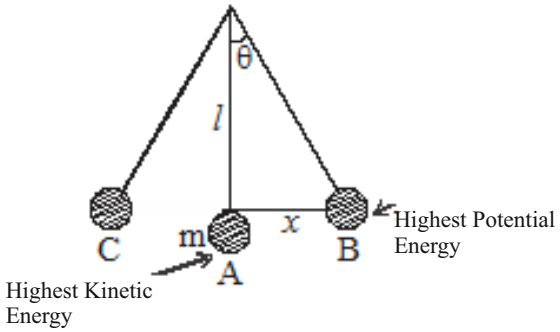


Fig. 11.11 Simple Pendulum

Because of this kinetic energy the pendulum moves towards other side of the equilibrium. During this movement its kinetic energy decreases and again its potential energy increases. At point C the speed of pendulum is zero. At this point the kinetic energy of the pendulum is zero and its potential energy is highest. The pendulum returns to its equilibrium position because of this acquired potential energy.

Let m is the mass of the bob and l is the legth of string to which it is suspended. The potential energy for displacement x of the bob.

$E_p = \frac{1}{2}\frac{mg}{l}.x^2$ (See example 13)

If $k = \frac{mg}{l}$ ($\because$ m, g and l are constant)

then potential energy $E_p = \frac{1}{2}kx^2$

Similarly, when a spring, whose spring constant is k, is displaced by distance x from the equilibrium within the elastic limits, then the potential energy of the spring will be $\frac{1}{2}kx^2$

$E_p = \frac{1}{2}kx^2$

Example 6. A student lifts an object of mass 3 kg from the surface of the earth and put it on a table at height of 50 cm. Calculate the potential energy of the object. (Gravitational acceleration $g = 10\ m/s^2$)

Solution: Mass $m = 3\ kg$

Height $h = 50\ cm = 0.50\ m$

Thus potential energy $E_p = mgh = 3 \times 10 \times 0.5 = 15\,J$

Example 7. Spring constant of a spring is $k = 6 \times 10^3\,N/m$. Calculate the work done to stretch it by 1 cm.

Solution: Spring constant $k = 6 \times 10^3\,N/m$

$$x = 1\,cm = 0.01\,m$$

Work done in stretching the spring = acquired potential energy

$$= \frac{1}{2} kx^2$$

$$= \frac{1}{2} \times 6 \times 10^3 \frac{N}{m} \times (0.01m)^2$$

$$= 3 \times 10^3 \times 0.01 \times 0.01\,J$$

$$= 0.3\,J$$

Therefore 0.3 J work will have to be done to stretch the sprign by 1 cm.

11.7 Electrical energy

Energy contained in the charged particles is called electrical energy. When particles are charged then electric field is developed around the charged particles. This electric field exerts force on other nearby charged particles and causes motion in them and energy is transmitted.

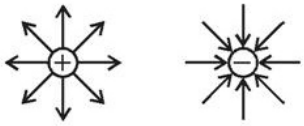


Fig 11.12 (a) Positive and negative electric field

Electric field produced by positively charged particles repel s other positive charges while electric field produced by negatively charged particles attracts other positive charges. According to conventionn the direction of electric field always points towards that direction where a positively charged particle will move in the field. Therefore, electric field because of positively charged particles is shown by outward arrows around a positive point while the electric field because of negatively charged particles is shown as inwards arrows around a negative point.

Because of the position of the charged particles they have potential energy. When force is applied on these particles by electric field then the particles move in certain direction.For example, if a positively charged particle is to be taken away from a negative source then we shall have to apply external force. In this process the potetial energy of positive particle will increase. As soon as external force is removed the particle will move in the electric field from higher potential to lower potential. Similarly, the positively charged particle will naturally move towards negatively charged source. In this process the potential energy of charged particle will covert into kinetic energy. We shall get this energy as electrical energy.

In routine life we use electrical energy at home in the form of electric current and electric potential (voltage). Equipments like bulb, fan, electric iron, hair dryer, geyser, mobile etc require electrical energy to operate. Once electrical energy is converted to other form then we get light, heat, kinetic and other energies. Electricity is produced by different processes. In 1831, Michael Faraday invented electric generator. Even now electricity is mainly, produced in a generator by a wire or copper disk between magnetic poles.

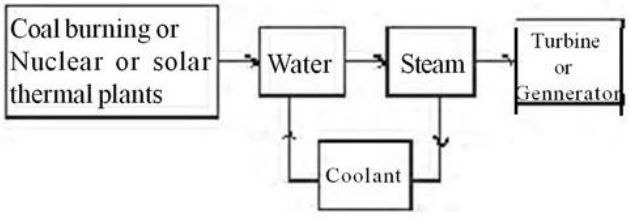


Fig 11. 12(b) Block diagram of power plant

Now-a-days different types of electricity generation plants (Power plants) are used for production of electrical energy. A few of them are as follows.

1. **Coal Power Plant** - In power plants running on coal, the chemical energy of coal is released by

buring it and we get thermal energy. This heat is used to convert highly pure water into steam. The steam then turns the turbine and the generator, attached with the turbine, starts producing electricity.

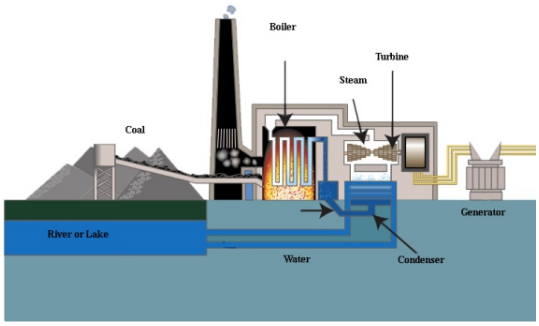


Fig 11.13 (a) Coal power Plant

2. **Nuclear Power Plant -** In these power plants the nuclear fission is used as fuel and thermal energy is produced. This thermal energy converts water into steam and the steam then propel turbines. Electricity is produced by the generator combined with turbines. The procedure for converting thermal energy to electrical energy remains similar as the coal power plant.

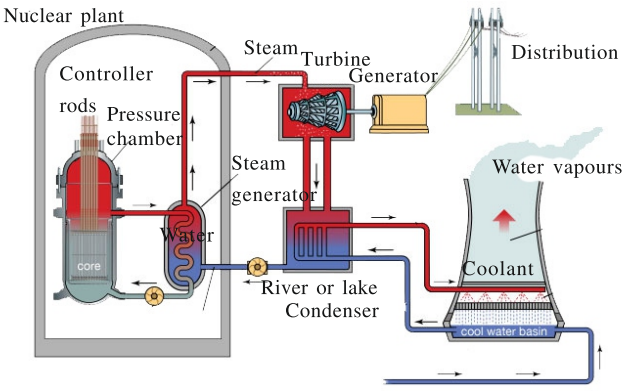


Fig 11.13(b) Nuclear Plant

3. **Hydro electric power plant -** In hydroelectric plants potential energy of water is increased by increasing the height of water level mostly by forming dams. This energy is converted to kinetic energy by flow of water and is fed to turbine. The turbine rotates and associated generator produces electrical energy.

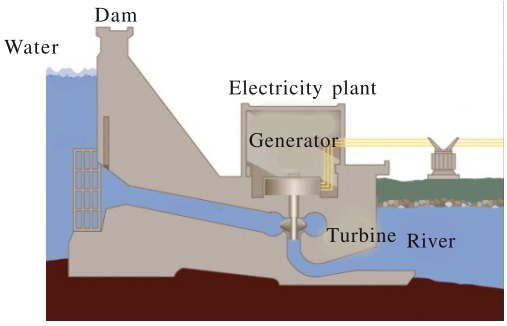


Fig 11.13 (c) Hydro power plant

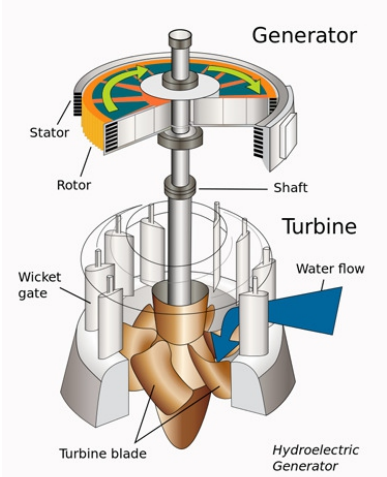


Fig 11.13(d) Turbine & generator

4. **Wind power plant -** In a wind mill the turbine is rotated by the kinetic energy of wind and generator associated with turbine produces electricity. This renewable energy source is most environment friendly as compared to other power plants.

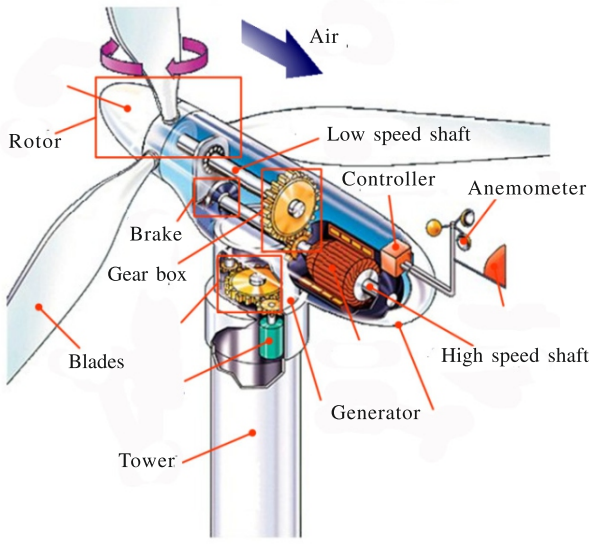


Fig 11.13 (e) Wind power plant

5. Solar thermal plant - Energy from Sun is concentrated with the help of lens and mirrors and them it is converted into heat. The heat is used to get steam. This steam rotates turbine and associated generator produces electricity.

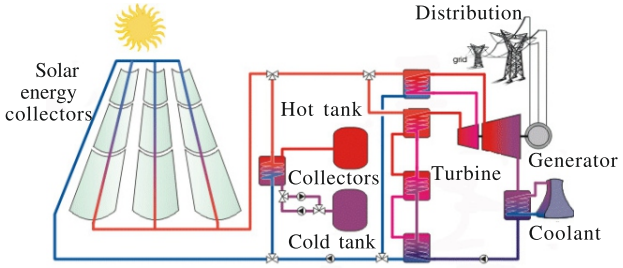


Fig. 11.3(f) Solar thermal generator

6. Solar photovoltaic electricity plant - In these plants solar penels, made of solar photo voltaic cells are used at open spaces and roof tops. When Sun light is incident on the photovoltaic cells of solar panel then these cells absorb the light photons and electrons jump to the excited states. These charged particles provide electric current in the circuit. Presently such small solar plants are being installed on roofops of many houses. Government is also providing two way meter for such houses so that excess electricity generated by the home solar plant can be trasferred to electricity board. The electricity board gives money for this electricity at the prescribed rate.

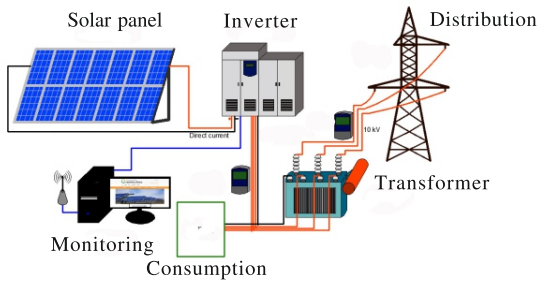


Fig 11.13 (g) Solar Photo Voltaic plant

Generally, we see and use petrol and diesel based generators in many offices and commercial establishments. At home we use inverters that has batteries in

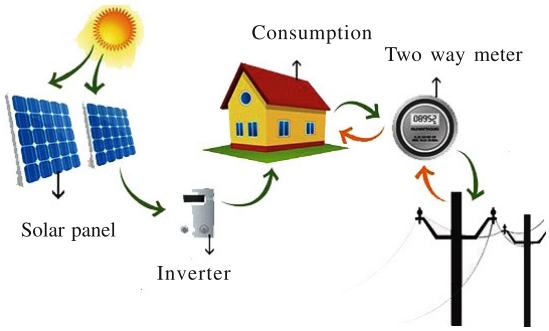


Fig 11.13 (h) Home Solar energy plant

Fig 11 Various electricity plants

it. In batteries chemical energy is transformed into electrical energy. Once discharged, the inverter batteries can be recharged.

A few examples of electrical energy

a. In a car the battery provides electrons as a result of chemical reaction and these electrons move as electric current. These moving charge provides electrical energy to the electrical circuitory of the car.

b. When we switchon a light bulb the electric current reaches to the bulb through electric circuit. In the filament of the bulb the speed of electric charge is slow and temperature of filament increases. When the temperature of the filament reaches a particular value the light energy is emitted.

c. In mobile the chemicl energy of battery is given to electrical charges. The charges move. This electrical energy goes through the circuit of the mobile and electricity flows in the mobile.

d. When electric heater or oven is connected to electric circuit then the moving charge enters the equipment. In filament, this electrical energy is converted to heat and this heat is used for cooking food or other useful work.

e. In our body a part of the energy received from digested food is coverted into electrical energy. This electrical energy reaches to our brain through nervous system. In addition electrical signals are required for heart beats. A signal sent by our brain to any part of

the body is in the form of electrical pulses.

11.8 Conservation of energy

According to the theory of conservation of energy the total energy of an isolated system remains constant. Energy can neither be produced nor be destroyed. The energy can only be trasformed from one type to another type.

To understand the concept of energy transformation in a better way we shall analyse the energy transformation process in the compression and stretching of spring. Attach one end of the spring to a wall and fix a rectangular block of mass m to the other end of the spring and place a frictionless horizontal surface below the system.

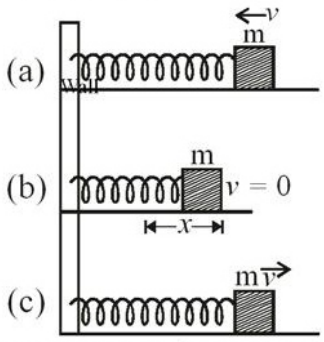


Fig 11.14 Energy transformation in a spring

To compress the spring we push the block towards the wall with velocity v (fig. 11.14 (a)). The kinetic energy of the block is $\frac{1}{2}mv^2$ and because of this energy the block compresses the spring to distance of x from its initial position. If k is spring constant then this compression will generate $\frac{1}{2}kx^2$ potential energy in the spring. Because of this potential energy the spring tries to return to its equilibrium position (initial state) and push the block with velocity v in the opposite direction. Again the kinetic energy of block becomes $\frac{1}{2}mv^2$. The block moves ahead of the equilibrium state (initial state) and stretches the spring because of this knietic energy. This time also kinetic energy and potential energy is transformed as happened during the compression of string. When the block returns to its equilibrium (initial) state after a full cycle then its kinetic energy is same as its initial energy.

When the kinetic energy remains the same as its initial energy after a cycle then such acting forces are called conservative forces. Work done by such conservative forces does not depend on the path and only depends on its initial and final state.

In this complete process the sum of kinetic energy and potential energy remains constant. It is known as mechanical energy. According to the law of conservation of mechanical energy the total mechanical energy of the system remains conserved. If the kinetic energy of the system increases then its potential energy will decreas and vice versa.

If the change in the potential energy and kinetic energy is ΔE_p and ΔE_k respectively then

$$\Delta E_p = -\Delta E_k$$

or $$\Delta E_p + \Delta E_k = 0$$

Total mechanical energy $E_m = E_p + E_k$

In reality the mechanical energy of the system decreases in one cycle. This decrease is because of the non-conservative forces like frictiong viscosity etc. Non conservative forces transform a part of the energy into sound, heat or other dissipative energy form. Thus the form of the energy of the system changes but the total energy of the system remains conserved.

$$E = E_M + E_{heat} + E_{friction} + Other = Constant$$

11.9 Dissipation of energy

When one type of energy is transformed to another type then a part of the energy is dissipated as heat, sound, light etc. From dissipation of energy we

mean that during the process of transformation or transmission, a part of the energy is converted in such form that is either not required or not usable by us. Though total energy is conserved but because of this unproductive dissipation we are not able to make one hundred percent efficient system. Energy dissipation occurs mainly through following ways.

(a) Heat Energy -Whenever any work is done then because of friction, resistance by air and other resistances the capability of doing work is reduced. Generally the body, on which work is being done, is heated. Alarge and significant part of dissipated energy becomes unusable as heat energy. In an incandescent bulb most of the energy is lost as heat energy.

(b) Light energy - In most of the combustion and burning processes a part of energy becomes unusable and is lost as light energy.

(c) Sound energy - During collision, friction and other processes a part of energy is dissipated as sound energy. Because of friction the vibration of molecules convert into pressure wave that creates sound.

To understand energy dissipation the best example is electricity that we use at home. Initially electricity is produced where energy is dissipated in different processes. In nuclear power plants, coal power plants, hydro electricity plants, wind wills and other mediums of electricity production heat energy or mechanical energy is produced by different processes. A part of energy is lost during these processes. Steam is produced from the heat energy to rotate the turbine. Mechanical energy of turbine, as kinetic energy, is used to operate the generator. In this process also a part of energy is lost. Turbine helps in electricity production in the generator. Efficiency of a coal plant is around 40%. Electric energy produced by the generator is converted into kinetic energy of electric charges. With the help of conductors this electrical energy is trasmitted to our houses. During the process a part of electrical energy is lost during transmission, distribution and storage. When we switch on a light bulb at home then electric current carry the electric energy to the bulb. The electrical charges give their kinetic energy to the filament of the bulb and heat is produced in the filament. At above certain critical heat of the filament we get light energy. In this process a large part of energy is lost as heat energy. Out of the total chemical energy available in coal a very small fraction is converted as light energy.

In the same manner when diesel or petrol is used in internal combustion engine of vechicles then the chemical energy of diesel or petrol is converted into heat energy. This heat energy creates pressure on the piston and piston starts rotating. This mechanical energy provides kinetic energy to the wheels of vechicles. In this process a part of energy is dissipated as the sound of the engine, as light produced during combustion of fuel, as friction between wheels and road and many such unproductive works. Around one fourth of the efficiency of the fuel is available as usuable energy for engine in vechicles at present.

11.10 Reducing energy dissipation

Energy is very important for our lives and using it properly is the responsibility of all of us. For a developing country like India it is even more important that we fulfil our energy needs with maximum possible efficiency and reduce the energy dissipation.

The more we reduce the energy dissipation as heat, sound, light, friction etc during the process of work, the more energy will be available for productive work. If there are more than one option to complete a task then we shall choose that option that is more energy efficient.

Some energy is dissipated in common household equipmenet like TV, microwave, washing machine etc when they are put on stand by mode when not is use. To save this energy loss we should switch off these equipments when not in use.

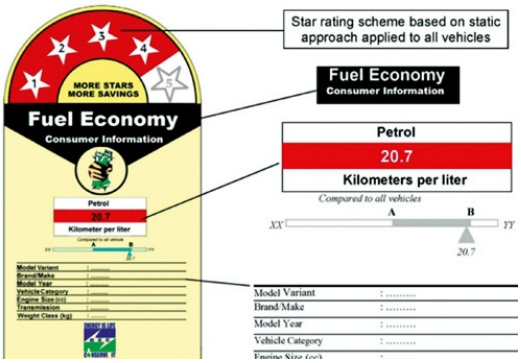


Fig. 11.15 Star rating

Presently many fuel and electric appliances like vehicle, fan, refrigerator, washing machine, air conditioners etc, are coming with star rating. More star rating means more energy efficiency. Energy efficient appliannces use around 30% less electricity. In addition we must purchase the appliance with appropriate capacity. Unncessarily purchasing a high capacity or high power equipment will cost more and will consume more energy.

In order to lower the consumption of electricity at homes we should use CFL and LED lights. A common incandescent bulb has an avergae life of around 1200 hours while average life of CFL is 8000 hours and usable life of an LED is around 50000 hours. A 60 W bulb, a 15W CFL and a 8 W LED gives almost equal light energy but CFL and LED consume very less electricity in comparison to a common incandescent bulb. Using LED will lead to low consumption of electricity and that, in turn, will reduce the emission of carbon dioxide, Sulfur dioxide and other harmful emitters during the electricity production.

In summers and winters a large amount of energy is lost in heat exchange during air conditioning and heating. To reduce this loss due to heat exchange the walls and roofs of houses should have insulators in them. This will also reduce the cost of air conditioning. Now-a- days new technology hollow bricks are being made that reduces the total weight of the building and acts as insulator medium between outer environment and inside atmosphere of building. This reduces the overall cost of air-conditing.

We must also preserve natural energy sources and should use them with maximum possible efficiency. We can use water for different purposes by collecting water during rainy season. Rest of the unused water should be used to recharge the ground water levels so that we can get water with minimum energy throughout the year.

More efficient systems should be used to produce electricity so that emission of harmful and unusable greenhouse gases could be lowered. More and more renewable energy should be for electricity production.

In this way wherever possible we must help in reducing dissipation of energy and increasing efficiency so that we could keep our environment better and could provide quality life to all.

11.11 Power

Till now we have read that the work does not depend upon the way it has been done. Work done in going from point A to point B shall remain same irrespective of the path. Whe one person cover this distance by running in certain time and other person covers the same path in lesser time by runinng faster then we say that the other person is more powerful. Scientifically rate of doing work or work per unit time is called power. Power is a scalar quantity like work. If time t is required to finish a work W then

$$\text{Power } p = \frac{W}{t} = \frac{Work}{Time} = \frac{Joule}{Second}$$

Work = Force × displacement

$$\text{So Power } \quad p = \frac{W}{t} = \frac{F \times s}{t}$$

$$\text{But } \quad v = \frac{s}{t}$$

$$\text{Therefore } \quad P = F\,v$$

$$= m\,a\,v$$

Fig 11.16 Examples of Power

Unit of power

In the honour of the inventor of steam engine 'James Watt' the unit of power is given by watt.

$$Watt = \frac{Joule}{second}$$

$$1W = 1\ J/s$$

Sometimes horse power is also taken as unit of power. It is equal to 746 Watt

11.12 Electric power

Just like mechanical power, electrical power is also measured as the rate of doing work. Its unit is watt but most of the time 'Wattage' is also used for electric power in many popular common languages. If a charge Q coulomb passes through a V volt electric potential in time t then

$$\text{Power P} = \frac{\text{Work}}{\text{Time}} = \frac{\text{VQ}}{\text{t}}$$

But Current $I = \frac{Q}{t}\ Ampere$

$\therefore$ Power = V.I Watt

Rate of transportation of electrical energy in eletric circuit is called electrical power. Electric power is mostly produced in electricity generator in different types of power plants. Some times, battery is also used to get electric power.

Commercially, the electric power providing companies charge the electric energy consumption as kilowatt hour. One kilowatt hour is called one 'unit' that can be read in electric meter.

1 unit = 1 Kilowatt hour = 1000 Wh

1 kWh = 1000 W × 60 × 60 s

$$= 3600000\ Ws = 3.6\times10^6\ \frac{J}{s}.s$$

$$= 3.6\times10^6\ J$$

If 1kilowatt (1000 W) bulb is used for one hour then one unit of electricity will be used or if 100 w bulb is used for 10 hours than one unit of electricity will be used.

Example 8 A person of mass 60 kg reaches a height of 5m in 30 seconds. Find the power used by the person $(g = 10\ m/s^2)$

Solution:- Mass of the person $h = 5\ m$

Distance travelled

Time taken t = 30 s

Power $p = \frac{W}{t} = \frac{F\times s}{t}$

$$= \frac{60\times10\times5}{30}$$

$$= 100\ W$$

Person used 100 W of power

Example 9 Suresh and Ramesh climb a 15 m high hill. Ramesh does the work in 19 seconds while suresh complete this work in 15 seconds. If both of them has mass 38 kg each then find the power used by both of them $(g = 10\ m/s^2)$

Solutio: (i) Power consumed by Suresh

Weight of Suresh = mg= 38 kg × 10 m/s^2

$$= 380\ N$$

height $h = 15\ m$

time $t = 15\ s$

Power $P = \frac{W}{t} = \frac{mgh}{t} = \frac{[380 \times 15]}{15} W$

$= 380\, W$

(ii) Power consumed by Ramesh

Mass of Ramesh $= mg = 38kg \times 10\, m/s^2$

$= 380\, N$

height $h = 15\, m$

time $t = 19\, s$

Power $P = \frac{W}{t} = \frac{380 \times 15}{19} W$

$= 300\, W$

Exampel 10 A lift reaches 300 meter height in 5 minutes. If the combined mass of the lift and the material inside the lift is 1000 kg then find the work done by the lift and power of the lift $(g = 10\, m/s^2)$

Solution: Mass of the lift $m = 1000\, kg$

height $h = 300\, m$

Time $t = 5m = 5 \times 60 = 300\, s$

Work done $= W = mgh = 1000kg \times 10\, m/s^2 \times 300\, m$

$= 3.0 \times 10^6 J$

and Power $P = \frac{W}{t} = \frac{3.0 \times 10^6 J}{300\, s} = 10 \times 10^3 W$

$= 10\, kW$

Example 11 A horse pulls a cart by 7.2 km/hour speed while applying 30 N force at an angle of 60° from the horizontal for one minute. Calculate the work done by the horse and the power used by the horse $\left(\cos 60^o = \frac{1}{2}\right)$

Solution: Force F = 30 N

Speed $v = 7.2\text{km/h} = \frac{7200\,\text{m}}{60 \times 60\,\text{s}}$

time t = 1 m = 60 s

Angle between force and displacemennt = 60°

Distance travelled in 1 minutes =

$= \text{v} \times \text{t} = \frac{7200\ \text{m}}{60 \times 60\ \text{s}} \times 60\ \text{s} = 120\text{m}$

Work done by the horse= $W = F.s \cos\theta$

$= 30 \times 120 \times \cos 60$

$= 30 \times 120 \times \frac{1}{2}$

$= 1800\ \text{J}$

Thus power $\text{P} = \frac{1800\ \text{J}}{60\text{s}} = 30\ \text{W}$

Example 12 If average power of a refrigerator is 100 W then find the energy used by a refrigerator in a day in electrical unit.

Solution: Power $\text{P} = 100\ \text{W} = 0.1\,\text{kW}$

Time t = 24 h

Energy $= \text{p} \times \text{t} = 0.1\,\text{kW} \times 24\ \text{h}$

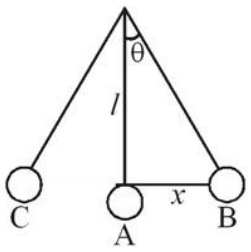
$= 2.4$ kwh

$= 2.4$ unit

Thus the refrigerator will consume 2.4 units of electricity in a day

Example 13 Calculate the potential energy of a simple pendulum of mass m when it is displaced slightly by x from the mean position.

Solutio: At any moment if the pendulum is at a displacement x from meann position then restoration force will be $F = mg \sin\theta$



If the bob is at a distance *l* from the point of suspen-

sion and displacement x is negligible in comparison to l then

$$\sin\theta \quad \theta = \frac{x}{l}$$

or $$F = mg.\frac{x}{l}$$

If $\frac{mg}{l} = k$ (as m, g o l are constant)

then $$F = kx$$

If the bob further slightly displaced by dx then the work done will be

$$dW = F\ dx = kxdx$$

Therefore the work done in displacing the pendulum from its mean position will be given by

$$W = \Sigma kxdx = \int_0^x kxdx$$

or $$W = \Sigma kxdx = \int_0^x kxdx$$

or $$W = \frac{1}{2}kx^2$$

where $$k = \frac{mg}{l}$$

$$\therefore \quad W = \frac{1}{2}\frac{mg}{l}x^2$$

The work done W will be equal to the change in the potential energy

or $$W = \Delta E_p = E_p - E_{p_0}$$

Where E_{p_0} is the potetial energy at mean position. For calculation we have assumed it zero.

$$\therefore \quad W = E_p = \frac{1}{2}\frac{mg}{l}x^2$$

or $$E_p = \frac{1}{2}kx^2$$

Important Point

1. Work is defined as displacement of an object by applying force.
   Work = Force × displacement in the direction of force.
2. When force F is applied and displacement is S and the angle between the direction of force and displacement is θ then the work will be given as $W=FS\cos\theta$
3. Work is a scalar quantity and its unit is Joule.
4. Capacity to perform work is called energy.
5. Mechanical energy has two forms (a) kinetic energy (b) potential energy.
6. If an object of mass m is moving with velocity v then the kinetic energy is given as $\frac{1}{2}mv^2$.
7. Energy of an object because of its position or state is called potential energy.
8. Potential energy of an object of mass m at height h will be mgh. Where g is gravitational acceleration.
9. The work done by the conservative forces does not depend upon the path.
10. Mechanical energy of a system is conserved in the presence of conservative forces i.e.the sum of the kinetic energy and potential energy of the system remains constant.
11. According to the law of conservation of energy the total energy of an isolated system is always constant. Energy can neither be produced nor be destroyed. Energy can only be transformed from one form to another form.
12. When energy transformation takes place a part of energy is dissipated as heat, sound, light etc.
13. Energy associated with charged particles is called electrical energy.
14. Rate of of performing the work is called power.

The unit of the power is watt.

15. Commercial unit of measuring consumption of electric power is unit. 1 kilowatt hour is equal to one electrical unit.

16. One horse power is equal to 746 watt.

Practice questios

Ojbective type questions

1. Unit of work is

(a) Newton (b) Joule

(c) Watt (d) None of these

2. If the angle between the force F and displacement S is θ then the work done will be given by

(a) $FS\sin\theta$ (b) $FS\,\theta$

(c) $FS\cos\theta$ (d) $FS\tan\theta$

3. If an object of mass m is moving with v velocity then its kinetic energy will be given as

(a) mv (b) mgv

(c) mv^2 (d) $\frac{1}{2}mv^2$

4. What will be the potential energy of an object of mass m at a height of h?

(a) mgh (b) $\frac{mg}{h}$

(c) $\frac{mh}{g}$ (d) $\frac{1}{2}mgh^2$

5. Unit of power is

(a) Newton (b) Watt

(c) Joule (d) Newton meter

6. Calculate the work done in taking object of 1 kg mass at 4 m height? ($g = 10\ m/s^2$)

(a) 1 Joule (b) 4 Joule

(c) 20 Joule (d) 40 Joule

7. Total energy of an object falling freely towards earth will

(a) keep on increasing

(b) keep on decreasing

(c) remains constant (b) be zero

8. If the velocity of an object is doubled then what will be its kinetic energy?

(a) one fourth (b) half

(c) double (d) four-time

9. What is the commerical unit of electrical energy

(a) Joule (b) Watt-second

(c) Kilowatt hour (d) kilowatt per hour

10. If a spring is compressed under elastic limit to x distance then what will be the acquired potential energy (spring constant = k)

(a) kx (b) $\frac{1}{2}kx^2$

(c) kx^2 (d) None of these

Very short type questions

1. Define work and write its unit.
2. What is energy? Write the unit of energy.
3. What do you understand by kinetic energy?
4. What is potential energy?
5. Write the law of conservation of energy.
6. What are the common forms in which dissipation of energy takes place?
7. Can you make a hundred precent efficient system?
8. What do you mean by electrical energy?
9. Write name of any three types of electricity plants.
10. What is power? Write unit of the power.
11. Which light will be useful in reducing consumption of electric energy at home?
12. Which important point we should remember while purchasing new electrical home appliances.
13. An object displaces 10 m when 20 N force is applied on it. Calculate the work done. (200 Joule)
14. It takes one minute to uplift a 30 kg object to

the height of 2m. Calculate the power used (10 W)

15. A 60 W bulb is used 8 hour per day for 30 dys then what will be the energy consumption in electic uint? (14.4 units)

Short type questions

1. What do you mean by work? If the direction of displacement is differennt from the direction of the force then how the work is calculated? Explain with example.
2. When force F is applied on an object moving with velocity u then its velocity increases to v. If the distance travelled by the object during this change of velocity is S then calculate the increase in the kinetic energy.
3. What is potential energy? An ideal spring having spring constant k is compressed by x distance derive the formula of acquired potential energy of the spring.
4. An object is moving with a uniform velocity v. If the mass of the object is m then find how much work will have to be done to bring this object to rest?
5. What do you mean by conservation of mechanical energy.
6. An object falls freely from a height and its potential energy is continuously decreasing. Explain how mechanical energy is conserved in this process?
7. How energy dissipaution takes place?
8. From the production of electrical energy to its cosumption at home how does energy dissipation takes place?
9. How work, energy and power are related to each other?
10. What do you mean by electrical energy? How does electrical energy is obtained from a coal power plant?
11. How electrical energy is produced from hydro electric plants?
12. How can we reduce the dissipation of electrical energy?
13. What improvements can be done to make air conditioning more efficient in homes.
14. What is electric power? How the consumption of electric power is calculated? Explain by giving an example.
15. When we switch on a bulb to get light then what energy trasformations take place?

Essay type questions

1. What is energy? Prove that the work performed by an object is equal to the difference between kinetic enegy of the objects in two different states.
2. What is electrical energy? How electrical energy is produced in following of the plants? Explain.
   (a) Hydroelectric plant
   (b) Wind electric plant
   (c) Solar energy plant
3. Total energy of an ideal simple pendulum is conserved. Prove this statement by calculating its energy in differet states of its oscillations.
4. Explain various energy dissipations during transformation of energy. What can be done to reduce the dissipation of energy.
5. Prove that the mechanical energy of a freely falling object remains constant at all points of its path under gravitational field.

Numerical Questions

1. An electron is moving with a velocity of 1.2×10^{6} m/s. If the mass of the electron is 9.1×10^{-31} kg then find its kinetic energy. (6.55×10^{-19} J).
3. A machine takes an object of 40 kg mass to a height of 10 m. Calculate the work done ($g = 9.8$ m/s^2) (3.92 kJ)
3. An object of mass 6 kg falls from a height of

5 m. Calculate the change in potential energy. ($g = 10\ m/s^2$) (300 J)

4. Spring constant of a spring is 4×10^3 N/m. How much work will have to be done to compress it by 0.04 m? (3.2 J)

5. 0.4 J work is required to be done on a spring to stretch it by 0.02 m. Calculate the spring constant (2×10^3 N/m)

6. Calculate the power used by an engine taking 200 kg mass at 50 m height in 10 seconds. ($g = 10\ m/s^2$) (10 kW)

7. In a house 5 electrical appliaces are used for 10 hours per day. Out of these two appliace are of 200 W and three appliances are of 400 W. Calculate the energy consumed in one day in terms of electrical units. (16 units)

8. An object of 40 kg mass is moving with 2 m/s velocity. Now force is applied on the object such that its velocity increases to 5 m/s. Calculate the work done by the force (420 J).

9. If an object of 50 kg is lifted to 3 m height then calculate its potential energy. Now let it freely fall and find its kinetic energy when it is just at middle of its path ($g = 10\ m/s^2$) (1.5 kJ, 750 kJ)

10. A block of 8 kg is moving with 4 m/s on a frictionless surface. This block compresses a spring and comes to rest. If spring constant is 2×10^4 N/m then find the compression in the spring. (0.08 m)

Answer key

1. (b) 2. (c) 3. (d) 4. (a) 5. (b)
6. (d) 7. (c) 8. (d) 9. (c) 10. (b)

Chapter -12
Main Natural Resources

Every organism is surrounded by a variety of living organism and non living environment (Air, light, soil, water, temperature etc). These biotic and abiotic factors form the specific environment of the organism. Man has tried to maintain harmony with nature since his emergence. His existence is depended on nature's resources. Therefore, man has been respecting nature since time immemorial. Unfortunately in the last few years there is seen an increased tendency of imprudent use of nature, because of that we are facing many bad effects in the form of natural calamities such as flood, drought, landslides, epidemic, earthquakes, tsunami etc. In the ancient Indian culture know that in the vedic period our ancestors gave excessive importance to nature. They believed in the concept of Panch tatva (Sun, sky, earth, water, fire) and by worshiping these tatvas like God, they explained the significance of nature to mankind.

12.1 Meaning of natural resources

Every object that is used directly or indirectly by human is called a resource. The resources that we are receiving from nature and which we use directly without making any change in it are called natural resources.

12.2 Types of natural resources

Natural resources can be divided into three parts.

1. On the basis of development and use
2. On the basis of origin
3. On the basis of storage or distribution

On the basis of development, natural resources can be further divided into two levels -

1. **Actual resources-** Those resources or objects whose structure or quantity is known to us and which we are using in the present time are called actual resources, eg. quantity of coal in Germany, quantity of mineral oil in West Asia, quantity of black soil in Maharashtra.

2 **Possible resources-** The objects whose exact quantity or numbers cannot be guessed and which we are not currently using but can use in future, are called possible resources. The example of possible resources is wind mill which was a possible resource 20 years ago, but in modern time our country has made technical progress due to which today we are able to use mills. Uranium found in Laddak is also a possible resource which we can use in the near future.

On the basis of origin, natural resources can be divided into two levels -

1. **Biotic resources -** Living things are called as biotic resources eg. plants, animals, human etc.

2 **Abiotic resources -** Non-living objects are called as abiotic resources for eg. - air, soil, light etc.

On the basis of distribution, resources can be divided into two levels -

1. **Universal -** Those objects which are found everywhere and which are easily available are called universal resources eg.- air

2 **Local resources -** Those objects which are found at a few places only are called local resources eg- copper, iron ore etc.

Natural resources more clearly, we can further divide it into two parts-

1. Renewable resources- The things that can be manufactured and used again, meaning that the objects which can be replenished easily, these objects are called renewable resources for eg- solar energy, wind energy.

2. **Non-renewable resources-** The things whose stocks are limited and there is no hope for its creation or it takes too long to build again are called non-renewable resources eg-coal, petroleum, natural gas.

We should not use any resource in a careless manner because its continuous and excessive use will make it exhaust soon and the future generation will not be able to use it.

12.3 Management of natural resources

Man exploits natural resources for his livelihood. The primitive human being was dependent on plants and animals for his requirements. At that time the density of population was less, the requirements of humans were limited and the level of technology was low. There was no problem of conservation at that time. With time man has developed the technology of tapping the resources. In addition to the exploitation of the livelihood resources, man by scientific and technological developments also began to exploit the resources of production. Due to the continuous growth of population, the demand for resources had increased. With the development of technology man increased his capacity to use these resources. Therefore this competition has created a doubt that there will be question mark on the life of humans if the resources exhaust soon.

12.3.1 Judicious use and conservation

Natural resources can be conserved and used for long period of time if they are used judiciously and prudently. Planned, prudent and adequate use of resources is their conservation. Conservation does not mean

1. Not to use natural resources and only protect them.
2. They should be used miserly.
3. Inspite of their need they should be kept for future use.

But by conservation we mean that resources should be used sensibly to meet the requirements of more people for a longer period of time.

12.3.2 Need for conservation of Resources

Human being has been using various natural resources to fulfill his needs. He plough the land for the supply of food and for other substances, he has exploited and used forest products and minerals for the development of irrigation and power. In the last two centuries there has been a rapid growth in population and industrial production. Two hundred years ago the global population was 1.75 billion, now it has reached 5.25 billion. Our consumption for food, cloth, shelter, means of transportation, various types of equipments, industrial raw material has increased several times. Because of this we are rapidly exploiting natural resources in a destructive manner. This has resulted in worsening of the natural balance. If this equilibrium is lost then the existance of human beings will also be in danger. Thus for the existance and for the progress of human being conservation and management of natural resources is necessary.

12.3.3 Ways of conservation of resources

Natural resource is our capital. It should be used for beneficial works in a planned manner. For this firstly we must be aware of the resources of a country or a region, and should also keep in mind that various resources are mutually influential and interactive. So if one reduces or gets destroyed, then its bad effects fall on the whole economic cycle. We should use them on priority basis. Finishing indiscriminately those resources or natural resources which are limited, is a blind sight. It is essential to search for the alternative options for the limited resources like coal and petroleum. For the conservation of resources it is necessary to get support at government and non government level.

12.3.4 Forest conservation and management

Forest is the base of life on earth. This is an area where the action of the development of life has been going for ages and millions of species of animals and plants have been evolved. Forest not only control the

rain and supplies water continuously to the rivers, but also provide humidity to the atmosphere.

Fig. 12.1 Forest

Forests not only protect fertile soil from erosion due to water and rain but also are one of the important factors for the formation of fertile soil from active abiotic rocks. Forests help to keep the environment clean and maintains the natural balance. Clean environment is not possible without forest. In the last few years, the demand for timber as well as the increase in its prices had led to an increase in the timber trade that now the forests around the world have become threatened. Due to the reduced cover of the forests drought occurs at many places. In the absence of trees, the fertile soil flows away with rain water. Due to cutting of trees on the hills, soil flows down with rains and comes into the rivers, consequently the rivers become so shallow that it floods, when the water level increases a little. The question of protecting the forest has now become a question of life and death for us today.

In spite of the accelerated destruction of the forests in the last few years, there are about 15000 species of flowering plants and double the number of other remaining flora species are found in India. Only 15% of all available species of plants are of economic importance. Indian forests are spread across around 8 lakhs sq km. In India mostly the tropical forests are found. One of the specialities of evergreen tropical forests is that they are rich in biodiversity. In some parts of the country we have deciduous temperate forests. About 35 lakhs cubic meter of timber, 13 lakhs cubic meter firewood, innumerable types of products like - bamboo, medicine, gum, resins, rubber, scented oil, oil seeds and many other useful products are obtained from forests.

Protecting forests is today's priority. Figures sourced from the satellites show that in our country 1.3 million hectare of forests are declining each year. With the increase in population forest land is cleared for agricultural purpose. Forests are cut around the world for different construction works, factories and animal husbandry. Initially approximately 70% of the earth was covered with forests but now only 16-17 percent of the land is covered with forests. Jhoom farming is considered as one of the reasons for deforestation. In this type of farming the flora of a particular region is burnt to ashes, thereby increasing the fertility of the land, for two-to three years good harvest is taken. With the decrease in the fertility of the soil the same method is adopted in other areas. In our country the tribal people of Nagaland, Mijoram, Meghalaya, Arunachal Pradesh, Tripura and Assam adopt this method of farming.

The Major side effects of deforestation are depletion of natural resources, soil erosion, destruction of forest life, change in climate, desertification, increase in pollution etc. are notable.

The following measures can be adopted for the protection of the forests-

1. Forest should be cut upto the optimal limits, there should be an equal ratio between the rate of forest cutting and plantation.
2. Forest should be protected from fire, for this the observation posts and fire protection path should be made.
3. Forest should be protected by spraying insecticides to kill harmful insects and by removing diseased trees.
4. More priority should be given to diverse forest over uniform forest.
5. Destruction of forest for agriculture and habitat

purpose and jhoom method of agriculture should be stopped.

6.To prevent deforestation, alternative sources of fuel and timber should be worked out.

7.Conservation of forest resources should be kept in mind while planning for dams and other multipurpose schemes.

8. Awakening public awareness about the importance of forests. Chipko movement, silent valley area etc are the result of this awareness. Social and voluntary organization have a great role in forest conservation.

9. It is creditable to give incentive to social farming.

10. The rules and regulations of forest conservation must be followed strictly.

12.3.5 Social forestry

In our country more than one crore hectare of degraded land needs to be replanted every year so that ecological balance can be maintained. This target can be achieved through social forestry. This will not only increase the forest area but will also create employment on a large scale. The National Commission Agriculture had also suggested to adopt social forestry in order to increase the forest area, so that with the expansion of forests, the villagers could get fodder, firewood, and secondary forest produce. It is recognized as a programme of the people, for the people and by the people.

There are three main components of social forestry-

1. Agro-forestry

2. Plantation done by the forest department to meet the needs of the public at public places like canals, roadside, hospital etc.

3. Plantation on public land done by villagers.

12.4 Conservation of wild life

In general the term wild animals are used for those that live in natural habitat like, elephant, lion, rhinoceros, deer etc. But the term wild life is widely used for all the species of animals and plants found in nature. India is a country which is endowed with religious, cultural, political, climatic, land diversity and a rich biodiversity. It is remarkable that the land of our country has only 2.4 percent of the total land area of the world, where as 8.1 percent of the world's total biodiversity is found in our country. Overall in India 500 mammals, 1200 aves, 220 snakes, 150 lizards, 30 tortoise, 30 crocodile and alligator, 105 fresh water fishes and thousands of invertebrate species are found.

Fig. 12.2 Wild animals

But at present there has been such a cause created by humans that the existence of wildlife is ending. Apart from humans there are also some natural reasons due to which the wildlife is becoming endangered.

Reasons for the Extinction of wildlife-

1.Destruction of natural habitat- There are many reasons for the destruction of the animals in natural habitat. The main reasons for this destruction are natural calamities like earthquake, volcano, tsunami etc. Following are the other reasons -

(i) Due to the population growth the needs of human beings have increased. Human used forest land for housing, agriculture, industries, which resulted in a crisis on the habitat of wildlife.

(ii) Due to large scale water projects like Bhakra Nangal, Tihari, Vyas project etc the forest land was submerged in water, thereby decreasing the habitat of wildlife.

(iii) Natural habitats were also destroyed due to the mining works in forests, acid rain etc.

(iv) Oil leakage from oil tankers in the ocean is destroying the habitat of sea organisms.

(v) Because of the Green house effect the climate is getting hot around the earth, thereby destroying the biodiversity.

2. Illegal poaching of the wild animals.

3. Pollution

4. Conflict between humans and wildlife.

Apart from the above mentioned reasons for the destruction of wild life, natural, genetic and man-made reasons are also there.

In India conservation of wildlife was under the National Forest Policy during 1952-1972. For the protection of wildlife in 1972, wildlife protection act was framed which is implemented today with many amendments. An International organization IUCN (International Union for Conservation of Nature) was formed in 1948 due to the world wide awareness among people, for the conservation of nature. IUCN compiled a book on all the species which have reached the brink of extinction, this book is known as Red Data Book. IUCN has defined the following five category of species -

1. Extinct species- The species which are extincted from this world and not surviving today are kept in this category like- Dinosaur (animal), Rhynia (plant) etc.

2. Endangered species- These are the species whose conservation measure if not taken, will end in the near future like Rhinoceros, Godawan (Great Indian Bustard), Lion etc.

Fig. 12.3 Godawan

3.Vulnerable species- These are the species which are likely to become endangered unless the circumstances threatening its survival and reproduction improve like- common leopard, alligator etc.

4. Rare species- A rare species is a group of organisms that are very uncommon, scarce and can become endangered in near future, like- giant panda, snow leopard etc.

5. Inadequately known species- These are the species which exist on earth but not much is known about their distribution.

National parks, wildlife sanctuaries, Biosphere reserves, are the main protected areas set up with the view of conservation of wild life.

12.1 National Park

National parks are the natural areas where wildlife and natural habitats are preserved along with the environment. There is a complete ban on cattle grazing in national parks. Private organizations are prohibited to conduct their private activities in national parks. Some part of the national parks can be developed to promote

tourism. Their control, management and policy making is done by central government.

Table 12.1 India's Main National Parks

S.No.	Name	State
1	Kajiranga National Park	Assam
2	Gir National Park	Gujarat
3	Great Himalya National Park	Himachal Pradesh
4	Bandipur National Park	Karnataka
5	Satpura National Park	Madhya Pradesh
6	Sundarban National Park	West Bengal
7	Ranthambhor National Park	Rajasthan
8	Kevla devi National park	Rajasthan
9	Corbet National Park	Uttranchal

12.4.2 Sanctuary

These are also protected areas, they have completed restriction on wildlife hunting. These allow private organizations to enter on the condition that their activities should be creative and should not adversely affect wildlife. Following are some of the sanctuaries in India- Nagarjun sagar (Andhra Pradesh), Hazaribagh prani vihar (Bihar), Nal sarovar prani vihar (Uttar Pradesh), Kedarnath pranivihar (Uttranchal)

Table 12.2 Main wildlife sanctuaries and wild animals of Rajasthan

S. No.	Wild life Sanctuary	Wild animals
1	Sariska, Alwar	Deer, Godavan
2	Darrah, Kota	Panther
3	Mount Abu, Sirohi	Wild Cock
4	Tal Chhappar, Churu	Black deer
5	Jawahar Sagar, Kota	Alligator
6	Sitamata, Pratapgarh	Flying Squirrel
7	Kailadevi, Karauli	Bear
8	Nahargarh, Jaipur	Fox, panther

12.4.3 Biosphere Reserve

These are the natural areas which have been declared as a silent area for scientific study. These are the areas comprising terrestrial, marine and coastal ecosystems. Each reserve promotes solutions by reconciling the conservation of biodiversity with its sustainable use. Until now 669 biosphere reserves in 128 countries has been established. India has 18 biosphere reserves. In India first biosphere reserve came into existence in 1986 at Nilgiri.

Table 12.3 :- Main Biosphere Reserves of India.

S. No.	Region	Reserve
1	Andaman and Nicobar Islands	Great Nicobar
2	Assam	Kajiranga, Manas
3	Karnataka, Kerela	Nilgiri
4	Uttarpradesh	Nanda devi
5	West Bengal	Sundarban
6	Madhya Pradesh	Kanha
7	Rajasthan	Thar Desert

12.5 Water conservation and management

Water is life. Seventy percent of earth surface is submerged in water. Only 2.5 percent of this water is used by humans, 97.5 percent of total water being saline is useless for us. Increasing population and indiscriminate exploitation of natural resources has created many problems for human being. Of these water crisis has emerged as an important problem. The reasons for this are pollution of water bodies, over exploitation of ground water, industrial demand of water, uncertainity of monsoon, and neglecting the traditional sources. Problem of water deficiency has created tension at national and international levels. In India there is a situation of tension exists in neighbouring states about the water sharing of almost all the rivers. So water conservation and management is today's biggest demand. There are three important principles of water conservation and management :

1. Maintaining water availability
2. Protecting water from getting polluted.
3. Cleaning the contaminated water and recycling it.

12.4.1 Ways of water conservation and management.

Water is a cyclic resource, if it is used judiciously, it will not be depleted.

Conservation of water is the conservation of life. The following measures should be taken for the water conservation

1. Water should be declared as a national asset and proper planning should be done.
2. Water should be collected by rainwater harvesting methods.
3. Wastage of water should be minimised in domestic works.
4. Ground water should not be over exploited.
5. Water should be prevented from being polluted.
6. Water should be recycled and used again.
7. For flood control and proper use of water the rivers should be linked together.
8. Fountain method or drip method should be employed for irrigation.

First step in this direction is the scientific management of water resources through integrated water shed management and the second step is rain water harvesting

12.4.2 Integrated watershed management

In the watershed management, there is an integrated use of agricultural, forestry, techniques for land and water management of a particular region is practised. Watershed is an area whose water flows towards one point. It's a geo-morphological unit, a river basin, which can be used according to the convenience of small natural areas. Watershed management is the overall developmental thinking in which the conservation of soil and humidity, flood control, water harvesting, plantations, feeding gardens, grassland, social forestry etc programs are inclined. Watershed development program in India is run in collaboration of the ministry of agriculture and rural development and ministry of forests.

12.4.3 Rain water harvesting

Rain water harvesting is an important measure of ground water recharge. In a state like Rajasthan where most of the drought and famine continues, rain water harvesting is the primary requirement. Since ancient times, there has been tradition of rain water harvesting in the country. Water was harvested in taal-talaiya, tanks, well, johad, step wells etc. Rajasthan has the following indigenous methods of water harvesting-

1. **Khadeen-** Khadeen is a temporary pond made up of soil, which is built at the base of sloppy land. It has walls of soil on two sides and a strong stone wall on the third side. When the amount of water is high the Khadeen fills and the water moves into the next khadeen. The Khadeen is cultivated when the water dries in it.

Fig. 12.4. Khadeen

2-Pond- Pond is the main ancient technique of storage of rain water in Rajasthan. These were separate for men and women. A well was made at the bottom of the pond, commonly known as Beri. This ancient method of water harvesting still holds its significance and is a scientific basis for increasing the level of ground water.

Fig. 12.5 Pond

3. **Lake-** In Rajasthan both types, natural and artificial lakes are found. Lakes have been very traditional system of water storage form ancient times. The water leaking out of the lakes is helpful in increasing the water levels of wells, step wells, kund etc which are situated below it.

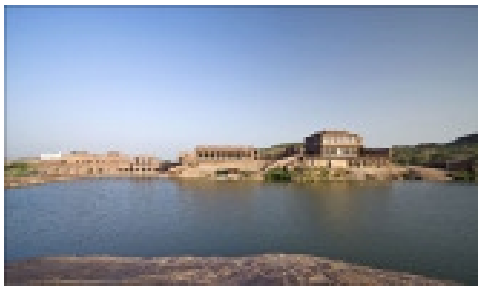


Fig. 12.6 Kaylana lake (Jodhpur)

4. **Step well -** Step well or Baori has its own importance in Rajasthan. These are one of the oldest methods of water harvesting. Stairs and Tibare were made to go down into step well. They are adorned with beautiful art work.

Fig. 12.7 Step well

5. **Toba-** Toba is the traditional source of water harvesting in Thar desert. It resembles that of a Nadi, but its depth is more than Nadi.

Fig. 12.8 Toba

12.5 Conservation of coal and petroleum

12.5.1 Coal

Coal is a solid organic substance that is used in the form of fuel. Coal is very important as a major source of energy, 35-40 percent of the total energy used is obtained from coal. Various forms of coal contain different amount of carbon. Other inflammable and useful products are also obtained from coal. Years ago, due to subdued vegetation, coal was produced. Nearly 30 crore years ago earth was covered with dense forests, kutch fields and water bodies. Vegetation groups fell into the water, died and buried under the layers of soil. Due to the high heat and pressure under earth these remains of organisms get converted in to coal. Coal mainly contains carbon and its compounds. In addition to carbon and hydrogen, nitrogen, oxygen and sulphur is also present. Apart from this phosphorus and some inorganic matter are also found. Based on the quantity of carbon, coal is divided into the following four types-

1. Anthracite (94-98 percent carbon)
2. Bituminous (78-86%)
3. Lignite (28-30%)
4. Peat (27%)

Bitumen, coal gas and Ammonia are produced when coal is heated at 1000-1400 degree celsius temperature in the absence of air.

Pic. 12.9 Coal

This process is called as destructive distillation of coal. In India coal is mainly found in Jharkhand, Madhya Pradesh, Orissa, West Bengal and Andhra Pradesh.

12.5.2 Petroleum.

Petroleum is a very useful mineral that is very much used in daily life. like coal, petroleum is also a fossil fuel. It is also formed like coal, due to the burrying of vegetation and organisms under earth and in long period of time because of extensive heat and pressure they got converted into coal and petroleum. The petroleum found in nature is also called crude oil, unrefined oil, rock oil etc. which is a thick, black coloured liquid that contains different components.

Fig. 12.10 Petroleum

These components are separated by the fractional distillation method. By fractional distillation petrol, diesel, kerosene, natural gas, Vaseline, lubricants are separated.

Coal and petroleum are fossil fuels which are non-renewable resources of nature. These are formed in hundreds of years and their quantity in nature is limited. If humans continue to use them indiscriminately then these resources will end in the future, therefore they should be used very prudently and judiciously. Apart from this, non-conventional sources like air, water and light should be used as an alternative, which are abundant in nature Biogas can be used in place of natural gas.

Biodiesel is obtained from biological sources and is equivalent to diesel as a fuel. It is purely made from renewable resources. This can run traditional diesel engines without any alteration. This is a clean substitute for conventional fuels. It is considered as the fuel of future. It is non poisonous and biodegradable. The good thing about bio diesel is that like other fossil fuels it is not harmful for the environment. Rajasthan Government has set up Bio fuel Mission and Biofuel Authority to promote biodiesel in the state.

12.5.1 Sustainable development

Use of any resources should be cautious so that not only we can use them, but also the generations to come can use them to fulfill their needs.

12.6 Participation of people in conservation of natural resources

Man is a social animal. Clean environment is essential for any society. Human life and health are directly connected with clean environment. Today development has become the cause of destruction. This has caused huge damage to all the aspects of the environment. Though the water, air, land all have become polluted, the human's uncontrolled and irrational economic development journey is continuing. The harmony between the economic development and environment protection has ended. Environmentalists are constantly warning that if natural resources are continue to be exploited, balance between environment

and ecosystem may have to face serious crisis. In spite of all, some successful experiments and mass movements are also running, which are playing their role in maintaining balance in the environment and ecosystem.

12.6.1 Chipko movement

Chipko movement is a progressive step in the direction of protection of forests. Its main purpose is to protect forests from contractors and prevent cutting of trees. This movement has started from Khejarli village in Jodhpur district of Rajasthan, where 363 vishnoi men, ladies and children sacrificed their lives with Amrita Devi Vishnoi.

Fig. 12.11 Amrita devi (Chipko movement)

In 1730 AD wood was required for the construction of the palace of Maharaja of Jodhpur. His soldiers reached Khejarli village and started cutting the trees of Khejri. On hearing the sound Amrita Devi and her three daughters came there and politely requested the soldiers not to cut the trees, but the soldiers did not stop their axes, then Amrita Devi and her daughters hugged the trees. Soldiers cut them along the trees. News spread like fire throughout the village and surrounding areas. People came over there, hugged the trees and sacrificed their lives. In this way 363 people sacrificed their lives to protect the trees. Even today Vishnoi community is committed to preserve the plants and wildlife. After the sacrifice of Khejarli, in 1973 women in Uttrakhand launched the Chipko Movement for the protection of trees. This movement lasted for eight years, then in 1981 government banned the cutting of green trees in areas with height above 1000 mtrs. Sundarlal Bahuguna extended the Chipko movement after the Khejarli sacrifice. Same kind of movement was also run in Karnataka, which was called Appiko. Appiko is a kannada language term which means, to stuck. Today khejarli sacrifice is an ideal for the protection of forests. Khejri trees still remind of the sacrifice and provides inspiration. Khejri is considered as the kalpvriksh of Thar. Its scientific name is *Prosopis cineraria*. In 1983 Khejri was declared as the state tree.

Important Points

1. Human existence depends on natural resources. Natural resources are renewable and non-renewable.
2. Forest are green gold, which requires significant evaluation, plantation and protection.
3. Social forestry is a special program of the people, for the people and by the people for forest safety.
4. Due to the destruction of natural habitat, pollution, population expansion, illegal hunting etc, the wildlife survival is in danger.
5. Endangered species are notified in Red Data Book.
6. Due to the presence of water, Earth is called as Blue Planet. Conservation of water is the conservation of life.
7. Coal and petroleum are mon-renewable sources of fuel. They should be exploited prudently and rationally.
8. Chipko movement was launched to protect the forest from being cut.
9. Amrita Devi Vishnoi wildlife protection award is given for the safety of wildlife and environmental protection.

Practice questions

Objective type questions

1. Who is associated with Khejarli sacrifice-
   (a) Baba Amte
   (b) Sunderlal Bahuguna
   (c) Arundhati Rai
   (d) Amrita Devi
2. Reasons for ground water crisis.
   (a) Pollution of water sources
   (b) Over exploitation of ground water
   (c) More demand of water
   (d) All of the above
3. Red Data Book is related with-
   (a) Endangered wild life
   (b) Rare wild life
   (c) Extinct species
   (d) All of the above
4. Sariska wild life sanctuary is situated at
   (a) Alwar
   (b) Jodhpur
   (c) Jaipur
   (d) Ajmer
5. Which Coal contains highest amount of Carbon.
   (a) Peat
   (b) Lignite
   (c) Anthracite
   (d) Bituminous

Very short type questions

6. What is meant by endangered species?
7. What is a National Park?
8. What are the various methods of irrigation?
9. Flying squirrel is found in which sanctuary.
10. Write down the components of petroleum.

Short type questions

11. Explain the three principles of water conservation and management.
12. What is social forestry?
13. Write the name of different types of coal?
14. What is the meaning of sustainable development?
15. What is meant by wild life conservation?

Essay type questions

16. Write the methods of water conservation and management.
17. Explain the measures for forest conservation.
18. Describe the causes of wildlife extinction.
19. Describe the various traditional methods of water harvesting in Rajasthan.
20. Write an article on the Chipko movement.
21. What are natural resources? Describe different types of natural resources.
22. Describe the different species classified by IUCN.

Answer key

1. (d) 2 (d)
3. (d) 4. (a)
5. (c)

Chapter-13
Waste and its Management

In the twenty first century, today we are proud of our scientific and industrial progress, because of this we are provided with many pleasures. Due to this progress the quality of life has improved on one hand, the problem of environmental degradation is born as a result. Because of this the whole world is worried today. One of the many dimensions of environmental degradation is the growth of waste materials and their adverse effects on environment and human health. Due to industrialization, urbanization and rapid population growth, the amount of waste is increasing continuously and the quality level is coming down as there are no proper disposal mechanism. Hence proper analysis and diagnosis of this problem is necessary.

13.1 Waste

The waste materials or products that are formed at the end of any process are called waste or it refers to those substances which are thrown away after use as useless items. On one hand it includes the materials used by human beings such as paper, cloth, plastic, glass, rubber etc. and on the other hand, there are liquid and solid waste disseminated from the industries. Apart from this the debris of mines and the dumping of agricultural waste etc. in open causes the environmental pollution as well as land pollution. This problem is more in cities than villages, because of the concentration of population and centralization of industries, the quantity of waste products are increasing regularly. In the developed country like the United States the amount of urban waste is 4.34 crore tons per year. In country like India, where there are no provisions for waste disposal, its quantity is multiplied.

13.2 Types of waste

Depending on its nature the waste can be classified as solid, liquid and gaseous waste, but the waste is classified into two classes based on decomposition- Bio-degradable and Non-bio degradable waste.

1. Biodegradable waste

Those waste materials that are decomposed by biological agents are called as biodegradable waste, such as, domestic organic waste, agricultural waste, bio-medical waste like cotton bran, blood, flesh pieces etc.

2. Non-biodegradable waste

Those waste materials that are not decomposed by biological agents are called as non-bio degradable waste, such as, plastic bottles, polythene, glass, syringe, metal pieces etc.

13.3 Sources of waste

Waste in the environment is discharged by various sources such as, domestic sources, municipal, industries and mining operations, agriculture and medical sectors.

1. Household source

Dirt is released every day after cleaning the houses, which include dust, paper, cardboard, clothes, plastic, wood, metal pieces, vegetables and fruits peels, rotten products, dried fruits leaves etc.

Fig. 13.1 Household waste

Table 13.1 Industrial Waste

S. No.	Type of Industry	Waste	Symptoms
1.	Pharmaceutical manufacturing industry	Microorganisms organic chemicals	Suspended and dissolved organic matter
2.	Textile industry	Fibres and waste fabric	Alkaline and suspended substances
3.	Chemical industry	Raw material, intermediate and end products	Poisonous, acidic, Alkaline inflammable (depending on the nature of industry)
4.	Petroleum industry	Research chemicals	Oily and acidic
5.	Fertilizer industry	Solid waste	Calcium and calcium sulphate
6.	Thermal power plant	Flying ash.	Silicate, iron oxide, semi burnt carbon
7.	Rubber industry	Rubber	High chloride, rubber powder

Their quantity increases in occasional celebrations and parties. All these products are thrown out of the houses on roads or dumpedat fixed places. Their rotting creates many pathogens that causes pollution and also spread diseases.

Municipal Source

This means the total garbage and dirt collected from the city. In addition to domestic household wastes it includes faeces, urine, waste collected from markets, roads and from different institutions, materials thrown from dismantling of houses and products thrown from workshops. In fact the entire dirt of the town is included in it. Its volume is dependent on the population of the town and its expansion. According to an estimate, approximately 5000 tons of municipal waste per day is collected from 45 major cities of India.

Fig. 13.2 Municipal waste

3. Industrial and mining waste

Large amount of waste of used products are thrown in huge quantities from industries. It includes pieces of metals, chemical substances, many poisonous inflammable substances, oily substances, acidic and alkaline substances, bio degradable substances, ashes etc. All these substances harm the environment. Some waste from different industries are shown in table 13.1

Likewise the huge piles of waste substances from the mines in the mining sector cause environmental pollution.

Fig. 13.3 Industrial waste

4. Agriculture

After agriculture activities clusters of pasture, grass-straw, leaves, stalk etc are collected at one place or spread out. These agricultural waste start rotting with rain water and due to biological activity of decomposers becomes the cause of pollution.

Fig. 13.4 Agricultural waste

5. Medical Sector

Waste like glass, plastic bottles, tubes, syringes etc from the hospitals are non-biodegradable waste. Apart from this biodegradable waste such as blood, flesh pieces, infected tissues and organs provide the medium for infection of many diseases.

Fig.13.5 Containers for collection of medical waste

In the cities of India, 90 percent garbage is in the form of ash, mixed matter and different forms of carbon. In developed countries its nature varies, such as in United States of America, the waste constitutes 42 percent paper and cardboard items, 24 percent metallic matter and 12 percent food ingredients. It is clear that urban waste today is a major cause of environmental degradation, which is gradually increasing.

13.4 Losses due to Waste

Waste materials harm human beings as well as plants, animals and environment. Irregularly thrown garbage affects the natural beauty of any place. Biodegradable waste attracts many harmful micro-organisms and insects, which increases the likelihood of the spread of many infectious diseases. These waste emits bad odour on decomposition, thereby affecting the environment. During the decomposition process of these waste substances, harmful green house gases like methane, carbon dioxide etc. are emitted that pollute the environment.

Waste like contaminated cotton, bandages, blood, syringe, I V set, tube, glass and plastic bottles, which comes out of the hospitals is biomedical waste. The claim for the disposal of these wastes is greatly appreciated but proper arrangements are not there. In small private hospitals, clinics and in villages there are no arrangements for disposal of biomedical waste. Biomedical waste spread in and around like litter pile is dangerous in many ways. Hepatitis-B, tetanus, infection related diseases, AIDS due to infected needle, smoke emitted by burning of these waste, lead to many types of diseases. While exposed for long period of time in air, soil and water the artificial non-bio degradable waste like plastics starts to produce harmful toxic substances. Plastic is a petroleum based product. Its harmful toxic substance reaches the source of water, which increases the chance of having many types of diseases. Polythene waste is also proven to be fatal for humans, animals and birds. Various kinds of diseases are spreading in people, the fertility of the soil is decreasing and underground water sources are getting contaminated. Excessive exposure to plastic increases the amount of phthalates in blood due to that the growth of the foetus of pregnant women stops and reproductive organs are damaged. The chemical bisphenol which is used in plastic products causes diabetes and unbalances the liver enzymes.

The flow of water is blocked by throwing the polythene bags in the drains outside the houses, whereby many types of pathogenic microorganisms and their carrier insects flourish. The polythene bags that are thrown in the waste are several times eaten by animals, which gets trapped in their stomach and intestine that leads to the death of animals. Similarly burning of polythene waste emits toxic gases like carbon dioxide, carbon mono oxide and dioxines. It increases the risk of diseases related to respiratory tract, skin, eyes etc.

In the cities where waste materials are collected, poor people start living there. They are slum areas. People living here live a hellish life with poor hygine and sanitary conditions. These colonies are a blame on our urban development. There are many dirty settlements or slums in Delhi, Mumbai, Kolkata, Chennai and the capitals of the states and they are expanding. These slum settlements are expanding in many cities of Rajasthan like Jaipur, Jodhpur, Kota, Bikaner, Udaipur, Bhilwara, Shri Ganganagar, Alwar, Bharatpur etc. Also due to the limited resources and apathy of municipalities, today in all the cities the waste materials are spreading into the residential areas, which is a matter of extreme concern.

13.5 Waste management

Waste is not just n India problem but a global problem. Inadvertence towards garbage management has been taken seriously today and concerns have been raised at national and international levels about the side effects on the environment. There are total of 5161 cities in India, 35 of them get metropolitan status. In addition to 393 first class and 401 second class cities there are also small towns with 20000 to 50000 population. In India about one Lakh tones of waste are produced daily from these cities. The average amount of litter in small town is 0.1 Kg per person whereas 0.4-0.6 kg average garbage comes out in big cities. This garbage plays an important role in spoiling the beauty of the cities in India. The middle class villagers being attracted towards the urban culture are increasing the population of the cities. So these new cities are naturally careless towards waste management. Waste management is difficult in small towns due to the shortage or unavailability of funds, lack of contractors. It is easier to develop the cheaper and necessary management of waste by the people in the form of organic manure, vermi compost by using the litter of their own areas. Because of the unavailability of manure and increased side effects of chemical fertilizers, it will be more natural and beneficial to depend on organic manure. Management of litter is possible only with personal interest. It is not only a social duty but also the determinant biological duty of a human being for interdependence of life and environment.

Waste management is collection, transportation and disposal of garbage, sewage and other waste products. Waste management consists of solid, liquid, gas and radioactive substance. Different methods and expertise are used for each substance. Methods of waste management is different for developing and developed countries, villages and cities, residential and industrial producers. The aggregation and expansion of wastes is a serious problem in big cities today and will be in small towns tomorrow. Development is a natural process that cannot be stopped. It is necessary to give it a proper direction so that the imagination of waste free development can be done with the help of government machinery, NGO's and citizens.

In 1975 the Government of India constituted the Shivaraman committee for this work, which suggested the establishment of large dustbins, proper disposal of human excretory waste, proper arrangement of the waste collection in the cities, burning the piles of litter etc. Following methods are used for the control and management of wastes-

13.5.1 Methods of waste management

Waste management is different for different reasons, including the types of waste material, use of surrounding land and available area.

1. Landfill -

In this process waste is managed in this way- Landfills are often made in non-use mines, mining pits etc. This is a very clean and relatively low cost method of waste disposal and in most countries it is a common practice. But old and wrong method of landfill can have reverse effects on the environment like, waste flies with the air, attracts insects, produce liquid, etc. Apart from this, the decomposition of organic waste produces methane gas, which is a green house gas,

that produce bad odour and can destroy the vegetation. Waste is executed in a planned manner in modern landfill. Pits are filled with soil and landfills gas system can be established for collecting the landfill gas. Electricity can be produced by collecting this gas.

Fig. 13.6 Landfill

2. Incineration

In this method of execution of the waste, materials are burned at high temperature by which waste are converted into heat, gas, steam and ash.

Fig. 13.7 Incineration reactor

Incineration is performed on both scale. It is used by individuals on small scale, industries use it on large scale for the execution of liquid, solid and gaseous waste. It is recognized as a practical method for the execution of biological therapeutic waste. But because of emission of gaseous pollutants, incineration waste execution is a controversial method. Incineration is more prevalent in countries like Japan because it requires a small piece of land. It does not require large areas like land fill.

3. Recycling methods

Conversion of waste into new material is known as recycling, by which the waste material is renewed. Raw material can be removed and reprocessed or caloric content of waste can be converted into electricity. In most developed countries, popular means of recycling refers to the extensive collection and reuse of daily waste products.

Pic. 13.8 Recycling process

The most common consumer products for recycling are aluminum drink cans, steel, food and aerosol cans, plastic and glass bottles, card board boxes, magazines, plastic goods etc. Natural organic waste such as residual food, paper, wool, etc can be used to make compost, vermi compost and organic manure. Also by this process electricity can be produced by producing gas.

4. Chemical reaction

Many waste materials can also be destroyed by chemical action or they can be made useful again.

Apart from these, other remedies for waste disposal are as follows-

I. Waste can be disposed in deep oceans, but it is necessary to note that the ocean environment is not polluted.

II. Fat can be obtained by baking animal residues such as bones, feathers, blood etc which in turn can be used for making soap and its protein part can be used as a cattle feed.

III. Garbage can be changed to solid bricks by exerting heavy pressure.

IV. The urban sewage water should be stored in a

pit away from the city and after purification it can be used in irrigation.

V. Regarding the disposal of waste material and reuse requires extensive research at government and non- government level. Further the developed countries should provide all the technologies to the developing countries which are helpful in disposal of waste and for protection of environment.

VI. For solving the growing problem of waste products and environmental protection, it is necessary to form a long time master plan for a region, even for each city so that it can be resolved in a planned way.

VII. The most essential is the improvement in the behaviour of general citizens. If each of us stops to throw the house hold waste in front of own or others house or drainage and collect at a appropriate place then this problem will be automatically reduced. Similarly municipalities will have to renunciate their apathy and bring the skills and dutifulness in the work of the cleaning staff. There is a need of collective effort to avoid environmental pollution from waste materials and its adverse effects on our health because the environment is a common heritage that we have to keep safe.

Important Points

1. In today's era of comfort and luxury where scientific and industrial progress has taken place, the whole world is worried due to the problem of environmental degradation.
2. Due to industrialization, urbanization and population growth the amount of waste is continuously increasing.
3. The waste materials or products produced at the end of the process are called waste, it can be of solid, liquid or gaseous nature.
4. Waste in the environment are emitted from many sources like - domestic household source, municipality, industry and mining work, agriculture and medical sector.
5. Waste materials harm the humans as well as plants and animals in the environment. They increase different types of pollution and cause many diseases.
6. Methods for waste management varies with different types of waste.
7. For the disposal and management of waste materials methods like landfills, incineration and recycling can be used.
8. By reusing, less using and recycling, the amount of waste can be reduced.

Practice questions

Objective type questions

1. Which technique is suitable for the disposal of bio medical waste -
   (a) Landfill (b) Incineration
   (c) Recycling (d) Disposal in water.
2. Recycling is the best treatment for what type of waste -
   (a) Metal waste (b) Medical waste
   (c) Agricultural waste (d) Domestic waste
3. Which of the following is the main green house gas -
   (a) Hydrogen (b) Carbon monoxide
   (c) Carbon dioxide (d) Sulphur dioxide
4. How much average waste per person gets in the big cities of India -
   (a) 1-2 kg (b) 1- .2 kg
   (c) 2-4 kg (d) 0.4 to 0.6 kg.
5. Organic manure can be made from -
   (a) Domestic waste (b) Agricultural waste
   (c) Both (d) None of the above

Very short type questions

6. How biogas is made?

7. What is a waste?
8. Write the names of Green House Gases?
9. What is vermicompost?
10. Which diseases can be caused due to the stoppage of water in the drains?

Short type questions

11. Explain waste management?
12. What is meant by solid waste?
13. Write difference between biodegradable and non biodegradable waste?
14. What do you understand by landfill?
15. What does the recycling mean?
16. Incineration method is used for what purpose?

Essay type questions

17. Describe the types of wastes?
18. Write an article on waste management?
19. Write an essay on the sources of waste?
20. Make a list of different waste materials by classifying them around your surroundings?
21. What will you do for management of waste in your colony or village?

Answer key

1. (b) 2. (a) 3. (c)
4. (d) 5. (c)

Chapter - 14

Economic Importance of Plants and Animals

14.1 Economic importance of plants

There are some fundamental requirements for human life like food, cloth, shelter etc. Cereals, pulses, oil, sugar etc for food, fibres for cloth and wood used for making shelter are obtained from plants. All the living organisms of whole biosphere directly or indirectly depend on plants, therefore plants are very important for human kind.

Study of economically important plants and their products is called **economic botany.**

Economically important plants are divided into following categories-

1. Food Plants: Cereals, pulses, oil, spices, beverages, vegetables, fruits etc.

2. Medicinal Plants: Ashwagandha, opium, sarpgandh, guggal, safed musli etc.

3. Timber and fibres related plants: Teak, shisham, rohida, khejri, cotton, jute etc.

14.1.1. Plants of food Importance

Energy is required for various vital activities of organisms. This energy is obtained from food. Some important food plants are as follows-

14.1.1.1 Cereals

This is the most important group of food plants. They are members of grass family (Graminae or Poaceae). They are the main source of starch which is used as a respiratory substrate in human body. Some of the important cereals are as follows-

(i) **Wheat:** *Triticum aestivum*- It is sown as Rabi crop. Some of the improved varietes of wheat are- Sonalika, Kalyan Sona, Sharbati, Sonara etc.

Fig 14.1 Wheat

(ii) **Rice:** *Oryza sativa*- It is sown as a Kharif crop. India is at the top in the world in rice production. Some improved varietes are- Basmati, Swarndana, Jaya, Ratna, Sona etc.

Fig. 14.2 Rice

(iii) **Maize:** *Zea mays* - It is also sown as a Kharif crop. Some improved varietes are- Vijay, Shakti, Ratan etc.

Fig. 14.3 Maize

(iv) **Pearl-Millet:** *Pennisetum typhoides*- It is also shown as a Kharif crop. It is an important millet cereal.

Fig. 14.4 Pearlmillet

14.1.1.2 Pulses: They are good source of protein. They are the members of family leguminosae. Some important pulses are as follows-

(i) Gram- (*Cicer arietinum*) - It is a crop of Rabi. India is at the top in the world in production of gram. It is known as king of pulses.

Fig 14.5 Gram

(ii) Red gram (*Cajanus cajan*)

Fig 14.6 Red gram

(iii) **Pea** (*Pisum sativum*)

Fig 14.7 Pea

(iv) Ground nut: *Arachis hypogea* - India is the largest producer of ground nut in the world.

Fig. 14.8 Ground nut

(v) Soyabean : *Glycine max* - It contains the highest protein.

Fig 14.9 Soyabean

14.1.1.3 Oil yielding plants

They are complex organic compounds which are made up of hydrocarbon, ester, alcohol, aldehyde etc.

(i) **Edible oil-** Oil of ground nut, oil of sesamum, oil of coconut, oil of soyabean, oil of alsi, oil of sunflower etc.

Fig 14.10 Oil

(ii) **Non-edible oil-** Oil of castor, oil of terpentine etc.

(iii) **Perfumed oil-** Kapoor, sandal, clove, khas oil etc.

14.1.1.4 Important spices

Black pepper, cumin, redchilli, fennel, coriander, clove, ajwain, turmeric, asafoetida, ginger, dalchini (cinamon) cardamom etc.

Fig 14.11 Spices

14.1.1.5 Beverages

Tea and coffee are the most commonly used beverages.

Tea- *Camellia sinensis* obtained from young leaves of plants and coffee (*Coffea arabica*) is obtained from roasted seeds of plant.

Fig 14.12 Beverages

14.1.1.6 Vegetables

Vegetables are also an important part of human balanced diet, like cereals and pulses. They are the chief source of vitamins, minerals, fibres, water etc. They may be obtained from various parts of plants like root, stem, leaf, flower, fruit, seed etc. Some important vegetables and their botnical names are as follows-

Fig 14.13 Vegetables

(a) Obtained from roots

(i) Carrot- *Daucus carota*

(ii) Radish- *Raphanus sativus*

(iii) Turnip- *Brassica rapa*

(vi) Sweet potato- *Impomoea batatas*

(b) Obtained from stem

(i) Potato- *Solanum tuberosum*

(ii) Arbi- *Colocasia esculenta*

(c) Obtained from leaf

(i) Spinach- *Spinacia oleracea*

(ii) Fenu greek- *Trigonella foenum-graecum*

(iii) Bathua- *Chenopodium album*

(d) Obtained from inflorescence

(i) Cauliflower- *Brassica oleracea var botrytis*

(e) Obtained from fruits

(i) Tomato- *Lycopersicon esculentum*

(ii) Brinjal- *Solanum melongena*

(iii) Lady's finger (Bhindi)- *Abelmoschus esculentus*

(iv) Clustar bean (Guar)- *Cyamopsis tetragonoloba*

14.1.1.7 Fruits

Structure formed from fertilization of ovary of a flower is called fruit. Some important fruits are as follows-

(i) Mango- *Mangifera indica*

(ii) Banana- *Musa para disiaca*

(iii) Orange- *Citrus reticulata*

(iv) Guava- *Psidium guajava*

(v) Papaya- *Carica papaya*

(vi) Custard apple- *Annona squamosa*

Fig 14.14 Fruits

14.1.2 Medicinal plants

Chemical substances of medicinal value are found in various parts of plants like root, stem, leaf, flower, fruit, seed etc. Some medicinal plants of them are as follows-

(a) Obtained from stem

(i) Turmeric- *Curcuma longa*

(ii) Ginger- *Zingiber officinale*

(iii) Garlic- *Allium sativum*

(iv) Guggal- *Commiphora wightii* etc.

(b) Obtained from root

(i) Serpent root (Sarpgandha)- *Rauwolfia serpentina*

Fig 14.15 Serpent root

(ii) Chlorophytum (Safed musli)- *Chlorophytum tuberosum*

Fig 14.16 Safed musl

(iii) Ashvagandha- *Withania somnifera*

Fig. 14.17 Ashvagandha

(c) Obtained from bark

(i) Quinine- *Cinchona officinalis*

(ii) Arjun- *Terminalia arjuna*

(d) Obtained from leaf

(i) Aloe (Gwarpatha)- *Aloe vera*

(ii) Ocimum (Tulsi)- *Ocimum sanctum*

(iii) Brahmi- *Centella asiatica*

(e) Obtained from fruit

(i) Opium- *Papaver somniferum*

Fig 14.18 Opium

(ii) Emblic (Anvala)- *Emblica officinalis*

14.1.3 Plants of constructional importance

Various parts of plants are used to obtain furniture, windows, doors, clothings, strigs, broom, mattresses etc. Fibres and wood related some plats are as follows-

14.1.3.1 Fibre yielding plants

Various parts of plats like stem, leaf, seed etc. have thick walled tissues, from which clothing, packing bags, ropes are made, called as fibres. Some fibres yielding plants are s follows-

(i) Jute - *Corchorus capsularis*

(ii) Cotton- *Gossypium* spp.

Fig 14.19 Cotton

(iii) Sun hemp- *Crotolaria juncea*

(iv) Coconut- *Cocos nucifera*

14.1.3.2 Timber

Out of three fundamental needs of human beings like food, cloth and shelter, timber plays very important role to fulfil the need of shelter. Secondary xylem of perennial dicotyledons and gymnosperm plant is known as wood. Some important timber yielding trees are as follows-

(i) Teak- *Tectona grandis*

Fig 14.20 Teak

(ii) Saal - *Shorea robusta*

(iii) Shisham- *Dalbergia sissoo*

Fig 14.21 Shisham

(iv) Rohida or Marwar teak- *Tecomella undulata*

Fig 14.22 Rohida

(v) Khejri (State tree of Rajasthan)- *Prosopis cineraria*

Fig 14.23 Khejri

(vi) Deodar - *Cedrus deodara*

14.2 Economic importance of animals

Man has domesticated the animals and used them for obtaining food and other useful products. The rearing of new species of these animals has become much simpler and more beneficial due to the development of new technology. The brief description and rearing of different animals like honey bee, silkworm, lac culture, pearl culture, corel and corel reefs, fish, cattle etc and their superior breeds are as follows-

14.2.1 Apiculture

Honey bees are the most important insects for pollination in plants. Apiculture has dual advantage for human. The yield of crop is increased because of the easy process of pollination due to apiculture. The honey bees have been used for obtaining honey for thousands of years. It is high energy food material therefore, it has also been used as medicine. Pure honey does not destroy for a long time, therefore, it is used as a preservative.

Fig. 14.24 Apiculture

Honey and honey bee was obtained from honey combs or hives found in nature from ancient time. Nowadays large amount of honey is obtained from artificial honey hives of apiculture.

14.2.2 Sericulture

We are rearing sericulture from thousands of years to obtain silk. The weaving of cloth from silk was first started in china. Now,. it has become small scale industry in many countries of the world.

Introduction of silk worm

Those insects which produce thread like silk are called silk worm. Out of them, *Bombyx mori* which feed on mulberry leaves, is the main species. Now-a-days. India is third in position after China and Japan in the field of silk production. *Bombyx mori* belongs to

Lepidoptera order and good quality of silk is produced by this silk worm.

In India 2 to 7 generations of the insect can be developed in one year. After the incubation period, the larva hatches out of the egg known as **caterpillar**. Larva has one pair of salivary glands, known as **silkglands.**

Fully developed silk gland becomes five times longer than larva. Silk is secreted in the form of liquid which hardens on exposure to the air.

The full grown larva or caterpillar is 7.5 cm in length. It stops feeding and after that starts cocoon formation. It secretes thread of silk around the body and closed fully inside threads. The inactive larva closed inside cocoon is called **Pupa**. Cocoon is made up of approximtely 1000-1200 meter long thread of silk. The weight of one cocoon is about 1.8 to 2.2 gm. Silk is made up of protein. Its inner part is made up of **fibrin** and outer part is made up of **sericin** protein for sericulture. It is necessary to have mulbery gardens.

Fig 14.25 Sericulture

14.2.3 Lac culture

The scarlet resin substance secreted by glands of lac insects is called **lac**. The rearing of lac insects for commercial production of lac is called **lac culture**. India produced 80% part of lac of total production of lac in the world.

Scietific name of lac insect is *Lccijer lacca.* It is minute crawling scale-insect which is enclosed by covering of lac secreted by itself. This covering protects lac insect. Male lac insects are smaller in size then female and pink in colour. They produce lac in nymph stage only. Female lac insect is large in size and produce more lac. They start to suck the juices when stick with soft twings and starts the formation of lac around the body. There are four crops of this every year in country. 50% part of lac production in India is obtained Rangini crop.

Fig. 14.26 Lac insects

Two methods for lac productions are as follows -

(i) Old common method

(ii) Modern method

(i) Old common method: This method used by tribals is ancient and non-scientific. In this method lac is collected by harvesting the plants of lac insects. There is a great loss of next crop in this method due to the loss or dmaging of insects.

(ii) Modern method: This is a scientific method in which next crop is not more harmed because lac is obtained in intervals not continuously. Research about lac is done at Indian research institute, Ranchi, Bihar.

14.2.4 Fishery

Fish is an easily available proteinaceous, highly nutritious and easily digestive food resource,therefore, fishery has been done by human for breeding and production of fishes. Now-a- days the position of India in world is sixth in case of sea food production. In west Bengal, bihar and orrisa about 1500 years old fish industry is present.

Fishery is more floureshed in freshwater as compared to saline water. For fishery in fresh water, native fishes like Rohu (*Labeo rohita*): Catla (*Catla catla*) mrigal (*Cirrhinus mrigala*) etc. are

being produced. In fishing industries fexotic fishes like common carp (*Cryprinus corpi)* are cultured. The land with clay soil is considered good for construction of a pond. The temperature, light, Oxygen, water flow of this pond are regulated for the maximum production of fishes. The natural food given to fishes are like-microscopic aquatic plants, animals and artificial like husk of rice, bran of wheat, pieces of grain etc.

Fig 14.27 Fishes

14.2.5 Animal husbandry

The branch of agriculature which deals with the study of food of domesticated cattle, habitat, health breedig etc is know as **animal husbandry**. Animal husbandry has special importance in Indian economy, in which maximum contribution is of milk production.

Fig. 14.28 Animal husbandry

India has the 55 percent buffalo and 15 percent cows of world's total number. 53 percet milk production of country is obtained from buffalo and 43 percent from cows. India ranks first in milk production in the world. Population of goats is second in the world, third in population of sheeps and seventh in population of fowls. These small cattle play an important role in the economic development of poor people.

14.2.5.1 Dairy industry

Humans are using domestic animals to obtain milk since ancient times, Now-a-days milk production become a major and beneficial business of dairy industry. Buffaloes are more important for milk production point of view. Some good breeds of buffalo are as follows. Jaffarabadi, Murrah, Surti, Bhadawari, Mehsana etc. Similarly some good breed of cow are as follows- Gir, Sahiwal, Sidhi, Devki, Haryana etc. In some states goats are also domesticated for milk production. Sirohi, Bar-bari, Kashmir pashmina, Jamuna pari etc are the good breeds of goat.

14.2.5.2 Poultry

The tradiation of poultry for eating eggs and meat (Chicken) is since ancient times. This industry fulfils a major part of protein requirement as a food substance. India ranks 5th position in the world in egg production point of view. For good growth and to maintain good health, it is essential to provide protected habitat and nutritious food to fowls. The poultry feed includes maize, barley, pearlmillet, wheat, jowar etc.

14.2.5.3 Wool industry

A large number of sheeps are domesticated in north India to obtain wool. Wool is prepared from hair of sheep. The colour of wool depends on the species of sheep and the climate of that region. Some indigeneous breeds of sheep like-Lohi, Nali, Marwari, Patanwadi etc. are domesticated. Rajasthan is an important state of country in wool production point of view.

14.2.6 Coral and coral reefs

Single or colonial polyp animals of mollusca phylum secrete $CaCO_3$ skeleton, know as Coral. Most of the corals secreted by members of class Anthozoa of phylum Colentrata.

The calcareous rocks or mounds of shell like structures formed from continuous budding in polyps of coral colonies are called as coral reefs.

Fig. 4.29 Coral reefs

14.2.7 Pearl culture

Animals of phylum Mollusca are economically very important for humas. They are useful for business point of view because Button, Pearl and Cowrie are obtained from these animals. Pearls are considered to be valuable as gems and beads since ancient times. The thousands of tons of mollusca are use every year for this purpose. Very beautiful, attractive and valuable pearls are obtained from pearl oyster.

Fig. 14.30 Pearl culture

The process to obtain pearl from rearing of sepia by artificial technology method is called **Pearl Culture**. Pearl is cosidered as a valuable gem which is usually white, shiny, rounded structure which secreted by mollusca like oyster under the shell of itself for their protection.

This technology was first developed in Japan. Lingha pearl are considered as best which are obtained from sea oyster. Pearl are also obtained from sepia of fresh water are less valuable.

Other uses of animals

In addition of honey, wax, silk, lac etc. other uses of animals are as follows-

(i) Colour - Tanin and cochinol colours are obtained from dry body of some scaly insects which are present on cactus. These are used in cosmetics.

(ii) Scavenger - Some insects decompose body of dead plants and animals to prevent stink and decay or acts as a scavenger like- Termite, cockroach etc.

(iii) Medicinal use - Cantheridine medicine is obtained from some insects like blister beetles. It is used to **prevent hair fall**. Honey obtained from honey bees is used to cure ulcer. Carminic acid obtained from cochineal insects is used to cure whoopig cough and nerve pain of face and head.

(iv) As a food - Carnivorous humans used frogs, lizards, snakes, fishes etc as a food.

(v) Pollination in plants - Pollinnation process is very essential for fertilization in flowering plants many insects like butterfly, ants, honeybee, fly, wasp etc help in pollination from one flower to another flower.

Important Points

1. The study of economically important plants is known as economic botany.
2. Fundamental needs of human like food, cloth and shelter are fulfilled by plants or their products.
3. Economically important plants are divided into following classes like food related plants, medicinal plants and construction related plants etc.
4. Vegetables are obtained from roots, stem and leaves of some plants.
5. Spices usually obtained from stem and fruits of plants.
6. Medicine is formed from roots of ashvagandha and safed musli.

7. State tree of Rajasthan is khejri and state flower of Rajasthan is Rohida or marwar teak.

8. Human starts to obtain product from domesticcation of animals since ancient time,

9. Sericulture increases the yield of crops as well as nutritions and medicinal value based honey and beewax are obtained.

10. Silk is obtained from rearing of silk worm.

11. Rearing of fishes by making artificial ponds has become a good business, fish culture is now become easier in fresh water.

12. Indigenous and foreign good breeds of buffaloes, cow and goat are domesticated from the point of view of milk production.

13. Deshi or indigenous and foreign breeds of fowl are domesticated to obtain eggs and meat (Chicken).

14. Some indigenous breeds of sheep in north india are domesticated to obtain wool.

Practice questions

Objective type questions

1. Which one of the following is not a cereal-

(a) Wheat (b) Rice

(c) Barley (d) Gram

2. Timber (Wood) is which part of plant

(a) Primary phloem

(b) Secondary phloem

(c) Primary xylem

(d) Secondary xylem

3. Which part of opium is of medicinal value

(a) Root (b) Stem

(c) Flower (d) Fruit

4. State tree of Rajasthan is

(a) *Prosopis cineraria*

(b) *Prosopis chilensis*

(c) *Acacia senegal*

(d) *Tecomella undulata*

5. Vegetable obtained from inflorescence is

(a) Potato (b) Cauliflower

(c) Lady's finger (d) Tomato

6. Honeybee culture is called

(a) Sericulture (b) Silviculture

(c) Apiculture (d) All of the above

7. How many types of bees are present in hive of honeybee

(a) One (b) Two

(c) Three (d) Four

8. Silk is obtained from

(a) Adult insect (b) Pupa

(c) Cocoon (d) Egg

9. Poultry is the main product of

(a) Egg (b) Wool

(c) Milk (d) All the above

Very short type questions

10. Write the name of one cereal sowing as a rabi crop.

11. Write the name of two improved varieties of wheat.

12. Write the name of protein rich pulse.

13. Write the name of two vegetables obtained from root and stem.

14. What is timber.

15. Write the botanical name of two medicinal plants.

16. Which is the state flower of rajasthan.

17. Write the two indigenous good breeds of buffalo.

18. Write the two products of Apiculture.

19. Silk worm is reared on leaves of which plant.

20. Which water is considered as more suitable for fish culture.

21. What is fowl rearing.

22. Write the name of one indigenous good breed of sheep.

Short type questions

23. Write the botanical name of two cereal yielding plants.

24. Write the name of four spice yielding plants.

25. What is wood ? Write the name of one timber yielding plant.

26. Write the name of two plants of medicinal value.

27. Write the name of two oil yielding plants.

28. Why animal husbandry is necessary.

29. Explain the method to obtain silk.

30. Write the name of diseases in fowls.

31. Write the two indigenous breeds of buffalo and cow.

32. Write the name of bees found in hive of honey-bee.

Essay type questions

33. Write an essay on food related plants.

34. Describe the important medicinal plants.

35. Describe the fibre yielding and timber yielding plants.

36. Write an essay on dairy industry.

37. Explain the division of labour in honey bee culture and its importance.

38. Describe the formation of silk from silkworm.

39. Explain the importance of fish culture and poultry.

Answer key

1. (d) 2. (d) 3. (d) 4. (a) 5. (b) 6. (c) 7. (c)
8. (c) 9. (a)

Chapter- 15
Structure of the Earth

The distance of the earth from the sun is about 15 crore kilometers. This distance is also called as the astronomical unit. The earth is constantly in motion. It rotates on its axis in a day, forming day and night. On the part where sunlight falls, there is day and in the part there is night. Earth revolves around the sun in one year. Earth does not stand straight on its axis but it is 23.5 degree inclined. That is why the sun is in the state of uttarayan (Summer solstice) and dakshinayan (Winter solstice) and seasons are formed on earth. These qualities make the earth special from the point of view of life.

15.1 Origin and evolution of earth

Nothing can be said about how exactly the earth has originated. The earth is a member of the solar system, hence it is assumed that it would have originated with the solar system. Tidal hypothesis is currently considered the most reliable. According to it a huge star came near the sun, due to its attraction a lot of matter bulged out of the sun. This bulge was thin at the tips and thick in the middle. Later the star went on its way and the part came out of the sun and broke up to form the planets. If the planets are arranged according in a sequence, cigar like structure is formed having thin heads and middle part thick.

Evidence gathered from various branches of science reveals that the earth was formed about 4.5 billion years ago. Earth's age is about one third of the age of the universe. Initially the earth was very hot. Its rotation speed was also very fast. The outer part of the earth cooled down due to rotation, but it would have been separated by splitting. It took millions of years to cool down. While cooling, the heavy elements went into the depth and the surface was formed by lighter elements. Atmosphere was formed by remaining gases. After the origin of life there have been many changes on Earth. It is also called as the world. Some uncommon names of the earth are land and tera. The earth is the largest solid planet in the solar system in terms of diameter, mass and density.

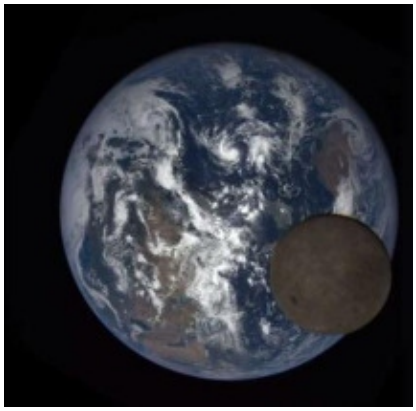


Fig. 15.1 Earth's picture taken from space

15.2 Structure of earth

Since very ancient times man has been keen to know about the structure of the earth . When there were no resources for digging too deep into the earth, man became aware that the texture inside the earth was not exactly the same everywhere after seeing the lava coming out of the volcano . By indirect methods such as study of seismic waves etc. information about more depth is collected.

Immediately after separating from the sun, the earth must have been like a boiling liquid. Even after the formation of the earth for a very long time a major part of the earth was liquid. One of the reasons for this is that the objects of space used to collide with it. 4.40 million years ago moon was formed by the collusion of an object of the size of Mars with earth. Moon is earth's only natural satellite. By its attraction power it produces marine tides, helps the earth bend properly on its axis, slows down the rotation of the earth.

Some rocks formed on earth after cooling were light and some were heavier. Heavy rocks sank deeper

and the rocks made up of lighter elements remained above. The earth's surface was formed by these lighter rocks.

Today we know that the earth's structure is in the form of layers like onions peels. The distance from the surface to the center of the earth is estimated to be around 3900 km. So far it is has not been possible to make a hole deeper than 15 km. into the earth.

It is roughly believed that the earth is made up of three types of layers. The thickness of these layers is demarcated on the basis of either the chemical composition of rocks or the mechanical characteristics.

The upper layer of the earth is a solid layer called crust. It can also be considered as the skin of the earth. Its thickness is not uniform at all the places. Due to this difference at some place the mountains and at some places seas are formed. Earth surface is divided into two parts the hydrosphere and the lithosphere. Most of the part of the lithosphere is formed of soil. The part of the hydrosphere, the lithosphere and the atmosphere where life exists is called as the biosphere. The biosphere has not yet been formed on any planet other than earth. The structure of the earth crust has not been the same from the beginning as it is today. At present 70 percent of the earth surface is covered with water. This normally remains flat. The remaining 30 percent part is land, which has plains, mountains, desert sand valleys at different places.

Pic. 15.2 Internal structure of the earth

For a few million years after the earth's creation the earth's crust was thin and in the form of a unit. With the cooling of the earth, the crust turned into huge rocks. These huge rock segments are called the tectonic plates. The continents are located on these tectonic plates. These tectonic plates are slowly moving away. The speed of movement of these plates is compared with the speed of the growth of our nails. Initially when the tectonic plates were light their speed was fast, now it is slow. 29 tectonic plates have been found on the surface of the earth.

The second layer of the earth is called as mantle. This is the thickest layer. It is normally made up of hot molten rocks. The amount of iron and magnesium in these silicate rocks is more as compared to the earth crust. Bubbles keep rising as in a boiling liquid. In the middle part of the earth the mantle keeps moving up and down. The Earth's central part is called the core. Being the deepest part, it is the hottest part of the earth. The temperature of the core is estimated to be 7000 degree celsius. The reason for the high temperature of the core is, the heat which was left inside during the formation of earth. There are also evidences of the gradual cooling of the core. The core of the earth is divided into two parts. The internal core is believed to be solid and is purely formed of iron. Some scientists have expressed the possibility of having gold and platinum is this part. Outer core has molten, iron and nickel prominently present in it. Scientists believe that the core is not stable but keeps on revolving faster than earth. Core is the most dense part of the earth. Its density is much higher than that of the crust. The cause of the magnetism of the earth is the core. Earth's chemical structure is similar to that of the meteorites. So the earth can also be called a large meteorite.

Table 15.1 Main elements and their quantities found in the earth

S.No.	Name of element	Percentage
1	Iron	34.6
2	Oxygen	29.5
3	Silicon	15.2
4	Magnesium	12.7
5	Nickel	2.4
6	Sulphur	1.9
7	Titanium	0.05
8	Others	3.65

15.3 Energy system of the earth

We live on the surface of the earth. About 70 percent of the surface of the earth is covered with water. Plains, mountains, valleys, deserts are seen on the remaining 30 percent part which is land. There are many evitences which can prove that the surface of the earth was not always the same like the one we are familiar with. Where there is a huge mountain like the Himalayas there was once a sea named Tetheys. Several types of forces work continuously to change the surface of the earth. These powers are called the tectonic powers. Tectonic powers are of two types:-

1. Internal tectonic powers
2. External tectonic powers

15.3.1 Internal tectonic forces

These forces work by staying inside the earth and can not be seen from outside. Their origin is due to the spreading of the rocks by molten, below the surface of the earth and also due to the shifting of the magma. When the internal tectonic forces work vertically to the earth's centre, some part of the surface of earth rises and some others are submerged, thus the continents, islands, plateaus, plains, oceans etc are formed. Sedimentary rocks which are formed inside the seas rise and move towards continents.

Waves are produced when the internal tectonic forces work horizontally. Due to these waves there is a huge upheaval of the rocks found on the earth surface. Folds and cracks are formed on the surface, valleys and mountains are also formed.

15.3.1.1 Volcano

Volcano is the strangest event of the internal tectonic forces. The earth shakes due to the activity happening inside the earth and by breaking the crust the smoke, ash, vapours and gases begin to flow out. Many times the extremely heated rocks melt and flow out in the form of lava. This causes horrific destruction. There is heavy loss of life and property. Due to the flames coming out of the mouth formed on the surface of the earth, they are named Jwalamukhi in hindi. Volcano name in english is named after Volcanic islands. The old volcano present on this island was considered to be the way to the hell by the Romans.

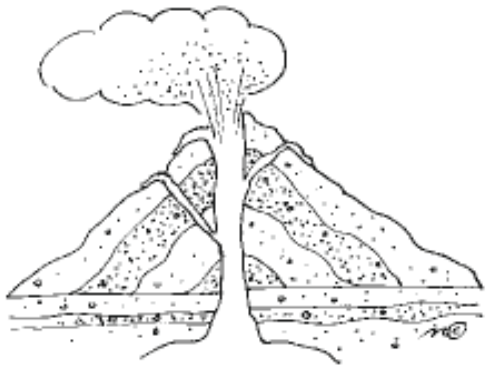


Fig. 15.3 Structure of a Volcano

Volcano is related to earths womb. Due to the pressure, lave rises in the form of a tube and erupts and spreads all over. Some volcanoes are continuously active while some become active after a gap. Many a time active volcano becomes inactive. Volcanoes are found in every part of the world, but generally they are found along a chain of mountains. eg. They are found on the islands on the coastal regions of the Pacific ocean.There are many advantages and disadvantages of volcanoes. Many useful chemical substances like sulphur, boric acid etc, and precious metals come out with the lava. Hot water springs are also formed due to volcanoes.

15.3.1.2 Earthquake

Earthquake is one of the effects of internal tectonic forces. Earthquake means the shaking of earth surface. Any activity inside the earth cause shaking. The point from where the vibrations initiate is called the epicenter. Waves spread in all directions from the centre. The waves moving from the depth when reache the surface of the earth make the surface to move to and from and sometimes up and down. The effect of earthquake depends on its intensity. The intensity of the earthquake is sometimes so less, that the earthquake is not even felt. The intensity of earthquake at any place depends on the intensity of the shaking of the earth's womb and its distance from the epicenter. The earthquake under the water of the sea is called

seaquake or under water earthquake. Earthquake is measured by seismographs. The intensity of an earthquake is expressed on the Richter scale. Earthquakes with a magnitude of 4 are weak, upto 5.5 are strong. Earthquakes above the 6 are considered as destructive and above this are are disastrous.

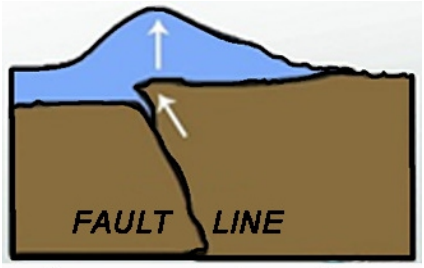


Fig. 15.4 Diagram of earthquakes on the basis of the internal structure of the Earth

The cause for the origin of the earthquakes is the disturbance in the equilibrium in the internal structure of the earth. An imbalance can also occur naturally or due to the pressure of man made water reservoirs or explosions. At present earthquake is interpreted on the basis of plate tectonic theory. We have previously learnt that the surface of the earth is distributed in 29 plates. Among these 6 are main. We also know that these plates move slowly. All tectonic events occur on the edges of these plates. The edges of the plates are of three types creative, destructive and conservative. The destructive earthquakes of greater magnitude come only on the destructive edges. Platonic collisions are believed to be the reasons for the occurrence of earthquakes in Northern India, Tibet and Nepal. Earthquakes also occur in parts where the edges of the plates are not destructive and their occurance is difficult to explain. India is divided into 5 parts according to Earthquake risk. Some parts of Jammu Kashmir, Himachal, Uttarakhand are considered to be the most risky, some parts of Punjab, Haryana and Uttar Pradesh are considered as least risky. It is seen that this division is generally disregarded. Even though Kolkata was the area of minimum risk, there was a terrible earthquake in 1737 in which about 3 lakh people were killed.

15.3.1.3 Tsunami

Tsunami is also one of the destructive events caused by internal tectonic forces. Due to the Tsunami, waves of high energy rise in the sea. These waves cause heavy damage in the coastal areas. Tsunami is a Japanese word which means "seismic sea wave". Earthquakes of more than 7 units at the bottom of the sea, are the main reasons for the occurrence of tsunami. The tsunami moves from the originating center in two directions one towards the deep sea and the other towards the shore. The tsunami which runs towards the shore causes destruction. Debris etc which flows with the tsunami hits very deep inside coastal regions. The buildings, human and animals suffer heavy losses. Earlier there were no good means of giving warming of the tsunami. Now due to the use of various apparatuses its occurrence can be known much earlier. The hazardous areas are now cleared and people can move to safer places, but the immovable properly is damaged. India's National Institute of Oceanography has discovered the submerged harbour in the Dholavira region of Gujarat. Studies say, 1500 years ago the biggest harbour of Harappan civilization was burried in due to some sea storm like Tsunami. 14 to 18 meter wide wall found here is believed to be a textimon, in that period also Indians knew how to deal with the destructive storms like tsunami.

15.3.1.4 Constructive and destructive natural forces

Two types of forces work on the surface of the earth all the time. A group of forces help in creating new land forms like planes, mountains etc. on the ground, but the second group starts destroying the newly formed mountains etc. The forces inside the surface of the earth create new land forms on the surface but the external forces destroy the new forms. As soon as any land part emerges out of water the external erosioned forces start acting on it. Their endeavour is to reduced or erode the the rising structure.

15.3.2 External tectonic forces

Based on the method of work, the external

tectonic forces can be divided into two parts. In the first group there are forces that work only by staying at its place. They have no speed but by initial preparation they help the second group of tectonic powers. First group of external tectonic powers are called weathering forces. Second type of forces which move from its place are called erosional forces.

15.3.2.1 Weathering forces

The weathering forces trie to break the rocks and change them into soil. Sun heat, rain, frost and physically breaks the rocks. During the day time the rock expands by the heat of the sun and during night it contracts by cool it down. By repeated expansion and contraction, the rocks become weak and breaks down. Rain hitting hot rocks also accelerate their this disintegrating speed. Rain water also cuts the rocks. At the time of frost water collected in the cracks of the rocks freezes to form ice and expands. Force generated cracks the rocks. When the dust particles flying with the air collide with the rocks, they wear out the rocks like emery paper. Due to this continuous flow for thousands of years, comprehensive effect of these forces can be seen. The reason for not finding a mountain in the desert is the weathering force of air. The weathering forces reduced the desert mountains and converted them into deserts.

Chemical reactions in nature like oxidation, carbonating, joining of water molecules, mercurialization etc weaken the rocks and helps in their weathering. Biological forces like plants, animals and other organisms also play a major role in weathering. The root of the trees enters the rocks, later grows and breaks the rock. Animals helps in breaking rocks by making burrow in it. Man has proved to be the biggest enemy of the rocks. The force of weathering by human is currently the highest with the help of machines and gun powder. Organism produce out different chemical substances in nature, they are also helping in weathering process.

The forces of weathering has proved to be very useful from the point of agriculture. Soil is very important for agriculture and it is formed by the forces of weathering. Their role in the construction of plains for agriculture is important. Many types of chemicals come out of the rocks due to weathering.

15.3.2.2 Erosion forces

Air, water and snow are three such substances found on the earth which flow from one place to another in large quantities. There is force in their drift. The large structures which come in their way breaks and flow away. Air, water and ice also do erosional work. Their work does not end there but they transports these substances collected from the place of erosion to far distances. Where these substances get deposited and the shape of that surface changes.

15.3.2.3 Power of wind

A cover of different gases is found around the surface of the earth which we call atmosphere. We are alive by with the gases of the atmosphere. Plants also need the gases of the atmosphere for photosynthesis, by which animals get their food.

Fig. 15.5 Effect of flowing air

Besides these important work, erosion is also an important work of the air. The air remains in motion and is not static. The speed of the air provides it, the power of erosion. With an increases in thevelocity of the air, its erosion power also increases and destroys large tracts of land.

To understand the erosional force of air, we have to understand what runs the air? When we turn on the fan due to the rotation on of the fan the air gets pushed and starts rotating. We know that energy is required to perform any work. Fan gets its energy from electricity to rotate. The arrangement of the air flowing in nature is somewhat complicated in comparison to the air flowing in a room.

The only source that gives, the energy needed to do any work in nature is the sun. You know that the sun is a star, due to the nuclear reaction in it, enormous amount of energy dissipates in all directions. A small part of this energy also reaches the earth. This small part of solar energy is enough to carry out all the activities on the earth. The energy of sun does not reach in the same amountn to every part of the earth and in the all the months of the year. Due to this imbalance of the energy the air is less warm at some places and more warm at other places. Air expands after getting heated and rises up due to being lighter. Air pressure at that place becomes low. In this case the air start flowing from area of high pressure to the area of low pressure. Flowing air is called wind. The speed of the wind depends on the difference between the air pressures at both places. The greater the difference, the higher is the velocity of the wind. On many places on earth the difference in air pressure remains uniform throughout the year, for this reason the wind blows in the same direction with same speed throughout the year. In ancient times, wind were used to sail ships in the direction of the wind.

The direction of some winds on land is not always the same. Their direction changes according to the season, because of this they are called as Monsoon. For 6 months in summer the wind blows from the ocean to the land and becomes the cause of summer monsoon. In winter for 2 months the wind moves from the land to the oceans and becomes the cause of winter monsoon. In India the south-west monsoon brings on rain everywhere. Water is available for the full year due to the monsoon rain. Monsoon rains are affected by many elements. For this reason the rainfall is scarce at some places and abundant at other places. Floods occur when there is more rain at one place in comparison to the availability of storage or drainage. The flowing water destroys everything coming in its way. There is a lot of economic loss due to floods.

Irregular winds

Many a time winds with irregular speed arise. The cyclone is a prime example of the variable winds. In the cyclone the winds do not move straight it moves towards the central point in a circular path. Cyclonic winds arise due to the low air pressure at the center. The area of a cyclone ranges from 400 km to 3000 km. The extension of cyclones and the speed of air is more in the temperate zone as compared to the tropical zone.

Due to cyclone the weather of that an area changes completely. In the month of May the Monsoons arrive. With strong winds there is heavy rainfall. The heavy thunder of clouds and lightening generates a feeling of fear. Trees are uprooted and roofs of houses fly away. Normal life is interrupted due to power failure. After a few days the situation becomes quite normal. Powerful storms also arise due to the formation of pressure difference at local level, . These storms cause great destruction in that particular area.

15.3.2.4 Hydropower

You must have seen the power of running water in the form a river. River originates from mountains and ends up in a lake or in sea, it constructs many land forms like valley or delta. The importance of the river depends on the water flowing in it. Some rivers flow only during rain and some keep flowing for twelve months. River holds an important place in the development of human civilization. Vedic civilization developed on the banks of such a river called the Saraswati. Later on after the change in the rout of Saraswati rivers flow, the people had to settle in other places. Efforts are on to find the Saraswati river again. Everyone knows about the importance of the ever flowing rivers like Ganga, Yamuna and Chambal. Water and fertile soil obtained from these help millions of people to live. To emphasize the importance of river, it is called mother. When the rivers get more water we have to face its destructive power.

Glaciers

There is no rain in cold areas. Water freezes and rains in the form of snowflakes. This event is called as snowfall. Conditions of snowfall on high mountains like Himalayas or polar regions continues. Thus a thick

layers of snow or ice accumulates in these areas. Later due to the gravitation force the entire layer of the ice starts moving downwards. The moving layers of ice is called a glacier or a snow river. Due to the slow speed of the snow river its impact cannot be seen immediately as seen in the case of a river. But the long term effects are seen very much. Due to the huge size of the glacier, their power too is very high. They grinds the rock that obstruct their path like flour. Ganga and Yamuna are the rivers which originate from the glaciers. Now a days the average temperature of the world is increasing. It is called global warming. Due to global warming less snow is forming and more snow is melting. Because of this the glaciers started shrinking in size. The sea level is rising due to the glacier have water flowing into it. Many cities situated at the sea shores are gradually submerging into the water. The Dwarka city of India has submerged in water several times in ancient times and every time a new dwarka has been created. Old drawkas have been discovered inside the water.

Oceanic Currents

Most of the water is contained in the oceans. Because of its huge size the sea always looks the same. Floods or drought like situations rivers are not seen in sea. Thats why the sea is called calm. By looking deep the power of sea can be seen. Due to the influence of the air you must have seen sea water rising up and down in the form of waves. Sea waves becomes fatal when earthquakes or a volcano burst or a storm occurs.

The second form of the power in sea water is seen in the ocean currents. Oceanic currents can also be called a river flowing in the sea. In this, the water flows continuously in a certain direction. In some oceanic currents warm water flows while in some the cold water. The reason for the flow of the oceanic current is not due to the slope but because of the difference in the inter temperature density. These currents have a great effect on human life. The hot streams makes the area hot and the cold streams makes the area cold. Winds that pass through the hot streams takes away lot of moisture with it, which is the reason for rainfall in high altitudes. In the places where the hot and the cold streams meet, temperature variation is created, which gives birth to storms like hurricane and typhoon. These currents affects the operation of the ships and the life of sea organisms.

In the form of tides too much power is propagated by the sea water. Tide is formed when the sun and the moon are in straight line. If this happens the gravitational force on the sea waterincreases. Due to its stretch tides are generated.

We have seen that various powers keep this trend alive while working continuously. Today humans have learned a lot about the causes for these forces being generated. By continuously keeping an eye on these, he started predicting the storms, rains etc. When humans started an attempt to understand the nature, he must have become impressed on seeing the effects of the natural powers. Human did not have the knowledge of the reason behind the natural powers.

You know that science is all about finding solutions and answers of the questions. Initially humans did not have the means to do research and to find solutions to the questions. Thus the imagination powers were used to find solution to the questions. Just like a child when he asks his father who runs the air, the father would have given the name of wind God (Varun) to calm the child's curiosity. Similarly in other parts of the world, other Gods and demons were created. After the birth of a character many of his stories were also formed. Even today these stories are enjoyed around the world. There are some scientific information in these stories too. In the story of the child Dhruva, there is a scientific fact that the pole star remains stable at its place. Even today we have not understood how without any means, in that period, people came to know that the pole star remains still.

Important Points

1. Evidences gathered by many branches of science shows that the earth was born about 4.5 billion years ago by solar nebula.
2. Immediately after separation from the sun the

earth would have been like a sphere made up of boiling fluid. After the creation of earth, for a long period most of its part was liquid.

3. The structure of the earth is in the form of layers like that of onion peels. The distance from the surface to the center of the earth is estimated to be around 3900 kilometers.
4. The upper layer of the earth or earth's crust is a solid layer it can also be considered as the skin of the earth. The thickness of earth crust is not same at all places. After the cooling down of the earth the earth crust turned into huge rock clusters. The huge rock clusters are called the tectonic plates.
5. The second layer of earth is called the mantle. It is the thickest layer. It is formed of hot molten rocks.
6. The central part of the earth, the core is the hottest part. Its temperature is estimated to be 7000 degree centigrade. The earth's core is divided into two parts. ? The internal core is solid and is made up of pure iron.
7. Around 70 percent part of the earth surface is covered with water. On there 30 percent land area, mountains, plains, plateau, valleys, deserts etc are seen. There are many evidences by which can say that the way we are familiar with the surface of the earth it was not always the same.
8. Several types of forces work continuously to change the surface of the earth, these forces are called as tectonic forces. Tectonic forces are of two types, internal tectonic forces and external tectonic forces.
9. The internal tectonic forces originate due to the heat present in the depth below the surface of the earth, spreading of rocks and due to the transfer of the hot fluid, the magma.
10. The earth shakes due to the bustle inside it and by cracking the crust the smoke, ash, vapors and gases begin to flow out. Many a times the extremely heated rocks melts and flows out in the form of lava. This is called a volcano.
11. Meaning of the word earthquake is the shaking of the earth surface. The cause of the vibration is any bustling inside the earth. At present, earthquake is described on the basis of plate tectonic theory.
12. Due to tsunami waves with high energy rises in the sea. These waves cause heavy damage in coastal areas. Tsunami is a Japanese word which means seismic sea wave.
13. Two types of powers work on the surface of the earth all the time. A group of power helps in creating new forms like mountains etc on the ground, but the second group starts destroying the new formed mountain etc.
14. First group of external tectonic powers is called as weathering forces. The second type of powers that is the powers which work with speed are called erosion forces.
15. Sun's heat, rain, frost, and air physically breaks the rocks. Chemical reaction in nature like oxidation, carbonating, joining of water molecules, mercurialization etc weakens the rocks and helps in their weathering.
16. Air, water and ice are three such substances found on earth, which flows from one place to another in huge quantity. There is excessive power in their drift. The large structures which comes in their way breaks and flows away.
17. Air flows from the region of high pressure to the region of low pressure. Blowing air is called as wind. The direction of wind on land is not always the same. Their direction changes according to the season. At the time of cyclone the winds do not go straight but moves towards the central point in a circular path. This happens due to the reduced air pressure at the centre.
18. The importance of river depends on the water flowing in it. Rivers hold an important place in the development of human civilization. Due to the gravitational forces the entire layer of ice starts

moving downwards, this is called glacier.

19. Oceanic currents can also be called as a river flowing in the sea. In this water flows continuously in a certain direction. In some oceanic currents warm water flows and in some cold water.

20. In the form of tides too much power is generated in the sea water. Tide is formed when the sun and the moon are in a straight line. Due to the increase in the gravitation force on the sea water, the tides form.

Practice questions

Objective type questions

1. Which one is not the name of the earth-

   (a) Bhoomi (b) Gaiy

   (c) Bhanu (d) Tera

2. At present how much part of the earth surface is covered with water-

   (a) 70 percent (b) 30 percent

   (c) 50 percent (d) Uncertain

3. The most abundant element found in Earth-

   (a) Silicon (b) Gold

   (c) Oxygen (d) Iron

4. Where was the largest harbor of Harappan civilization was found-

   (a) Dwarka (b) Dhoulavera

   (c) Surat (d) Karnawati

5. What is reason for the occurrence of tides-

   (a) Sun (b) Moon

   (c) both

   (d) Sun and moon being in a straight line

Very short type questions

6. What is the reason for sun being in the state of Uttarayan- dakshinayan?

7. What is the unit of measuring an Earthquake?

8. Where are tectonic plates found?

9. What is the reason for tsunami?

10. Which types of winds arise due to the decreasing air pressure in the centre?

Short type questions

11. What will be the condition of a place after an earthquake of the magnitude of 7 on richer scale had hit?

12. What are oceanic currents?

13. What are the advantages of weathering forces in agriculture?

14. Write down four causes which helps in weathering?

15. How the moon was born?

Essay type questions

16. Explain the internal structure of the earth. Also draw a well labelled diagram?

17. What do you mean by the earths internal tectonic powers? Describe any two?

18. What erosion? Explain the importance of the two types of erosion powers on human life?

Answer key

1. (c) 2. (a) 3. (d)
4. (b) 5. (d)

Chapter - 16
Universe and Organic Evolution

16.1 Origin of the Universe

The ancient belief about the origin of the universe is that the universe as it appears presently, it has always been the same. In this hypothesis, the earth was considered to be the center of the universe. After Copernicus proved that the Earth is not the center of universe, this concept became popular. In 1917, scientist Albert Einstein re-established the concept of stable Universe

Figure 16.1 The Landscape of the Universe as observed through the Hubble Telescope

On looking upward, the infinite sky is visible. Due to the bright sun shine during the day time things other than the sun and sometimes the moon are not visible in the sky. In the night or after the sun set, some planets, innumerable stars and other bodies appear in the sky. This whole assembly is called the **Universe**. The study related to the Universe is called **Cosmology**. Our earth is a very small section of this infinite Universe. Is our Universe the only one or more such universes exist is a question on which scientists do not have one opinion.

16.2 Indian cosmology

In Indian culture, the thinking about the creation of the universe started from the Vedic times. From the past few years scientists have started to address the question of the origin of the universe. However Indian sages have started this work from ancient times. The evolution of the universe has been discussed in detail in the **'Nasadiya Sukta'** of Rigveda. Describing the situation before the origin of the universe, it has been said- *NASDASINNO SADASITTDANI NASIDRAJO NO VYOMA PRO YATAH A KIMAVRIVH KUH KASYA SARMNNMBHA KIMASIDAH GAHANAH GAMBHI RAM AA*

Rigveda: 10 - 126

Pandit Jawaharlal Nehru also mentioned these Suktas of Rigveda in his book **'Discovery of India'.** The German scholar Max Müller called these Suktas **'the song of Genesis'**. Hindi translation of these Suktas was used as the title song of the television serial **'Bharat Ek Khoj'**

SRISTI SE PAHLE SAT NAHI THA / ASAT BHI NAHI, / ANTRIKSH BHI NAHI / AAKASH BHI NAHI THA / CHIPA THA KYA ? / KISNE DHAKA THA ? / US PAL TO / AGAM ATAL JAL BHI KAHAN THA ?

Fig. 16.2 Swami Vivakanand

(Meaning: There was no truth before the creation, nor were even lie/not even space / nor was sky / what was hidden? / where? / who covered it? / in that moment / where was the abyssal (deep) water also?).

Explaining the Vedic knowledge and intellect, Swami Vivekananda once said that consciousnesses has created the Universe by multiplication of consciournesses. Various types of creatures and

objects are visible in the world but they are basically the same form of that one consciousness. This belief is called "**Advaita**". Swami Vivekananda said that answer to the question of the origin and development of the Universe has been given many times and will be given many times more in the future also but with every effort the belief of "Advaitism"would become strengthened.

As we look around the Universe, we find that everything starts with a seed. During its development, it grows and reaches its peak and in the end destroys by getting converted into a seed. The bird starts its life from an egg and its existence depends upon the egg. The cycle of egg and bird is repeated many times. This is the principle rule of the whole nature. It can be said that the Universe and atoms both are created in the same way. There is a cause behind every work. Because of being micro this cause is not visible to us. Maharishi Kapil has said *'NASHAH KARNALAYA'* that is someone's destruction means its mingling with its own cause and roots. On his death, a person meets with his "Panchabhuts". The Chemistry and Physics has confirmed this.

The seed is made from a tree, but the seeds cannot become a tree immediately. Seeds have to wait for some time in the ground to prepare themselves. Similarly, the universe also functions in a necessary abstruse micro form for some time. This is the situation before the catastrophe or creation. The term of being present in the subtle form for some time and its reappearance in the world is called a **kalpa**. Many such kalpas are running the Universe. All the objects, from the entire Universe to the atoms coming under it keep moving in a floating manner.

Sristi constructivism (design theory) is similar to the above mentioned Indian thought. Swami Vivekananda agrees with the materialists that wisdom is the ultimate development of the cosmos. Nowadays, we apparently feel wisdom as human intelligence. This does not mean that the origin of wisdom has begun just now. Intellect has always been present in hidden cryptic form. A fully developed human marks the end of the nature/ creation. The omnipresent intellect which is exhibiting in the universe is named as **God**. Scientific sources that are present today were not present during the Vedic period. It was a great thing to imagine about the creation of the universe at that time. These days many Nobel laureates have supported the ideas described in the Vedas.

16.3 Theories

16.3.1 Theory of Biocentrism

In the 20th century, many famous scientists came to the conclusion that creation and operation of the universe cannot be explained merely on the basis of physical rules. They thought that the whole world was one unit. The entire universe was made up of one substance that was born during the Great Blast. The knowledge or consciousness of our being has originated from that substance only. A group of scientists has begun to accept that all the things in the world are different but they are actually related to each other. Our existence is like a drop in the Ocean like Param Brahma.

While clarifying this point, Nobel laureate Physicist Robert Lanza along with Astronomer Bob Berman proposed the theory of Biocentrism in 2007. According to this principle, the existence of this world is due to life. Putting it simply, the world has originated for the creation and development of life. Therefore, consciousness can be the true path to understand the aspects of nature. Without consciousness, world cannot be imagined.

The principles of philosophy to physics have been included in the concept of Biocentrism.The Man's independent will power cannot be explained by the principles of certainty and uncertainty. Assuming the physical nature of the world as definitive, the pre-supposition of each event is possible and assuming it uncertain, nothing can be pre declared. The organisms in the world independently exhibit certain and uncertain desires. It can be understood only by biocentrism.

Most materialists believed that the Lanza's thoughts are influenced by ancient mystical ideas and hence did not give any attention to them. Later on, in

the light of modern scientific facts, many other scientists attempted to explain the concept of Biocentricity. They presented the facts on the basis of the Relational Quantum Mechanics in a firm manner. This is the reason that even after many criticism; Biocentricity theory still remains a matter of discussion and conjecture.

According to Biocentrism, there is no physical existence of Einstein's place and time concept, but all of these are the senses of human consciousness. Lanza believes that only by keeping the consciousness in the center, many of the absurd puzzles of physics, such as the Heisenberg's uncertainty principle, the double Zirry experiment, micro-balance constant of various forces and the harmony of various laws with the living world can be understood. Since the time of Einstein, scientists have been trying to bring the complete physics together in the form of Unified Field Theory, but success has not yet been achieved. Robert Lanza says that many such problems can be solved only by keeping life in the center.

The supporters of Biocentrism opine that every event of nature seems to have occurred in human interest. Meteorites that occurred billions of years ago on the earth are also believed to occur for the betterment of humanity as they resulted in the destruction of the dinosaurs on the earth. This resulted in growth of mammals at a rapid pace.If the meteor would have been slightly larger in size or if they would have entered the earth's atmosphere at a different angle, then the whole life could have been destroyed. The meteorite was not a mere accident rather it was a pre-planned event of the nature.

Physicists like Wheeler said that the present exclusively represents the past, but then too it has to be believed that the development is pre-planned. The theory of Biocentrism does not accept Darwin's evolutionism theory. According to the principle of Biocentrism, life cannot be the result of any accident of physics and chemistry, as evolutionists think. Darwin's explanation of biological development on the basis of fortuitous incidences is fine for explaing the concept to the kids, but in fact the matter is not that simple. Without a self-sustained plan, biological evolution cannot be explained properly.

16.3.2 Big Bang theory

The current and most recognized concept regarding the origin of the universe is **Big Bang**. Modified concept of Big Bang theory has succeeded in explaining various stages of the development of the universe from its origion. It is believed in this concept that universe originated 13.8 billion years ago by the great explosion in a very intense and extremely hot body. After explosion in this object, its parts spread far and wide likewise the parts of the universe are still spreading and moving away from each other. Science has gathered many evidences in the favor of the Big Bang concept. Excessive presence of lightweight elements in the universe, the presence of micro radiations in the space, the presence of giant structures and the success in understanding the Hubble's law are some evidences of this success.

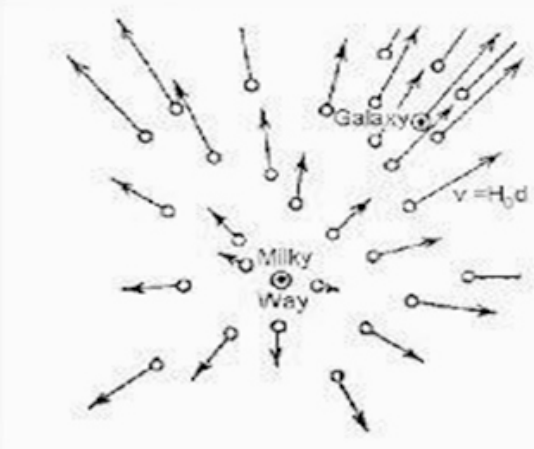


Figure 16.3 Outline depicting the Big Bang theory

Importance of this concept is that it does not neglect any known rules of physics.

As the universe cooled down after the great explosion, it caused the evolution of sub-atomic particles. Sub-atomic particles later converted into simple atoms. From the atoms, giant clouds of the primary elements, hydrogen, helium and lithium were formed. Due to the force of gravity, the giant clouds

condensed and gave birth to stars and galaxies. Later, the origin of heavy elements from the primary elements is presumed to have taken place in stars or supernovas.

Measuring red displacement of supernovas has revealed the fact that the speed of the expansion of universe is increasing continuously. One opinion about how the universe will end has yet not been framed. There is an idea that it will continue to spread and ultimately will get frozen. Recent information about the presence of large amount of grey matter and dark energy in the universe was accepted. The role of grey matter in the universe is still not known.

A group of materialists under the leadership of Stephen Hawkins did not accept the existence of consciousness. These scientists are confident that in the coming times all the secrets of creation will be known with the help of materialistic means only. While the second group of scientists believes that the entirely of creation/ nature cannot be known without accepting the role of consciousness. Till now, no one knows what is the truth? Efforts to know the secret of the creation of the universe continues till this day. Scientists have discovered weightless particles in the ECNR (European Council for Nuclear Research) laboratory located in Geneva. This has raised a possibility for a likely change in the thinking of physics.Remembering the words of Swami Vivekananda, science in all places is moving towards accepting the existence of weightless consciousness. While discussing the Higgs boson particles, physicist Vijay Kumar Pandey writes that physics brings the unknown to the periphery of known but the secret of creation lies in the expanse of the agnosticism, not in the periphery of the unknown. God can be found not only by scientific research but also through cognitive self-realization.

Naturalist theories for the creation of nature have been given in India also. In Jainism it is believed that creation can never ever be destroyed. According to Jain philosophy, the compounds have always existed and will always remain. These compounds are controlled by the laws of nature and are running through their own energy processes. According to Jain philosophy, the compounds are eternal. God or any other power did not make them.

Paul Steinhardt of Princeton University presented the **Ekpyrotic model** for the origin of universe. This theory proposes that our current universe arose from a collision of two three dimensional worlds in a space with an extra fourth spatial dimension. This theory also believes in the spread of the universe but it is different from the spread of Big Bang. The universe is believed to spread like a rubber membrane. The structures of the universe are moving away from each other, but there is no central point of increasing distance.

16.3.3 Physical theories for the origin of life

On the basis of their observations, philosophers such as Aristotle attempted to explain the origin of organisms with inanimate substances. According to this belief, living things have originated from inanimate things like frog from mud, flies from rotted meat etc.

The credit to reject the role of God in the genesis of organisms and analyze the origin of the organism according to the law of nature goes to Charles Darwin. Russian scientist Alexander Oparin, in 1924, gave a theory named '**origin of the life**' regarding the origin of living organisms from the nonliving. Oparin said that Louis Pasteur's statement is perfectly true that the origin of the one organism occurs from the other organism but this principle does not apply to the first organism. The first creature would have originated from inanimate substances only. Oparin said that there is no fundamental difference between living and nonliving. Life has developed from the complex combination of chemical substances. The presence of methane on various celestial bodies is a sign of the fact that the atmosphere of early earth due to the presence of methane, ammonia, hydrogen and water vapor was extremely reducing. The complex compounds made by the combination of these elements have combined further and created more complex compounds. Different configurations of these complex compounds have laid the foundation of life. Once started, these biological symptoms would have moved ahead on the path of competition and struggle and ultimately created

the present animated world.

In 1929, J.B.S. Haldane expanded the views of Oparin. Haldane divided the events from the origin of the earth to the formation of nucleated cells in eight stages. Haldane said that after separation from the Sun, the Earth gradually cooled down and a variety of elements developed on it. Heavy elements went towards the center of the Earth and the hydrogen, nitrogen, oxygen and argon made the initial atmosphere. These atmospheric elements through mutual interactions resulted in the formation of ammonia and water vapor. These processes consumed all the oxygen and created a reducing environment.Due to the effect of sunlight and thundering, a series of chemical reactions continued for a long period and resulted in the formation of amino acids, sugars, glycerol and many other types of compounds. The dissolution of these compounds in water resulted in the formation earth's primordial hot soup. There were no experimental evidences for the assumptions of Oparin and Haldane. In 1953, Stanley Miller supported the ideas of Oparin and Haldane by publishing the "**possible production of amino acids in the early stages of the Earth**". Miller created an electric discharge device for experimentation. This device had a round bottom flask, an electric immersion bulb and a condenser. After filling water in the round bottom flask, air was evacuated from the system and the device was filled with methane, ammonia and hydrogen in the ratio of 2: 1: 2.

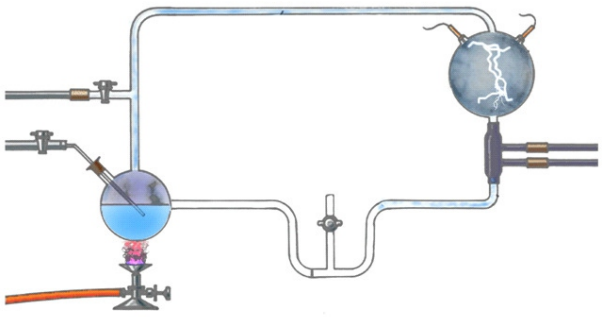


Figure 16.4 Apparatus used by Miller for the formation of biomolecules.

Using electrical discharges, water was boiled and the steam so produced caused the rotation of gases in a continuous circle. After condensation, the water vapor released from the electric discharge bulb could be collected for analysis. Miller analyzed the condensed fluid obtained after one week continued electrical discharges. Fluid analyses revealed the presence of various types of organic compounds like amino acids, acetic acid etc.

16.3.4 Spiritual theories for the origin of life

Life is not just a group of molecules. With the ever increasing knowledge about life, it is becoming even more difficult to explain the origin of the first creature. The idea of Oparin and Halden, which was established a long time ago experienced a setback when many young scientists refused to believe that the first creature born in the primordial soup was able to fulfill its energy needs through anaerobic respiration. They said that the Oparin and Halden's ideas do not conform to the principles of bio-physics and thermodynamics.

Current life is fully based on DNA. The information stored in the DNA is transported outside the nucleus into the cytoplasm by the RNA. As per the information received from the DNA, ribosomes present in the cytoplasm synthesize the proteins (enzymes). All reactions of life are directed by the catalytic functions of the enzymes. All kinds of synthesis takes place in the cell. Many types of proteins (enzymes) functions for the synthesis of DNA. So it is natural to raise this question that during the development of life, DNA came first or the proteins? It is quite possible that DNA was not there in the initial stages of life. RNA along with its functions might have played the role of DNA and proteins. Looking to the complexity of life, many scientists believe that several metabolic cycles have developed independently before the birth of life. As per the individual requirements, these metabolic cycles were utilized by various living beings.

New researches have brought a strategic shift in the study of the history of the origin of the first organism. Now, it has been revealed that the initial atmosphere was dominated by the oxygen containing gases such

as carbon dioxide, sulfur dioxide, water vapor etc. If this idea is accepted, then the previous theories of the origin of the first organism which were established by keeping in mind the reductive nature of the atmosphere have to be abandoned.

The first organism was not born on earth, rather came from a heavenly body in the form of subtle spores. The hypothesis of living beings coming from some outside place is very old. Lord Kelvin, Von Helmholtz etc. have given this theory in the nineteenth century. In the twentieth century Fred Hoyle, Wikramasinghe, Jayant Vishnu Narlikar etc. presented the same idea with new facts but this idea did not gain much attention as compared to the primordial soup hypothesis

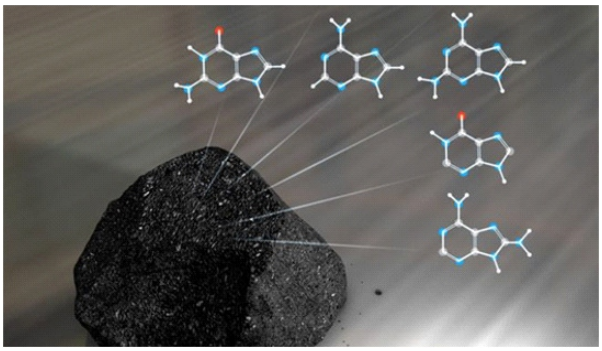


Figure 16.5 Discovery of biological molecules in Meteorites

Now the conditions have changed. After the development of new tools of research, some new facts have come to light, on the basis of which the scientists now firmly believe that the origin of the first organism was not on the earth. The micro-fossils obtained from the rocks of Hadean period have shown that the photosynthetic life on the Earth existed about 4 billion years ago. If this is the fact, then the matter of the origin of life on earth by chemical processes in just 58 million years cannot be considered as true. In this way, the only option left is - life on earth has come from some outside place.

Scientists believed that during the Hadean era life on Earth showered in the form of subtle spores. On Mars, life reached almost at the same time. Today, there are strong evidences that subtle particles can emerge from the atmosphere of one planet and after successful completion of the long and difficult journey of space, can descend on another planet. The scientists believe that the life has not originated only once rather it has originated many times at different places. Life after origin has spread in every direction.

Multi-directional efforts have been made from a long time to know the existence of life in the space.Information is being gathered by sending the spacecraft's to the solar system and beyond it. More information is being assembled by installing huge telescopes on the earth and in the space. The existence of Aliens is being discovered in the meteors that fall on the Earth. During the studies of meteors, presence of some acids like citric acid and its compounds that function in the cellular metabolic pathways have been found. Various ideas have been put forward about the origin of life on the Earth but no consensus has yet been made in the favour of any one.

Earth's atmosphere has proved very favorable for life. Life has taken different shapes so as to adapt itself in a variety of environmental conditions prevailing in different parts of the earth. A group of organisms capable of maintaining its nature/ characters over generations is called a **species**. Approximately 3 lakh species of flora, 12 lakh animals and about 10 lakh species of micro-organisms have been found. Along with the formation of new species, some species have been extinct. Like the species of dinosaur and dodo birds. The increased pollution and population has resulted in the loss of habitats which in turn has resulted in a sharp decline in number of members of many species. Domestic birds like sparrow etc. are facing the risk of extinction.

16.4 Fossils - origin and types

We know that the living organism have originated on the Earth billions of years ago. Since then life has evolved in various forms. Among these, many forms of life such as Dinosaurs have disappeared.The only source of information about the extinct organisms is

their remnants. The symbols/ remnants/ impressions or traces of ancient organisms are called as fossils. **Fossils** are made by the burial of organisms/ substances in the soil or other substances millions of years ago. The fossils of an elephant like organism buried in the ice were found in such a highly protected form that it seems as if this creature has died recently (but not billions of years ago).

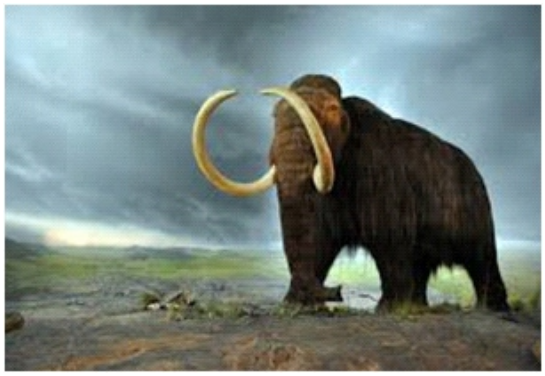


Figure 16.6 The Elephant like organism Hairy Mammoth which was found in the ancient times

Fossils buried in substances like amber or lac are also good enough. Sometimes the body of the buried organism is destroyed gradually, but it remains preserved in the form of an impression embedded in rock\mud. After seeing the fossils of Archaeopteryx, which were found in the form of an impression, it was discovered that birds originated from creeping

Figure 16.7 Fossil of *Archaeopteryx*

organisms. The soft parts of dead organisms get destroyed by decomposition but the harder parts like bones etc get pressed and preserved safely. From such fossils we have came to know that today's horse has evolved due to time to time changes accumulated in a fox-like organism.

Sometimes organic molecules in the body of the organisms are destroyed and their place is occupied by the inorganic molecules. As a result, in place of the organism, its stony idol gets prepared whose inner and outer conformations are similar to that organism. Fossils of many plants have been obtained in this form only. Indian scientist Birbal Sahni made a detailed study of fossils and assembled a lot of information for the world of science. Few organs in the body of the some organisms have no use. These are called vestigial organs. For example, there is no use of wisdom teeth and vermiform appendix (which is found connected with large intestine) in the present human body. The age of fossils can be calculated in two ways. The fossils obtained by deeper excavation are older. The age of fossil can also be calculated from radiocarbon dating. It is said that fossils narrate us the story of the old world, but this story is somewhat incomplete because the fossil of every organism is not available.

16.5 Organic evolution

From the ancient times, presence of various organisms found in the world has raised many questions in the mind of the man, but in the absence of any suitable answer, man satisfied himself by putting every responsibility regarding the creation of every thing on the God. After knowing that organisms found today are not the same as were present millions of years ago and many species found in the past are not present on today's earth, it was assumed that the successive evolution of the organisms has taken place.

The credit for explaining the biological evolution with logic goes to Charles Darwin, who in 1859 wrote a book "**The origin of Species**" based upon the development of species and shocked the old beliefs. Darwin through embryonic science (developmental

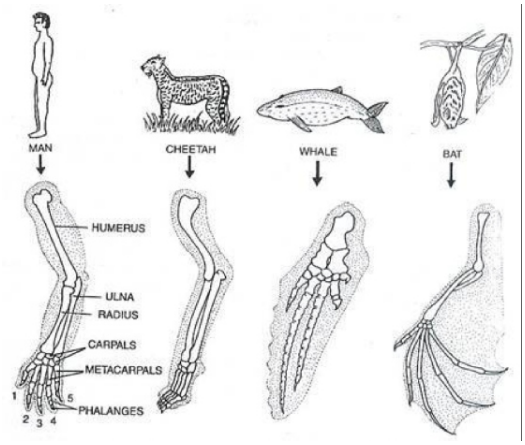


Figure 16.8 The basic structure of human hand, front leg of cheetah, fins of fishes and feathers of bats are the same.

biology), morphology, classification, functioning, somatology, fossils, different comparative studies and many other areas presented irrefutable evidences in the favour of evolutionism.

Figure 16.8 is showing that humans, cheetah, fish and bats are fairly different from each other, but the fundamental structure of human hand, cheetah's forehead, fins of fishes and wings of bats are the same. It is a proof of the fact that all these living creatures have originated from the same ancestors. The body of all the multicellular organisms is composed of eukaryotic cells. Enzyme trypsin, which digests proteins is functional in all i.e.from a unicellular organism to humans. The DNA that regulates the characteristics of all organisms works similarly in every organism. All these things confirm biological evolution. After studying the comprehensive classification of organisms, it seems that there has been a gradual development of multicellular organisms from unicellular organisms. The botanical studies have also provided evidences of biological evolution. The religious believes also provides the signs of biological evolution. In India, it has been said that after undertaking 84 lakh births ('yonies'), one gets human birth. This comment might have been made by viewing the development of human embryo from a cell.

16.5.1 Process of organic evolution

After obtaining the evidence of biological evolution, it was natural to raise the question that what was the process of biological evolution? Considering the qualities acquired by more use of some organs and comparatively less use of others as an inherited quality, Lamarck tried to explain the emergence of the new species. He told that some animals like lizard used crawling motion neglecting their arms and in the long run arms disappeared. This resulted in the origin of snakes. In the same way, Lamarck explained the development of Giraffe and Duck. Vismen cut the tail of the rats many generations and observed the tail length in progeny rats. He found full length tail even after 10 generations. Vismen said that the acquired qualities are not inherited.

Charles Darwin explained the origin of species through natural selection. Darwin said that the organisms of each species are produced in large numbers. No two organisms are alike. When organisms are present in high numbers, they engage themselves in struggle for food, space and others. During struggle only that organism which is best suited in nature produced large number of offsprings and produces new species. At that time the Mendelian laws of Inheritance were not known. Darwin could not explain the reasons behind the variations found among the organisms. People could not understand the formation of new species by accumulation of slight variations found in the members of same family or species.

In 1901, Hugo de Vries, a Dutch Botanist saw a new type of Primrose plant in between the group of Primrose plants growing in the garden. After further study, deVries said that the sudden big changes in organisms result in the origin of new species. de Vries named such changes as **mutations**. Today, we know that the properties of organisms are controlled by the DNA found in their cells. These properties are decoded by a chain of four nitrogenous bases *viz* Adenine, Guanine, Cytosine and Thymine which are represented by four letters A, G, C and T respectively. Any change in the sequence of nucleotides cause alterations in the characters of the organisms.

By combining de Vries mutations with the Darwinism, Neo-Darwinism theory was put forward. The Neo-Darwinism was accepted as a "true" reason for the creation of species. As you know that nothing in science is true. The evolutionary biologist Lynn Margulis, in 1995, disproved the Darwin's evolutionism and said that the road to evolution in nature has marched through mutual cooperation but not through competition. Margulis said that as per evolutionists, the history of animals begins from last 50 million years, whereas life on earth came into existence long before it. Fossils with an age of more than 400 million years have been reported. Darwinists did not consider those fossils because their thoughts are not supported by them. While Darwin told that the monkeys are ancestors of human beings, Margulis declared that bacteria are ancestors of all including monkeys. These days concept has changed. It is now believed that humans have more bacterial cells than human cells. The health of a person depends on the bacteria present in its body. To stay healthy, Indian thinking of proper food habits has become stronger.

16.6 Origin of species

Earth's atmosphere has proved very favorable for life. Life, in order to adapt itself as per the environmental variations found in different parts of the earth, has taken different shapes. A group of organisms capable of maintaining their characters over generations is called a species. Approximately, 3 lakh species of flora, 12 lakh animals and about 10 lakh species of micro-organisms are found. According to Neo-Darwinism, the development of species depends upon variations generated in organisms and the struggle associated with life. According to this theory, few long-necked Giraffe would have suddenly originated among the Giraffe's of ordinary neck length. Due to its long neck, the new giraffe could eat more food than the older ones, which is why it produced more healthy offsprings in large numbers. In the long run, the present species of Giraffe originated from the offsprings of the long necked Giraffe.

Margulis raised the question that how do such beneficial mutations caused by natural selection occur in the organisms? Margulis said that biological evolution cannot be explained by examples of animals. By explaining biological evolution with the examples of animals, we miss the three billion years history of life on Earth. The bacteria through mutual cooperation have given rise to the entire living world. The question about the process of evolution/ development of a species is still unanswered. You can also think something new about this subject.

Along with the formation of new species, some species got extinct. Like the species of dinosaur and dodo birds. The increased pollution and population has resulted in the loss of habitats which in turn resulted in decline in the number of members of many species. Domestic birds like sparrow etc. are facing the risk of extinction.

16.7 Phylogeny

The living organism seems different in appearance, but the basic structure and functioning of all the organisms found on earth is the same. According to the Margulis, bacteria with mutual cooperation have given birth to the entire animated world. Life has originated only once and all the other forms of life are created from this. All the species are dependent on each other. The effect of the loss of one species can be observed on others. As a theory, the American organization NASA has also started to believe that the whole earth is working together as an organism. Therefore, from the micro-organisms to the human beings, one should consider each and every thing as one unit.

Each species found on earth has developed from pre-existing species or accumulation of variations due to different reasons in the pre-existing species. For this reason, each species has its own history of evolution. This history is called **phylogeny of a species**. Using different scientific methods, the phylogeny of different species has been elucidated. After the development of DNA polymerase chain reaction, it is now possible to know the phylogeny of various species in a very convenient and

quick way. It is now possible to know the long history of a person's original ancestors. People have started analyzing their DNA curiously. Sometimes what is visible to us is just opposite to the history. An American person used to ridicule the African people and considered them inferior. On DNA analysis, he himself was found to be of African origin. It is clear that discrimination on the basis of caste or religion is not appropriate. The origin of whole mankind is the same.

Important Points

1. In the night after the sun set, some planets, innumerable stars and other bodies appear in the sky. This whole assembly itself is called as Universe. Our earth is a very small section of this infinite Universe.
2. In Indian culture, the discussion on the idea of the creation of the universe has started since Vedic times. The evolution of the universe has been discussed in detail in the 'Nasadiya Sukta' of Rigveda. Swami Vivekananda said that answer to the question of the origin and evolution of the Universe has been given many times and will be given many times more in the future also but with every effort the belief of "Advaitism" will be strengthened.
3. The intellect has always been present in an incognito form. A fully developed human marks the end of the nature/ creation. The omnipresent intellect which is exhibiting in the universe is named as God.
4. According to the theory of Biocentrism, the existence of this world is due to life. The world has originated for the creation and development of life. According to Biocentrism, there is no physical existence of Einstein's place and time concept, but all of these are the senses of human consciousness.
5. The supporters of Biocentrism say that every event of nature seems to have occurred in human interest. Darwin's explanation of biological development on the basis of fortuitous incidences is fine at the children's level, but in fact the thing is not that simple. Without a self-sustained plan, biological evolution cannot be properly explained.
6. It is believed in the big bang concept that, 13.8 billion years ago, the origin of the universe was caused by a great explosion in a very intense and extremely hot body. After explosion in an object, its parts spread far and wide likewise the parts of the universe are still spreading and moving away from each other. Measuring red displacement of supernovas has revealed the fact that the speed of the spread of Universe is increasing.
7. A group of materialists under the leadership of Stephen Hawkins, did not accept the existence of consciousness. These scientists are confident that in the coming times all the secrets of creation will be known with the help of materialistic means only.
8. Many Earth like planets have been discovered in space. Efforts have been made to find out life on other Earth like planets. Until this book is written, no life outside the Earth has been found.
9. The first creature would have originated from inanimate substances only. Oparin said that there is no fundamental difference between living and nonliving. J.B.S. Haldane expanded the views of Oparin. Haldane divided the events from the origin of the earth to the formation of nucleated cells in eight stages.
10. Life is not just a group of molecules. With the ever increasing knowledge about life, it is becoming even more difficult to explain the origin of the first creature. The idea of Oparin and Halden, which was established a long time ago experienced a setback when many young scientists refused to believe that the first creature born in the primordial soup was able to fulfill its energy needs through anaerobic respiration.

These scientists believe that during the Hadean era life has showered on Earth in the form of subtle spores. On Mars, life had reached almost the same time.

11. A group of organisms capable of maintaining its nature/ characters over generations is called a species. Approximately 3 lakh species of flora, 12 lakh animals and about 10 lakh species of micro-organisms have been found. Therefore, from the micro-organism to the human beings, one should consider each and every thing as one unit.
12. The symbols/ remnants/ impressions or traces of ancient organisms are called as fossils.Fossils are made by the burial of organisms/ substances in the soil or other substances millions of years ago.The fossils of an elephant like organism buried in the ice were found in such a highly protected form that it seems as if this creature had died recently (but not billions of years ago). It is said that fossils narrate us the story of the old world, but this story is somewhat incomplete because the fossils of every organism are not available.
13. Each species has its own history of evolution. This history is called phylogeny of a species. Using different scientific methods, the phylogeny of different species has been elucidated.
14. Organisms present today are not the same as were present millions of years ago. The credit for explaining the biological evolution with logic goes to Charles Darwin, who in 1859 wrote a book "The Origin of Species" based upon the development of species and shocked the old beliefs.
15. After obtaining the evidence of biological evolution, it was natural to raise the question that what was the process of biological evolution? Considering the qualities acquired by more use of some organs and comparatively less use of others as an inherited quality, Lamarck tried to explain the emergence of the new species.
16. Charles Darwin explained the origin of species through natural selection. People could not understand the formation of new species by accumulation of slight variations found in the members of same family or species. The sudden big changes in organisms result in the origin of new species. deVries named such changes as mutations.
17. Margulis raised the question that how do such beneficial mutations caused by natural selection occur in the organisms? Margulis said that biological evolution cannot be explained by examples of animals.

Practice questions

Objective type questions

1. What was present before the formation of sristi?

   (a) Water (b) Truth

   (c) Lie (d) None of these

2. Which Scientist revived the idea of a stable universe?

   (a) Darwin (b) Oparin

   (c) Einstein (d) Stanley Miller

3. Which is the most acceptable concept regarding the origin of the universe?

   (a) Stable Universe (b) Big Bang

   (c) Biocentrism (d) Indian concept

4. About how many years ago, photosynthetic life was present on Earth?

   (a) 4 billion (b) 3 billion

   (c) 5 billion (d) Uncertain

5. A group of organisms capable of maintaining their nature over generations is called

   (a) Ancestry (b) Association

   (c) Community (d) Species

Very short type questions

6. Which sukta of the RigVeda discusses the origin of the Universe in detail?
7. Can life be considered as a group of molecules?
8. Presently life is based upon which molecule?
9. What has changed in scientific thinking about the early atmosphere of Earth?
10. What is the history of the development of each species called as?

Short type questions

11. How can one get information about extinct organisms?
12. In which form did the fossil of Archaeopteryx was found?
13. What are vestigial organs? Write the name of one vestigial organ of the human body.
14. Can life from outside the Earth enter on the earth?

Essay type questions

15. Explain Indian thinking about the origin of sristi.
16. Explain the theory of Biocentrism of the creation of the universe. How is it different from the materialistic approach?
17. What is the Big Bang concept of creation? How is it different from the Indian concept?
18. What do you understand by biological evolution? How according to you biological-evolution has taken place?

Answer key

1. (d) 2. (c) 3. (b) 4. (a) 5. (d)

Chapter -17

Search of Life Outside the Earth

17.1 Position of the earth in space

New scientific research tells us that there are a billion worlds like earth in our galaxy. Most of these are rocky like earth. There are about 100 billion galaxies in the universe which have been seen till now. NASA's senior scientist Alen Stophen says that today the people of earth have very strong evidence that they will find life outside the earth in the coming decade. Strong evidences will be collected about Aliens in the next 20 to 30 years. There is no reason to doubt Alen Stophen as the virtual solar laboratories and remote sensing devices present in space have greatly increased human understanding as compared to the earlier times. Man is trying to find whether if life is present on any other planet just like on earth and on their, snow covered satellites. In our solar system we are trying to find if life is there on the Jupiter's satellite, Europa. It is not necessary that the life outside the earth will be the same as ours. There is a possibility of life in the ocean of liquid methane found on the satellite, 'Titan' of the planet Saturn.

It is also believed in the scientific world that in space life is present in abundance. In the form of micro-organisms it continuously comes on the earth. It is also believed that life did not originate on earth. Life on Earth came from outer space in a subtle form. The claims of life coming from space have been claimed but have not been fully certified till now.

The second group of scientist thinks life can be found outside the earth, but the possibility of it in a developed form as on earth is negligible. They believe that it is just not enough to be a watery, rocky planet like Earth, for the development of life. For the origin of life on an object like Earth, there is no need for the environment to be worthy of life. After being originated, for the continuity and development of life, it is necessary to have an environment which supports life. After the origin of life, to make the environment of the object life sustaining and to keep the environment continuously in that form is very difficult.

Scientists believe that when a planet like Earth is formed it is excessively hot and explosive. It takes about 50 million to one billion years to cool down the body so that the life can be originaed by the combination of non living chemical compounds. It is not necessary for the planet to have a life sustaining atmosphere for the origin of life. The real test begins after one or one and half billion years after the formation of a planet. After the origin of life it becomes necessary to keep the planet's atmosphere permanently life sustainable. Some scientists have compared the work of changing the planets dangerous environment to be life worthy, to riding a wild bull. Research suggests that most of the planets like earth do not make their environment worth living for during the first one billion years of their life, and the life that arose on that planet was destroyed in the astral state.

You are familiar with the word aliens. In the movie "Koi mil gaya" it was imagined that a child was left on the earth, who came with his family in a UFO. A group of children kept its name "Jaadu" and keep it safely with them. The organism outside the earth are called Aliens. You knows that there are many galaxies in the universe. One of these galaxy is named the milky way of which our sun is a star and we live on one of its planets the earth.

Fig. 17.1 A creative picture depicting an Alien.

Based on the information gathered till now, it is only the Earth that has a life full of biodiversity. Among all the organisms existing on the Earth, humans are the most developed ones. Humans have the power of thinking and understanding. Since the humans started to understand the environment, a question arose in his mind that are we alone in the universe? Is there life on any other planet other than the Earth?

Initially, humans had limited knowledge. Humans tried to answer the above questions by their creativity and imagination, which lacked any physical evidence and created many stories about the celestial bodies having a variety of life. Much literature has been written on it. Many popular movies have been made, one of which is mentioned above.

17.2 Possibilities of life in space

After the development of science, humans tried to answer the questions how and when life originated on the earth. It was clear from the various theories that the Earth originated as a hot solid ball and cooled down slowly, then gradually its environment was formed. Simple compounds were formed by the association of the elements present in the atmosphere and then more complex compounds were formed from them. These compounds had life based atoms such as water, amino acids, nucleic acids etc. The condensation of these atoms accidentally originated the first organism. The first organism through the bio-evolution gave birth to all the animals and humans. Life on Earth is possible because of the Earth's respective distance from the sun. The earth is that far away from the sun that water can stay in liquid form on it.

With the enhancement of information, it was clear that our galaxy had billions of stars like sun. Many of which have their own solar system and families. These various solar systems have planets similar to the earth, where life can be possible. With the development of Radio astronomy, we came to know that the chemical atoms which led to the origin of life on the Earth are present in the universe in abundance. This gave support to the thought that out of many planets similar to the Earth present in the universe, some may have life. It is also believed that many planets may have life much more developed one than that of the Earth. From this, originated the thinking that aliens came to the Earth in their spaceships.

In the year 1972 when pioneer-10 was launched, it was very much believed that highly developed life existed out of the earth. At that time, scientists were scared that due to any wrong notion, the life outside earth would attack people on the Earth. Pioneer -10 spacecraft was to pass by Jupiter and then go out of our solar system. The fear was that during its infinite journey, pioneer-10 would come in contact with some developed civilizations. The developed civilization could consider pioneer-10 as an attack over them from the people of the Earth and would retalita us. To remove this misconception, a plate was placed on pioneer-10 depicting male and female in a friendly posture and in sign language, a message was written about pioneer- 10 being sent from the earth. As planned pioneer-10 completed its mission successfully and no traces of life elsewhere were found.

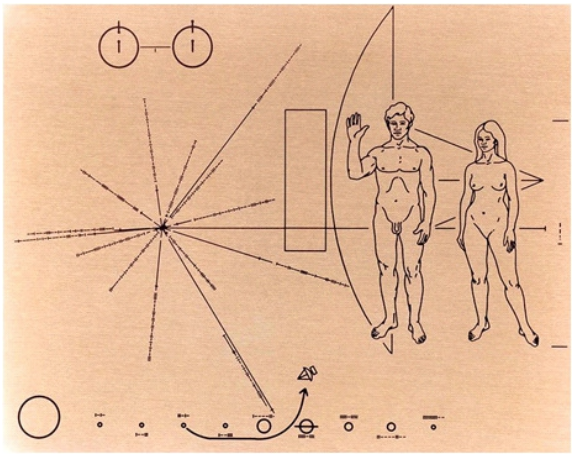


Fig. 17.2 A plate placed on Pioneer-10 to give message of peace to the Aliens.

With the advancement of scientific methods humans made rigorous efforts for finding life outside the earth. Search for extra terrestrial intelligence started in the year 1999, as a part of this effort. Efforts have been made to hear the murmuring in the universe by

radio telescopes. Huge radio telescopes have been setup in the space to find traces of life in space. The results of all these efforts is nil till now. Finding a civilization more developed than ours is a far fetched, one. The scientific cummunity has still not been able to gather any evidence of micro-organism outside the earth. In order to find life outside the earth and to reach some results NASA has started an ambitious program.

17.3 Main space campaign

Looking at the eternal sky, the human mind has been inquisitive since ancient times. When there were no means in the ancient times people just gathered information about the motion of planets-constellations with their naked eyes and co-related that with the occurence of weather, eclipse etc. After the invention of telescope the human vision began to cover more distance, the scope of information grew. Exploring space while living on earth is called astronomy, but sending automated machines or humans to space is part of space research technology.

Sending devices physically in space was possible after the development of powerful rockets in the twentieth century. Prior to the development of the rocket, it was possible to send an object up to 40 kilometers in the sky, during the First World War with a device called Paris-gun. During the Second World War German scientists sent the first man made device into space in 1942 by the invention of rocket. After the Second World War The United States of America started using German scientists and German equipments in military and non- military research. The first image of the Earth from the space was drawn in 1946. With the help of German scientists, Russia too came in the field of space research in 1947.

Due to the desire to outstrip one another the Soviet Union and the United States, the development of space science was some what faster. Soviet Union initiated by sending the first man made satellite named Sputnik-1 into the space in October 1957. Sputnik-I revolve around the earth by keeping a distance of 939 to 215 Km. The radio transmitter fitted on it sent the information about the upper atmosphere in form of beeps. While returning to the earth this satellite burnt out in the sky. Russia was the first to send first organism into the space, Euri Gagarin was the first man to go into space, establishment of space station Salute-I etc. In July 1969 America landed the first human on moon and pretended to show that it had left Russia behind.

Today space research centres of 22 governments are working in the world. Among these Russia's Roscososmos, America's NASA, China's National Space Authority, India's ISRO, European space agency of Europe are the main ones. America's and Russia's competition has now changed into coperation. In the beginning space research, was a question of prestige but today it has became a military and non-military requirement of every country.

The main reason for man's interest in space is the benefits that come through artificial satellites. Artificial satellites provide information about the earth surface and about the atmosphere of the earth, these information can not be obtained on the surface of the earth. Today the communication system of the world is based on the artificial satellite system. If the internet does not work properly, business activities along with television will also stoped. By the spying of other countries and destroying the artificial satellites of another country economic crisis can be can be caused. Therefore the military importance of artificial satellites has increased.

The second goal far space research after Earth is the moon. Moon has been attracting the humans since ancient times. Human beings have been successful in landing automated machine and human on its surface to study it. To encourage the tourism outside the earth, mining of helium 3 on moon and bringing it back to earth and to use moon as a station for the journey of deep space are matters of human interest.

The third subject of human interest in space is the planet Mars. Information is being collected about Mars by sending vehicles in its orbit. The surface of Mars is also being studied by landing automated

equipment on its surface. There is no confirm information about whether there is a subtle life on Mars. A private organization called Mars-1 is preparing for a unilateral journey to settle people on Mars. The target is 2030, but due to economic reasons the work seems to be halting.

In addition to Mars, satellites are also sent to other planets of solar system like, Mercury, Venus, Jupiter, Saturn, Uranus, Neptune, Pluto etc. America's satellite Juno is revolving around Jupiter, Kassini around Saturn and new horizon around Pluto and are gathering information about these Planets and sending it to the Earth. Along with the planets of the solar system, satellites like Galileo, Fabos, Europa are also being studied. The main reason for human interest in these satellites is to find life on them.

Fig. 17.3 Powerful rocket, Polar Satellite launching Vehicle (PSLV)

Sun is also a subject of human study and interest in space. The reason for growth and development of life on the earth is the radiation coming from the sun on the earth. The amount of the flow of this radiation is not always the same but, it keeps on changing. They have an effect on communication satellites. So the study of the sun from outside the Earth's atmosphere is being done by sending spacecraft. India is also preparing to study the Sun by sending the space craft, The Aditya.

Another attraction of human beings in space is the asteroid. You know that millions of small bodies are found between the Mars and Jupiter. Precious metals and other elements are found on some of these. Some countries are attempting to land the satellites on them for mining. Many of these asteroids revolve on a large circular path and are causing a danger of a collision with the Earth by passing very near to it. A space craft has been sent to take the samples of such an Asteroid, Bennu. It will return to earth by 2023. By studying the sample, it will be known how much damage will be caused on earth from the impact of the collision of Bennu. India is also planning to send a spacecraft for the study of Asteroids.

Spacecrafts are also being used to obtain information of space outside the solar system.

17.4 India in space

Space research in India started in 1948 as a physical research laboratory in Ahmadabad. In 1962 the Indian Government formed the Indian Space Research Committee under the leadership of Dr. Vikram Sarabhai. This committee built the Thumba Rocket Launching Station near Thiruvanathapuram and started the space research by studing the upper layers of atmosphere.

Fig. 17.4 Dr. Vikram Sarabhai

In 1969 the Indian Space Research Committee was replaced by Indian Space Research Organization (ISRO). Since its establishment, ISRO has started developing space technology. India launched its first rocket Rohini-75 in 1969 which was only 75 mm in diameter. It is clear that initially India's rocket capacity was not enough to send a vehicle to the space with its

help. India made an aggrement with Russia and in 1975 with the help of Russian rocket sent its first spacecraft Aryabhatta into space. After the successful flight and placing Aryabhatta in Earth's orbit India book the 11th position in the field of space research after America, Russia, Germany, China, France, England, Australia, Canada, Japan and Italy. After this, India sent two more satellites in Bhaskar series with the help of Russia. In 1981 the satellite Apple was sent with the help of Arian rocket of the European space Agency. It was placed at a height of 36000 kilometers from earth. The rotational motion of the satellite at this height is equal to the Earth's rotation, this way it sends the information to India by moving along with it.

You must have understood that the two major parts of, any space mission are the rocket and the space craft. You must have fired a rocket on Diwali. You may have noticed that the more gun powder in rocket, the higher it goes. Rocket works as a vehicle for carrying the spacecraft, uphence its efficiency is very important.

Fig. 17.5 Chandrayaan in Moon's orbit

India has been successful in enhancing its rocket capacity. India soon developed a rocket in the form of satellite launching vehicle-3 (SLV-3) which was able to carry the Indian Satellites into the space. The first flight of SLV-3 failed, but after learning a lesson from it, the Rohini Satellite was successfully sent into the space in the second flight. After acquiring the ability to send the spacecraft by its own rocket, India took the sixth place in the world. After this India on its own strength has sent many satellites in space to serve the country. They are sending important geographical, remote sensing information by revolving in the Earth's Orbit. India will soon launch Chandrayaan-2 in the orbit of the Moon and it is going to land a vehicle on moon's surface.

Important information about weather are gathered and sent to India. It is also helping in the operation of radio, Doordarshan, telephone, Internet, Telemedicine, remote education etc. India has achieved great success by developing powerful rocket, Polar Satellite Launching Vehicle (PSLV), which sends the space craft in a state of orbiting the Earth pole. Due to the high reliability of this vehicle, every country loves to send its satellites from this space vehicles. The operational costs of this space vehicle developed by India are cheaper as compared to that of other countries. India which spent a great amount of money to send its first three spacecrafts by the rockets of other countries, today is earning foreign exchange by sending other countries vehicles with its rockets. India has set a new record by sending 20 satellites simultaneously in space in June 2016. Among these 17 satellites were of other countries. India developed its Geosynchronous Satellite Launch Vehicle (GSLV) which is used to launch Geosynchronous satellite. With the help of the powerful rockets India established Chandryaan-1 in the moon's orbit in 2008 and achieved success in finding water on the moon and flagging India on the surface of the Moon. In its first attempt on its own strength, India sent Mangalyaan in the orbit of Mars and made the first place in the world. The Mangalyaan of India was declared the best invention of 2014. Until now no other country has been able to do this. India will soon be launching Chandrayaan-2 into the orbit of Moon and it is going to land a vehicle on moon's surface. The devices on this vehicle will collect information about the surface of the moon and send it to India. India is also planning to send Adityayaan to study the sun.

Personal Effort in Space

Private companies are now taking interest in space along with the government. The objective of the private companies is to trade with space tourism. Google has encouraged this by announcing the Lunar X awards. Team Indus is preparing to win the prize in 2017 by fulfilling the conditions by landing the robot on the surface of the Moon. A private company Moon Express has obtained the permission from NASA to start the service from the Earth to the Moon. It is possible that some people will enjoy the journey to the Moon by the middle of next year (2017). The Company's cofounder Naveen Jain says that hundreds of industries like diamond, energy, mining etc will be benefited from space. The journey to deep space will be easier by installing fuel pumps on the Moon.

17.5 International space station

Fig. 17.6 Structure of International Space Station

The International space station is the satellite set up in the lower orbit of the earth. This is the largest artificial structure present in the orbit of the Earth. It can also be seen from the earth without a telescope. Before sunrise and after sunset it is seen as a white moving point. On an almost circular path it maintains a distance of 330 to 435 kilometers from the earth. It completes more than 15 revolutions of earth in a day. Because of the involvement of Japan, Canada, Russia, America and European space agency in space station adjective, International is used. China is building its own space station.

Currently there are many rooms in it, which are used for living, and are used in the form of laboratories of biology, physics, astronomy etc. Horticulture is also done here. You must have also seen the picture of the bloomed flower printed in all the newspapers. There are several solar panels at the International space station for energy production. In many rooms air is filled at atmosphere pressure. Thereby, astronauts can work comfortably for many months, staying there without wearing a space suit. They have to wear space suit while working in other rooms or working in the open. The components that created the space station were made on Earth and sent to space with the help of Russian and American rockets and in the space they were assembled to give this look to the space station. Older parts are still changed constantly.

Fig. 17.7 Burning candle in the International Space Station as compared that on the Earth

Due to the proximity to the Earth, there is a gravitational force in the space station, but due to the orbital motion, the device is like an independently falling object. You know that the independently falling objects are in the state of weightlessness, and this is why it remains in a space. Since november 2000 this station has always been inhabited. Goods and passengers keep visiting here. American citizen of Indian origin Sunita Williams had worked in the space station more than once. She has also worked outside the space station. You would love to know that Sunita had carried the book Bhagwat Geeta, Lord Ganesha's sculpture and some Samosas with her. Only the people who are selected by the governments go to the space station and like government jobs, they do the work as directed

by the government. But there is a vacant seat in Russia's space shuttle Soyuz. By paying fare a traveler can go along for a few days. While living in the International space station, astronauts do their pre-determined work and also keep in touch with the students through radio, doordarshan etc. They keep sending videos for the students. Astronauts keep talking to their family members from time to time.

The food for each astronaut is sent in plastic bags with a tag of his name. There is a limited arrangement for cooling or heating the food. But when it is old it becomes tasteless. After a few days astronauts wait for the fresh food from the earth. Drinks have to be pulled in mouth with the help of straw. Guess why glass cannot be sucked? The solid food is also taken with the help of forceps and knife. Magnet is used to keep the forceps and knife on a tray otherwise they start flying in the air. There are also special types of toilets. Urine is collected and cleaned to get pure water that is used for drinking and other activities.

Living in weightlessness has many adverse effects on the health of the astronauts. To avoid this they resort to exercise. Tools like treadmill have been installed at the space station to help in exercise. Living with one or two colleagues in a small room for a long time, creates many types of psychological problems. You may think that there will be no danger like a road accident in space? It's not like that; a lot of garbage has been got collected in the space near the Earth. Used rocket or their pieces, inactive artificial satellites, weapons sent to destroy the satellites, Natural micro meteorite etc can cause trouble by stumbling across the space station. Due to the fast speed of the rotating objects in space, the collision of small pieces can also cause major damage.

After the development of the Internet, the economic importance of the artificial satellites has increased in human life. A country can harm its enemy by destroying its satellites. Human is making efforts to extablish colony out of the earth. In view of the importance of the space station, its budget has been increased till 2024. India is not yet connected to this. It is hoped that you will continue to gather the latest information about the international space station through the internet or newspapers.

Important Points

1. The organisms outside Earth are called Aliens. Since man started to understand his environment, one question arose in his mind that are we alone in the Universe? Is there life on any other planet outside Earth ?
2. With the development of radio astronomy, it is now known that the chemical atoms which gave birth to life on earth are abundant in space.
3. Pioneer-10 spaceship travelled out of our solar system by passing near Jupiter, but no sign of any external civilization was found.
4. Life is also being discovered on planets like our Earth and their snow covered satellites. It is also being searched on Europa the satellite of Jupiter in our solar system.
5. Alen Stophen, a senior scientist at NASA says that today the people of earth have very strong evidence that in the coming decade life outside the Earth will be discovered. In 20 to 30 years definite proofs about the aliens will be collected.
6. After the origin of life, it is very difficult to make the environment worthy for life and to sustain it in the same form.
7. After life has been produced on a body it begins to react with the physical environment of the planet. This dialogue can be both positive and negative.
8. On earth the development process from micro-organism to human beings have been possible. To this positive recharge dialogue was named Gaiyn hypothesis. (Mother land) by scientists James Lovelock and Lyn Margulis (1974).
9. To maintain life on planet temperature has to be maintained at one level. This is possible by regulating the green house gases. This is possible by Gaiyn regulation, as it happened

on earth. Some people consider this Gaiyn regulation hypothesis influenced by religion and reject it.

10. The International space station is a satellite set up in the lower orbit of the earth. This is the largest artificial structure present in the orbit of the earth.

11. On a circular path it maintains a distance of 330 to 435 kilometers from the Earth. In one day it completes more than 15 revolution of the earth.

12. Only the people selected by various governments go to the space station and like government jobs, they do the work as directed by the government. But a seat is kept vacant in the space shuttle of Russia. By paying the fare a person can go with them for a few days.

13. During the Second World War, German Scientists invented the rocket and sent the first man made device into space in 1942. After the Second World War the United States of America started using German Scientists and German equipments for military and non-military research purposes. The first image of the earth from the space was taken in 1946. With the help of German scientists in 1947, Soviet Russia also came into the field of space research.

14. Russia was the first country to send first organism into space, landed the first human in space, (Yuri Gagarin) first space walk, landing unnamed spaceship on any space object, Establishing of space station, Salute-1 etc. In July 1969 America landed first human on moon and tried to show that it had outclassed Russia.

15. Today the communication system of the world has become fully based on artificial satellites if the internet does not work properly, business activities along with television will come to a halt. By spying other countries and by destroying the artificial satellite of another country they can be put to economic crisis. It has resulted in military importance of artificial satellites

16. Space research in India started in 1948 as a physical research laboratory in Ahmadabad. India will soon make Chandrayaan-2 send it into the orbit of the moon and will land one vehicle on the surface of the moon. The machine engaged in this vehicle will check the surface of the moon and send information back to India. India is also planning to send Adityayaan to study the sun.

Practice questions

Objective type questions

1. The word Alien means-
   (a) Jadu
   (b) Organism outside the Earth
   (c) Complex Organism
   (d) Organism similar to cow

2. Life is possible outside the Earth-
   (a) On any star
   (b) anywhere
   (c) On planet similar to Earth
   (d) On any planet

3. First space craft to move outside the solar system was-
   (a) Chandrayaan-2
   (b) Mangalyaan
   (c) Pioneer -1
   (d) Pioneer- 10

4. Instruments used for listening to the murmuring in the universe-
   (a) Radio telescope
   (b) Telescopes
   (c) Microscopes
   (d) None of these

5. From which place can you see the sunrise 15 times a day?
   (a) At pole
   (b) At international space station

(c) At mars

(d) At moon

Very short type questions

6. Which place is the living place for humans outside the earth?
7. Which organism has given rise to the danger of global warming?
8. The physical environment of the earth and the organisms living on earth together form a system. What is this phenomenon called?
9. During the origin of the earth, the environment was very hot and explosive. How much time did it take to cool down?

Short type questions

10. How many planets similar to the earth can exist in our galaxy the milky way?
11. What is the meaning of the word Alien?
12. According to Darwin, how did the first organism originate on earth?
13. What were the scientists scared of during the launching of the pionner-10?
14. What do you mean by creative and destructive forces?

Essay type questions

15. What was the man's imagination about the organisms outside the earth during the launch of pioneer-10. What steps were taken to be safe from the assumed danger?
16. Assume yourself to be in International space station and describe your daily routine?
17. Explain the current scientific thinking about life outside the Earth. What is your view?
18. Explain the importance of satellites in details?
19. Explain the importance of India in the world of space campaign?

Answers key

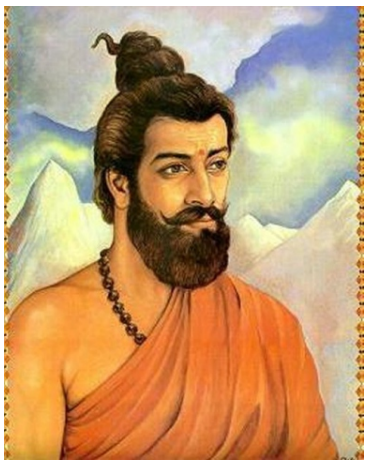
1.	(b)	2.	(c)
3.	(d)	4.	(a)
5.	(b)		

Chapter-18
Indian Scientists : Biography and Achievements

Generally science has two facets- basic sciences and application of sciences. Applied sciences impact the economy of the country and is known to have qualitative effect on life. Basic sciences develop the scientific attitude, understanding and knowledge where as the applied sciences help in our progress. From the ancient times the Indian scientists have been working towards development of both the scientific approches to make our lives better. In this context biographies and achievements of a few Indian scientists are described below in short.

18.1 Sushruta

Descendant of Vishwamitra, Sushruta was born around six hundred years before Christ. He learnt primary medical education in the ashram of Dhanwantri. Sushruta was the first to give the sophisticated knowledge of surgery in medical sciences. He refined the procedures of surgery and performed many complex surgeries and provided knowledge regarding equipments used in the surgical procedures.



Sushruta

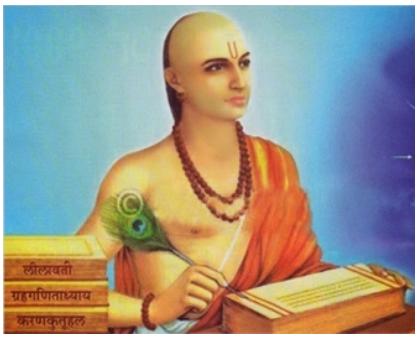
He has written 'Sushruta samhita' in which details of surgery is described. Long before the Joseph Ester, Sushruta thought of antiseptic and sterlization. He directed his subordinates and disciples to heat the equipments to kill bacteria. He used non poisonous leeches to speed up blood clotting.

In ancient scriptures, around 26 centuries old, examples of plastic surgens of ear, nose, lips etc. performed by him were given. He may be called the father of plastic surgery. He provided knowledge of 101 equipments. Many of his equipments were earlier versions of spring forceps or cutter or forceps for bandage etc. He also gave ideas for cleaning procedure of the operation area.

Conclusion : India was far ahead of other countries in medical sciences. Sushruta's grantha was translated in many languages and is very famous. Sushrut is one of the greatest surgeons.

18.2 Charak

Charak was the great acharya (Professor) of Ayurveda form of medical sciences. He was the first doctor who gave the concept of digestion, metabolism and body immunity. According to him the body has three main defects in its functioning- Pitt, Vaat and Kaf. Imbalance of these three leads to different diseases.



Charak

He wrote a grantha named Charak samhinta around 200 years before Christ. It is one of the ancient surviving grantha on medical sciences. It is

writtten in sanskrit. The grantha is divided into 8 sections and is both in proses and verses

More than 2000 years ago Charak discussed about principles of genetics. He knew the reason of determination of gender of child. Children suffer from genetic defects like blindness, lameness because of some deficiency or defect in child's father or mother. He told that heart is the controlling centre of the body and is connected to main arteries.

He has also given directives for doctors and medical students. Acccording to him doctors should not keep enmity with patients in any case. People associated with medical profession should not disclose household information of a patient to others. Doctors should always be ready to learn and acquire knowledge.

Charak has a meaning- to walk (sanskrit). Acharya Charak used to travel a lot to cure common people suffering with various ailments and to educate them and hence he was called Charak.

18.3 C.V. Raman

Chandrashekhara Venkat Raman born on November 07,1888 in Trichirapalli city of Tamil Nadu state of India. His father was Chandrashekhar Ayyer and mother was Parvati Ammal. His father was a lecturer in physics in Waltear college. Raman passed Inter in first division with scholorship from Waltear college in Visakhapatnam. He passed Master of Sciences in 1907 at the age of 19. He got M.Sc. with the highest distinction from University of Madras.

C.V. Raman

At the age of 19 he passed government competetive exam of economics in which literature, history, sanskrit and political sciences were the topics. He joined as Deputy Auditor General in government of India.

He also workded on musical instruments like Veena, Mirdang, Tanpura and other Indian instruments as well as western musical instrumetns like piano, violin etc and discovered the harmonic nature of the sound.

In 1917 Raman resigned from his government job becuase he was not able to give time to scienctific reserach and became the First Palit Professor of Physics in Calcutta University. During his tenure he discovered Raman effect in 1928. In 1930 Raman got Nobel prize for his famous discovery of Raman effect. Raman effect is also known as Raman scattering. Raman scattering is the inelastic scattering of a photon by molecules which are excited to higher vibrational or rotational energy levels. Important fact with this discovery is that he and his student K.S. Krishnan used very few and cheap equipment around costing two hundred rupees for the experiments.

In 1949 he was appointed as the First National professor by the Government of India. In 1954 Raman was conferred Bharat Ratna' by Government of India. For his work towards friendship between nations he was awarded Lenin Peace prize in 1957. He was also given Knighthood in 1929.

He explained the reason for blue colour of sea and space. He studied the Raman Effect in solids, liquids and gases He also carried out scientific research on magnetic field, X-rays, structure of crystal, and acoustics. He died on November 20, 1970. In his honour on 28 Februaary India celebrates Science day.

18.4 Dr. Homi Jehangir Bhabha

Bhabha was not only a great scientist but also an art administrator and lover. He was also an excellent artist and his paintings are exhibited in British art galleries.

Dr. Homi Jehangir Bhabha was born on October

30,1909 in a prosperous Parsi family in Mumbai. His early studies were in Cathedral and Johan Connon school in Mumbai and at the age of 15 he entered Elphinstone College Mumbai. Afterwards he went abroad to Cambridge Universtiy for further studies. He obtained a degree in mechanical engineering in 1930 and then started working on theoretical physics. His research was manily in cosmic rays and nuclear energy. In 1942 he was appointed lecturer in cosmic rays.

Bhabha was related to industrialist Tata family. In 1937 he studied cosmic rays with Watler Heitler and described that primary cosmic rays from other space interact with the upper atmosphere to produce particles observed at the ground level. The particles interact with air particles and produce showers of particles like electrons. He discovered these nuclear particles which were afterwards known as Mesons.

Dr. Homi Jehangir Bhabha

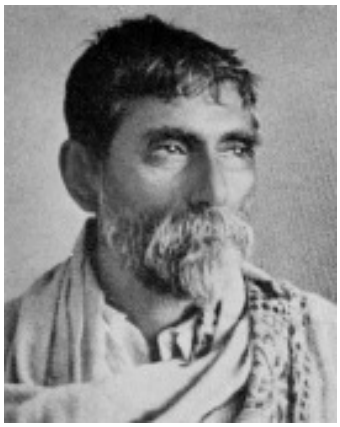
He was instrumental in the establishment of Tata Institute of Fudnamental Research (TIFR) in 1945 with the help of Dorabji Tata. In 1948, Atomic Energy Commission was formed and Bhabha was appointed its first chairman. He was also appointed the director of nuclear programme in India. Under his guidance atomic reactors Apasara, Cirus and Zeralina were commissioned. In 1963 the construction of first atomic power plant was started in Tarapur, Maharastara.

He is also known as the father of Indian nuclear science programme. In September 1956, 81 nations held conference in New York for establishment of atomic agency and Bhabha was elected chairman of the conference by common consent .

He died in a plane crash near Mont Blanc in Germany on January 24, 1966. In 1967, the Atomic Energy Establishment Trombay (AEET) was named after Bhabha to honour his dedication to nuclear energy in India and was named Bhabha Atomic Research Centre (BARC).

18.5 Dr. Prafulla Chandra Ray

Dr. Prafulla Chandra Ray was born in Raruli Katipara village of Khulana district of earstiwhile Bengal on August 02,1861. His father Harish Chandra Ray was a wealthy person and an expert in Persian. His early school education was in this village. Then his father migrated to Calcutta and he was admitted to famous Hare schoool of Calcutta. Beacuse of severe illness he returned to his village for a few years and again he resumed studies at Albert school Calcutta.



Dr. Prafulla Chandra Ray

In 1879 he cleared the entrance examination for admission to Metropolitan school. As there was no science classes in Metropolitan school so he used to go to Presidency college for science classes and laboratries as external student. He developed his curiority towards chemistry and in 1982 he was awarded one of the two Gilchrist prize scholarships after an all India competitive exam.

He did not complete his course for his degree

and went to Edinburgh University, Britain for B.Sc. Afterwards Ray completed DSc from the same university in 1887. Among his fellow workers were Professor James Walker, FRS, Alexander Smith and Huff Marshall. They all were motivating factors for his interest in chemistry He was elected vice president of Edinburgh Universtiy chemical Society in 1988.

After his return to India he joined Presidency College as temparary Assistant Professor in chemistry. He observed that many British teachers with lesser qualification than him were on higher posts and higher salaries. He complained about this inferior treatment to native intelligentsia to the director. The director told him satirically that if your are such an able chemist then why don't you start your business.

He took this seriously and with a meagre sum of Rs. 800 he started Bengal Chemical Works in 1892. Afterwords it was renamed Bengal Chemicals and Pharmaceutical Works Ltd in 1901. It was first pharmaceutical company in India. Soon it became a big business and gave way to other entrepreneurs to start businesses. He died on June 19, 1944 at the age of 83.

18.6 Dr. Panchanan Maheshwari

Dr. Panchanan Maheshwari was Indian Botanist. He was born on November 09,1904 in Jaipur. He studied at Allahbad University and started teaching at Agra college. Afterwards he taught in Allahabad, Lucknow and Dhaka universities. In 1948 he joined Delhi University as head of Botany Department.

Dr. Panchanan Maheshwari

His research contribution was in plant embryology. He developed a new branch by mixing embryology and tissue cultrue. He developed technique to provide artificial nutrition to different parts of flowers for their development.

His students were from America, Argentina, Astralia and other countries. Around 60 students did doctorates under his supervision.

Dr. Maheshwari represented India in many international conferences in botany. He developed centre for tisue culture and embroyology and to honour his research he was elected a Fellow of Royal Society (FRS) in 1965.

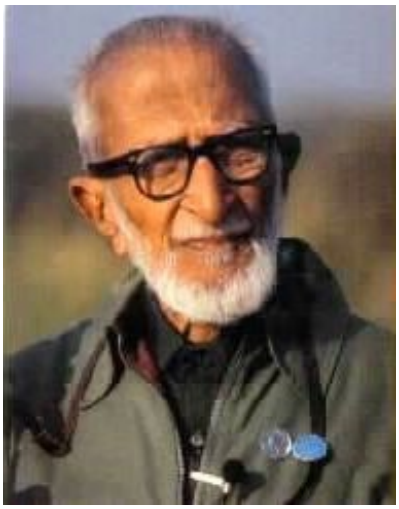
He died in May 18,1966 in Delhi

18.7 Dr. Salim Ali

Dr Salim Ali was born on November 12, 1896 in Sulemani Muslim family. He was an Indian ornithologist and naturalist. He is also referred to as Birdman of India. He was the first person who systematically conducted surveys on birds all around India. His books on Indian birds helped in popularising ormithology in India. In 1976, he was awarded the Padma Vibhushan, the second highest Civilian Honour of India. After 1947, he became the main person behind the Bomaby Natural History Society. He used his personal influence for getting government support for the organisation. He was also instrumental in creating Bharatpur Bird Sanctuary (Keoladeo National Park). He worked hard to stop the construction of a dam that was a threat to Silent Valley National park.

Under the guidance of the secretary of Bombay Natural History Society, W.S. Millard, Salim started studying birds thoroughly and identified an unusual sparrow that he had shot for sport with his toy air gun. Millard identified it as yellow throated sparrow and showed Salim the collection of stuffed birds in the collection of society. He gave a few books to start collecting birds and one of the books was common 'birds of Mumbai.'

In his autobiography "The Fall of a sparrow "



Dr. Salim Ali (Ornithology)

Salim writes that the event of yellow throated sparrow was life changing event for him because this event led him into ornithology.

Primary education of Salim Ali took place in Bombay. Later on he went to St Xavier's College, Bombay. He decided to take up the job of a guide to lecture in Prince of Wales Museum for Rs. 350 as he was not having formal university degree and then decided to continue his studies. He was awarded honorary doctorate by Aligarh Muslim University (1958), Delhi University (1973) & Andhra University (1978). He died in 1987 after prolonged cancer of prostate at the age of 91. In 1990 Government of India esablished Salim Ali Centre for Ornithology and Natural history.

18.6 Dr. A.P.J. Abdul Kalam

Dr Abdul Pakir Jainulabdeen Abdul Kalam was born on october 15, 1931 in Dhanush Kodi town of Rameshwaram district of Tamilnadu. His father was Jainulabdeen and mother was Ashiamma. His elementary education was in Rameshwarm and for high school he went to nearby town Ramnathpruam's Schwartz Higher Secondary School to study science. Iydura Soloman was his source of inspiration. Kalam made three points of teachings of Solomon as the basis of his life. In Solomon's words-willpower, faith and hope are three necessary points for a successful life.

Dr. A.P.J. Abdul Kalam

In 1954 he joined Madras Insitute of Technolgy to study aeronautical engineering. In 1958 Kalam was appointed senior scientist in Hovercraft project under Defence Research and Development Organisation. Influenced by Kalam's dedication and hard work, Prof M.G. Menon took him to Indian Space Research organisation in 1962. His golden period of life started from here.

Kalam took the training of technique of laucnhing of Rockets from NASA and first Rocket 'Nike Apache' was launched by India from Thumba. He was appointed project director of SLV project and under his directorship SLV III suceessfuly deployed 'Rohini' Satlellite into orbit.

In 1983 Kalam was appointed Chief Executive of Integrated Guided Missive Development Programme (IGMDP) and he played very important part in development and launching of 'Prithvi', 'Agni', 'Trishul', 'Nag', and 'Akash' missiles. He was present during First Nuclear Test at Pokaran and was Chief Project Coordinator for Pokaran-II nuclear test in 1998. For his important contribution to the development of missiles in India he is also known as 'Missile Man'.

Dr. Kalam was elected to the highest Consitutional post and served as the president of India from 2002-2007. Government of India honoured him with Padma Bhushan (1981), Padma vibhushan (1990) and Bharat Ratna (1997).

On July 27, 2015 Dr. Kalam died of cardiac

arrest while delivering a lecture in IIM Shillong. It was a great sad back not only for India but for the whole world.

Important Point

1. Charak was a great Acharya of Ayurveda. He had written Charak Samhita around 20 centuries ago. It is in sanskrit and contains in detail the human antomy, diseases and thier medication. ^
2. Sushrut was one of the greatest surgeons of ancient India. Around 26 centuries ago he introduced caesarean operation, antiseptic, sterlization and plastic surgery.
3. Sir C.V. Raman was born in 1888 in Trichirapalli. At the age of 19 he was selected Deputy Auditor General of Government of India.
4. Dr. Raman discoverd 'Raman Effect' for which he was awarded Nobel Prize in 1930. According to Raman Effect when light passes through transparent medium then because of scattering its frequency changes.
5. Born on october 30, 1909 Dr Homi Jehangir Bhaha became the First President of Atomic Energy Commission, Under this guidance atomic reactors Apsara, Cirus, Zerlina were established. He discovered mesons.
6. While woking in ISRO and DRDO, Dr. A.P.J Abdul Kalam provided international identity to Indian space and defence sector Missiles like Prithvi, Nag, Trishul, Akash and Agni were developed under his leadership.
7. Pokharn Nuclear test of 1998 was performed under his guidance. In 1997 he was awarded Bharat Ratn.
8. Dr. Kalam was elected for the highest constitutional post of India 'The President' in the year 2002.
9. Dr. Panchanan Maheshwari was a Botany scientist. His specialization is plant embroyology. With the help of combination of embrygology and plant tissue cultrue, he developed different parts of flowers with artificial nutrition.
10. Dr. Praful chandra Ray was a chemical scientist. He developed many medicines with very small amount. This work was done in Bengal chemical and Pharmaceutical works. This factory later on became worth crores of rupees. Many new industries started following the early success of this venture.
11. Dr Salim Ali is known as 'Bird Man of India' and is scientist of natural history. His study was on birds. He was instrumental is establishing Bombay Natural History Society. His special conribution was in the establishment of Keoladeo National Park and Silent Valley National park.

Practice questions

Objective type questions

1. For which branch of enginering Dr. A.P.J. Abdul Kalam studied at Madras institute of Technology.
   (a) Computer (b) Aeronautical
   (c) Electrical (d) Electronics
2. In which year did Sir C.V. Raman got nobel prize?
   (a) 1928 (b) 1930
   (c) 1932 (d) 1934
3. Who is ornithologist ?
   (a) Dr Panchanan Maheshwari
   (b) Meghnad Saha
   (c) Dr. Praful chandra
   (d) Dr. Salim Ali
4. Where is Bhabha Atomic Reserach Centre (BARC) situated?
   (a) Madras (b) Dehli
   (c) Kolkata (d) Mumbai
5. Charak Samhita is written is which language?

(a) Hindi (b) Persian

(c) Sanskrit (d) Urdu

Very short type qeustions

6. Dr. Bhabha identified which particle in the cosmic rays?
7. Sushrut was descendent of which saint?
8. According to Charak what causes genetic defects?
9. First appintemnt of Dr.C.V. Raman was on which post ?
10. Which reactors were established under the guidance of Dr. Bhabha
11. Which Scientist was instrumental in the establishment of Keoladeo National Park (keoladeo Bird Sanctuary)?

Short type questions

12- What is the contribuiton of Dr. Kalam in defence and space research?

13- What is Raman effect? What is its importance?

14- What is the contribution of Dr. Panchanan Maheshwari in Botany?

15. Match the following

(i) Bird Man of India	(a) Sushrut
(ii) Missile Man	(b) Dr. A.P.J. Abdul Kalam
(iii) Father of Plastic surgery	(c) Dr. Bhabha
(iv) Father of Indian Nuclear Science	(d) Dr. Salim Ali

Essay type questions

16. Discuss the life history of Sushurut and his contribution in science.
17. Discuss the life history of Dr A.P.J. Abdul Kalam and his contribution in science.
18. Discuss the life history of Sir C.V. Raman and his contribution in Science.
19. Disucuss the life history of Dr. Salim Ali and his contribution in Science.

Answer key

1.(b) 2.(b) 3.(d) 4.(d) 5. (c)

Chapter - 19
Biodiversity and Its Conservation

Biodiversity is composed of two words: Bio - which means life and diversity- which means variation. Accordingly the meaning of biodiversity is - the diversity found among the living beings found on the earth.

Biodiversity is a comprehensive term because the word living organisms includes the entire flora and fauna present on the earth. Its expanse ranges from microscopic plant algae to giant Banyan tree and Redwood, from microscopic water plankton to Mammoth, Whales and from bacteria to voluminous Elephants.

According to the "Technology Assessment Report" published by the United States of America in 1987, biodiversity has been defined as follows:

"The diversity, asymmetry and ecological complexity found among the biological organisms is called biodiversity."

Presently, the biodiversity found on our planet is the result of the continuous evolutionary and developmental process of life continuing from billions of years. In fact, biodiversity is very essential to maintain the balance our ecosystem.

19.1 Levels of biodiversity

(1) Species diversity

Species: - A group of organisms whose members are identical in appearance and have the ability to produce their offspring's by reproduction in natural conditions is called a species.

The total number of different species of organisms (plants and animals) found in any specified area is called species diversity of that region.

The general meaning of biodiversity is better understood by species diversity. It acts as a scale to measure the balance of an ecosystem. The microbial density and diversity is many folds higher than the other organisms found on earth. It is noteworthy here that only one gram of soil contains about more than 10 million bacteria and 50 thousand fungi.

(2) Genetic Diversity

The variation found in different members of the same species due to the genes (hereditary unit) is called genetic diversity. This diversity is found between different population groups of one species or between different members of a population. The different characters found in the members of same species (like varieties of Rice, Deer or Frog) inhabiting in different ecosystems of the world are example of genetic diversity. The higher the genetic variation in the members of a species, the lesser will be the risk of its extinction, because it will have greater ability to adapt as per the environment. This variation is also responsible for the genesis of new members (varieties) of a species.

(3) Ecosystem Diversity

The system established by mutual interactions among all the living organisms and the prevailing abiotic components in a specified area is called **Ecosystem**. Many types of ecosystem such as grasslands, mountains, desert, moist land, sea, river-valley, tropical forest etc are found on the earth. These ecological systems have their own geographical and environmental characteristics due to which they differ in the flora and fauna. Such variation is called as the diversity of the ecosystem.

19.2 Global biodiversity

There is lack of complete information about the biodiversity present throughout the World. According to the Millennium Ecosystem Assessment, about 50 to 300 million species of organisms are found on our planet out of which scientists could identify 17 to 20

million species only. Biodiversity distribution on Earth is uneven. The equator has the richest biodiversity but as we go away from the equator biodiversity decreases. The middle and south-east America and south-east Asia, where the maximum tropical forests on the Earth are found, has very rich floral biodiversity.These regions accounts for only 7 percent of the total area of the Earth, but hosts two-thirds of the world's floral diversity, 30 percent of invertebrates and 90 percent of pests.

According to the report of Ministry of Environment and Forests, Government of India (year 1999) the world wide distribution of different species of plants and animals found at different levels can be understood from the following illustrations:

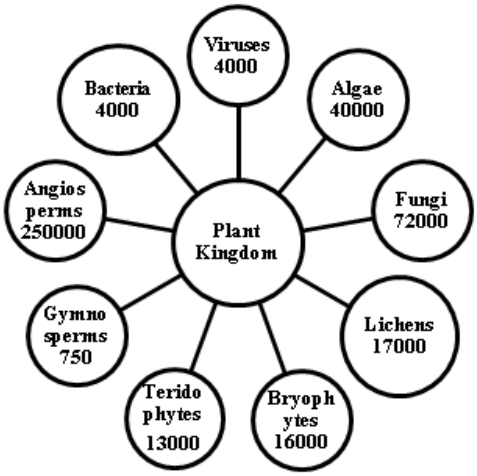


Figure 19.1 The Floral Diversity of the World

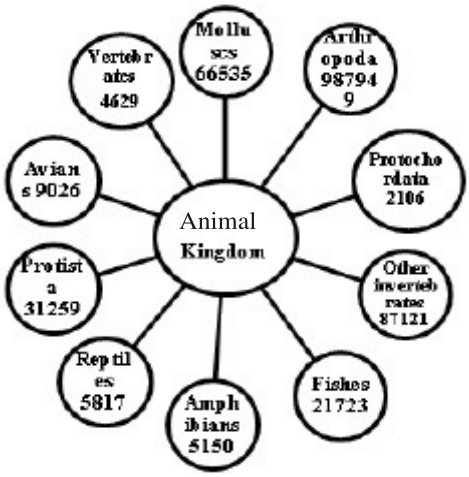


Figure 19.2 The Animal Diversity of the World

19.3 Biodiversity of India

India, due to its geographical location, has very rich biodiversity. India occupies only 2.4 percent of the total land of the world but it accounts for 7 to 8 percent of the total biodiversity found throughout the world. Almost all types of ecosystems that exist in the world such as grasslands, tropical rain forests, mangroves, coral reefs, river-valleys, islands, marshes etc. are found in India. Because of this reason, India has been included in 17 Mega biodiversity rich countries.

According to the report of the Ministry of Environment and Forest (2009) Government of India, 45968 plant species and 91364 animal species have been identified in India. The plant species comprises of 16,000 Fruit-Flowering plants, 12,500 Fungi, 2,500 Bryophytes, 2,300 Algae, 1,600 Lichens and 1,000 Ferns species. Similarly, 397 species of Mammals, 1232 of Birds, 460 of Reptiles, 240 of Amphibians, 2546 of Fish and 59300 Pests and Insect species are found here.

On account of its agricultural diversity, India has a prominent place in the world. In terms of its agriculture input, India has been placed on seventh place in the world. About 167 species of food crops are grown in India. About 50,000 varieties of rice and 1,000 varieties of mango are found in our country.

19.4 Biodiversity Hotspots

A place where a huge biodiversity is found is called as "**Biodiversity Hotspot**". This concept was first proposed by the British ecologist Norman Mayer in 1988. On this basis, 25 regions of the world were declared as biodiversity hotspot in 1999. At present, there are 34 biodiversity hotspots in the world. They accounts for 2.3% of the Earth's area.These hotspots host more than 50 percent of the world's endemic plant species.

There are two prerequisite conditions for declaring an area as a biodiversity hotspot -

(1) More than 0.5 percent of the total endemic species of the world should be present in that region. In terms

of number, at least 1500 endemic species should be present at that place.

(2) 70 percent habitation of that area must be redundant, that is, human activities have menaced the existence of that area. Such areas have an urgent need for protection, so they are declared as biodiversity hotspots.A large number of comprehensive conservative programs are organized at these places.

In the declared 34 biodiversity hotspots of the world, 42 endemic species of vertebrates, 55 species of fresh water fishes and 50 percent of plant endemic species are found. Some of the major biodiversity hotspots in the world are Atlantic Forest, East Malaysian Islands, Mountains of Southwest China, Islands of Madagascar, Central America, Colombia, Choco, Central Chile, Eastern Himalayas, Western Ghats, Sri Lanka, Indo- Burma etc.

19.4.1 Biodiversity hotspots of India

Among the biodiversity hotspots found globally, two - the Eastern Himalayas and Western Ghats are present in India while only a small portion of Indo-Burma Biodiversity Hotspot lies in India.

(1) The Eastern Himalaya Biodiversity Hotspot

The states of the east Himalayan regions like Assam, Arunachal Pradesh, Sikkim and West Bengal are part of this hotspot. The Himalayan mountain range is endowed with infinite biodiversity. The Himalayan biodiversity hotspot is spread in 7,50,000 sq km area and houses about 10,000 plant species, out of which 3,160 species are endemic. Apart from this, 300 species of mammals (12 are endemic), 997 species of birds (15 are endemic), 176 species of reptiles (15 are endemic), 105 species of amphibians (40 are endemic), 269 species of fish (33 are endemic) are also found here. Some of the key animals found in this area are - Himalayan Tahr, Golden Langur, Hoolock Gibbon, Pygmy Hog, Flying squirrel, Snow Leopard, Takin, Gangetic Dolphin etc.

Figure 19.3 Gangetic Dolphin

Do you know?

What is our national aquatic animal? In the year 2009, the Gangetic Dolphin was declared as India's National Aquatic Animal. The dolphin has the same significance in the river ecological system, which the tiger has in the forest.

(2) The Western Ghat Biodiversity Hotspot

The Western Ghats which are lined along the western coast of India is a major biodiversity hotspot of the world. This area is spread over 1,60,000 sq.km area, and includes the state of Kerala, Gujarat, Maharashtra, Goa, Karnataka and Tamilnadu. This hotspot hosts 5916 plant species out of which about 50 percent are endemic. Moreover 140 species of mammals (out of which 18 are endemic), 458 species of birds (out of which 174 are endemic), 267 species of reptiles (out of which 174 are endemic), 178 species of amphibians (out of which 130 are endemic), 191 species of fish (out of which 139 species are endemic) are found in this hotspot. The key animals found here include - Malabar Civet, Asian Elephant, Malabar Gray Hornbill, Nilgiri Tahr and lion tailed Macaque Monkey.

(3) Indo-Burma Biodiversity Hotspot

This hotspot spans about 23,73,000 sq Km area and extends in tropical East Asia covering parts of China, India, Myanmar, Vietnam, Thailand, Cambodia and Malaysia. This extensively large hotspot houses 13500 plant species, 433 types of mammalian species, 1266 types of amphibians and 1262 fish species.

Endemic Species-

Species which are found in a particular area, i.e., whose distribution or extension is limited to a specific area, are called **Endemic Species**. For example, the Lemur is limited to Madagascar Island only. Similarly,

Lion tailed Macaque Monkey

Metasequoia plant is found only in a specific valley of China. The Nilgiri Tahr and Lion tailed Macaque Monkey are found only in the Western Ghats of India.

Lemur

Therefore, endemic species of a place means that the said species could not be found anywhere else in the world.

Nilgiri Tahr

The main reasons for the endemic nature of a species are - the interaction between the region's climatic and geographical conditions and mutual interaction with other species. Due to the limited expansion of the endemic species, they are likely to get extinct or threatened. Therefore, there is a need to give special attention to their protection. The "Dodo" bird, which was firstly discovered in the year 1658, was an endemic species of an island of Mauritius. Due to the increased human activities and hunting on that island, this bird became extinct in just 23 years. It

Dodo

was last seen in the year 1681.

India is a nation which is rich in endemic species. Most endemic species of India are found in the Western Ghats, the north-eastern Himalayas and Andaman and Nicobar islands. In India, 17612 species of the wild animals, 44 species of the mammals, 57 species of the birds, 187 species of the reptiles and 110 species of amphibians are endemic. In addition, 5150 endemic species of plants are also found in India.

19.5 Importance of biodiversity

Biodiversity is a natural resource which can fulfill the natural and organic requirements needed for the life of organisms. This fulfills the basic necessities of human beings. The importance or value of biodiversity can be understood as per the following:

(1) Economic significance

Biodiversity directly provides us food, fuel, animal feed, building wood, industrial raw materials

etc. Due to biodiversity, we get diversified food, paddy, cereals, fruits and vegetables.

To meet the requirements of increasing population, biodiversity is being used to increase the agricultural yields as well as in the development of varieties of disease resistant and insect resistant crops. For example, the development of the dwarf varieties of wheat, which were responsible for the green revolution, was done from the Naren-10 variety of wheat found in Japan and the development of dwarf species of paddy was done from the **Dee-Geo-woo-gen** variety found in Taiwan.

In Asia, in the decade of year 1970, paddy crop in 1,60,000 hectare area was destroyed by the Grassy Stunt Virus. At that time, paddy species resistant to the above disease was developed by using the wild paddy species "*Oryzanivara*" which was collected in Eastern Uttar Pradesh in 1963. If this paddy species would not be preserved at that time, we could imagine the situation of Asia where majority of population is dependent on paddy.Today 20 genes of wild paddy are being used in Paddy Improvement Programs.

The compatible season provides favorable conditions for the production of different crops which could resist diseases. In this way, biodiversity of food grains acts as a boon for the humans.

Today, the entire world is worried for limited resources of petroleum and its uncontrolled exploitation. In such a condition, plants such as Jatropa and Karanja have shown a ray of new hope because the seeds of these plants can be used to develop organic fuels. These plants are also known as **biodiesel trees**.

(2) Medicinal value

Since ancient times, many herbaceous plants are being used for the treatment of many types of diseases. According to an estimate, approximately 40 percent of the medicines available today are obtained from the plants.

Treatment of many incurable diseases, which were reported from time to time on earth, has always been sought through the biodiversity. The treatment of incurable malaria fever was found in the bark of **Cinchona** plant. Similarly **Vincristine** and **Vinblastine** are used in the treatment of incurable blood cancer (Leukemia).

Bark of tree *Taxus baccata* is used in the treatment of cancer and *Rauvolfia serpentina* is used in the treatment of hypertension. Treatment of AIDS which has become an epidemic disease in today's world, is also possible with biodiversity. AIDS resistant properties have been found in plants like Tulsi, Brahmi, Ashvagandha, Shatavari, Gilgo, Giloya etc.

(3) Environmental value

(a) Protection of food chain

We know that in a food chain one organism consumes another, that is, one species depends on another species. Therefore, the extinction of any one species may result in a danger of the termination of the food chain. A rich biodiversity ensures multiple food chains (the food web) operating in an ecosystem. On extinction of any species in a food chain, another species operating in the food web can conserve the food chain by compensating its deficiency.

(b) Regulation of Nutrient cycle

Biodiversity is helpful in maintaining the nutrient cycle. The micro-organisms of soil break down the dead parts of plants and animals resulting in the replenishment of the nutrients back to the plants. This is how this cycle continues.

(c) Disposal of environmental pollutants

Biodiversity also plays an important role in the disposal of environmental pollutants. Some plants have the property of degrading and absorption of the pollutants. For example, a plant called *Catharanthus roseus* has the ability to disintegrate the deadly explosive chemicals like trinitrotoluene. Micro-organisms like *Pseudomonas putida*, *Arthobacter viscosus* and *Citrobacter spp*. have the ability to remove heavy metals from the industrial effluents. In the same way fungi *Rhizopus oryzae* has the ability to remove Uranium and Thorium and *Penicillium chrysogenium* has the ability to eliminate harmful

elements such as Radium.

(d) Social, cultural and spiritual significance

The human culture and environment has developed simultaneously. Before the today's modern and consumerist approach, a harmony existed between the humans and nature. Even today, some tribal societies are completely dependent on the nature to fulfill their needs. Some plants like Peepal, Banyan tree, Mango, Basil (Tulsi), Amla, Banana etc. still have very special place in our society and we worship them on some festivals. Similarly, some animals like cow, peacock, goose, rat, elephant etc. are also very special in our culture. Our country still has some reserve forest areas called Dev vans and people voluntarily conserve these places.

Considering the economic, environmental, social and cultural significance of biodiversity on a global scale, the year 2010 was celebrated as **International Biodiversity Year** by the United Nations, so that the world community should try to maintain and understand the importance of biodiversity. 22 May has been declared as the **International Biodiversity Day** by the United Nations.

In fact, biodiversity is an outstanding gift of nature which plays an important role in maintaining life on the Earth. Therefore, we all have the duty to protect the biodiversity so that life on earth could smile in its various forms.

19.6 Threats to biodiversity

Extinction of vegetation and animal species in nature or the emergence of new species is a natural phenomenon. Generally, one species of mammal extincts in 400 years and one ovian species lasts in 200 years. But at present, the human activities and the indiscriminate destruction of natural resources have increased this rate from 1000 to 10000 times. As a result the biodiversity is decreasing rapidly. According to an estimate, about 700 species have become extinct since the year 1600 AD. Today about 4000 species of animals and 60,000 species of plants are on the verge of extinction. At present one bird from every 8^{th} on Earth, one mammal from 4^{th}, one Coniferous tree out of 4, one amphibian in every 3, 6 of the 7 sea turtles are facing the risk of extinction. Not only this, today we have lost 75 percent of the genetic diversity of the agricultural crops. Due to excessive exploitation, about 75 percent of the world's fish are at the risk of extinction. In the last few years, Asian Cheetah, Javanese Rhinoceros, Himalayan Quail and Pink-headed Duck became completely extinct from India.

Following are some of the reasons for biodiversity loss seen today:

(1) Destruction of natural habitats

Nature has set aspecific habitat for every organism in which it dwells and increase its number as per the laws of nature . But in order to fulfill the needs of the growing population of the world, we are expanding the townships and agricultural land by destroying these natural habitats.

There are 50 million to 300 million species on our planet out of which over 50 percent species are found in the tropical forests. But today these forests are being cut at a rate of 1.7 crore hectare per year. If tropical forests were destroyed at this rate, then according to a scientific estimate, in the next 30 years, 5 to 10 percent of the plant and animal species inhabiting in these forests will become extinct. In the last 60 years due to deforestation in Europe, 50 percent of fungal species have become extinct. Similarly, the temperate rainforests are being destroyed at a rate of about 1 crore hectare per annum.Unfortunately, the majority of the extinct species could not be recognized by the scientists.

(2) Habitat Fragmentation

The natural habitats of wild creatures, which were earlier extensively and indiscreetly spread in the area, have now been disrupted by the construction of roads, railways, gas pipeline, canal, electricity lines, dams and farms. They have adversely affected the natural activities of the wild life and these creatures feel unsafe in such activities. When they encroach into

human habitats many wild animals are slayed by the vehicles or killed by local residents. Every year, about half a dozen tigers and many small animals meet with accidents on the railway track passing through the Dudhwa National Park.

(3) Climate change

Human activities have significantly enhanced the amount of greenhouse gases on earth. This has resulted in a continuous increase in the temperature of the earth. With the rise in the temperature, the ice on poles is melting rapidly and the water level of the sea is increasing.This has resulted in adverse impact on marine biological diversity. Because of the decrease in land availability, terrestrial biodiversity has been affected adversely. According to an estimate, if the temperature of the earth increases by 3.5 degrees centigrade, 70 percent of the species will face a danger of extinction.

(4) Environmental pollution

The environmental pollution badly affect the animals and plants. Many plants and animals are destroyed in the land and water, polluted by industrial effluents. Many micro-organisms and plants are destroyed by the acid rain caused due to the excessive air pollution. Similarly, the excessive use of chemical fertilizers and insecticides to increase agricultural yields, has resulted in extinction of micro-organisms found in the soil. This has an adverse impact on the fertility of the soil.

(5) Over Exploitation of the natural resources

The use of natural resources for the fulfillment of local needs is in no way harmful. But man has excessively exploited the trees and animals for his commercial benefits.This has resulted in a threat of extinction of many species. For example, frog legs in Europe and North America are used to increase flavor of food. Many Asian countries including India exported legs of frogs. In 1983, India exported 3650 Metric Tons of frog. This resulted in depletion of number of frogs in the forests and unexpected increase in pests which were otherwise would have been eaten by the frogs.Looking to the seriousness of the problem, on 1 April 1987, the Government of India has banned the business of the frogs.

(6) Commercial practices in Agriculture and Forestry

Prior to the Green Revolution, farmers used to grow various varieties of cereals, fruits, vegetables etc in their fields and kept many breeds of livestock. However, in the greed of getting more production in less time, today's farmer grows improved seeds varieties only and maintains the more productive hybrid species of livestock. These practices have resulted in steep decline in the genetic biodiversity. In Indonesia, from the last 15 years, 80 percent of the farmers are producing more productive hybrid varieties of rice. This has resulted in the extinction of 1500 local varieties of rice.This is a huge threat for the future because once a pandemic is spread; all the crops will be destroyed together and shall result in hunger problem.

In the same way, forests of the same species are being planted for meeting today's needs of paper, matches, plywood and industrial raw materials, thereby decreasing the faunal biodiversity.

(7) Invasion of foreign species

Many times, the existence of local species is threatened by the desirable or undesirable influx of foreign species and they cause an imbalance in the whole ecosystem. Some plant species such as Lantana and Hyacinthus were imported for beautification. The British had brought Lantana to India in 1807 and planted it in the Botanical Garden of Calcutta, but it gradually spread throughout the subcontinent. Today, this plant has become a menace for the local biodiversity because it does not allow other plants to grow near it nor do animals eat it. Similarly Hyacinthus, which is also called waterlili, due to its beautiful purple flowers,was brought to India from Brazil but today it has spread to so many water bodies of India. The uncontrolled pervasion of hyacinth prevents the sunrays to reach beneath

the water, as a result the plants present in the water are destroyed and due to lack of oxygen the organisms begin to die.

Similarly, some exotic species came involuntarily with imported food grains. For Example,congress grass (Parthenium) came to India along with the wheat imported from the US in 1950s. Congress grass is one of the most dangerous weed species of the world, which is not consumed even by the animals. This plant contains many chemical substances that cause allergies. This grass has become a huge threat to our local biodiversity.

Consider this with another example - some deer's were introduced in Andaman and Nicobar Islands almost 50 years ago, without keeping it in mind that there was no natural consumer of the deers. The result was that the number of deers enhanced rapidly and they consumed the local plants with a high pace and then turned towards the fields for their feeds. Thus, interference in the system of the nature without a concrete thinking not only affects the local ecosystem, but also messes up the social and economical system of the concerned area.

(8) Superstition and Ignorance

Due to superstition and ignorance of the people, the threat on some specific species of living beings increases tremendously. For example, due to the misleading concept of understanding the dialect of humans, people started to catch the Gagroni parrots (*Psittacula eupatria*) in large numbers and this resulted in their loss.The bird Godavan (The Great Indian Bustard/ *Ardeotis nigriceps*), being considered to be a sex enhancer, are hunted in larger numbers and hence are facing a great danger. Similarly, in the rural areas of Rajasthan, it is a misconception that the breath of Monitor lizard is poisonous, so the villagers try to kill it on the very sight.

19.7 Conservation of biodiversity

For the balance and general functionality of our biosphere and ecosystems, there is a need for maintaining the diversity of organisms and vegetation. But with the influence of modern man's selfishness and the consumerist culture, uncontrolled and excessive exploitation of the natural resources has caused destruction of the earth's biodiversity. As a result, presently many species of animal and plants are rapidly becoming extinct or endangered.

A number of efforts are being made at International, National and Local level to protect the endangered species.

19.7.1 International efforts

In view of the worldwide constant loss of biodiversity, in the year 1968, under the auspices of United Nations, an international organization - "**International Union for Conservation of Nature" (IUCN)** was formed. After an extensive worldwide four years study on Plants and Animals, a book called "**Red Data Book**" was published by this Institution in 1972. This book enlists the disappearing species, their habitat and their present number.

With the intension of their conservation, IUCN has divided the organisms of the world into 5 categories -

(1) Extinct species

Species which are no longer found anywhere in the world are called extinct species. For example - Dodo bird, Dinosaur, Rhynia plant etc.

(2) Endangered species

Species which are on the verge of extinction and if not protected will extinct soon. For example - Cheetah, Tiger, Leopard, *Ginkgo biloba*, Sarpagandha (*Rauwolfia serpentine*), etc.

(3) Vulnerable species

The species whose population is decreasing rapidly and soon expected to become an endangered species. For example - Yak, Nilgiri tahr, Red Panda, Cobra, Black bug etc.

(4) Rare species

Species which are usually limited to a particular geographical area or whose number is very sparse. For example - Red Wolf, Hainan Gibbon etc.

(5) Insufficiently known species

Those species about which sufficient information is not known and hence cannot be kept in a particular category.

In the year 1973, IUCN organized a convention called **Convention on International Trade in Endangered Species (CITES)**, in which various countries agreed to control the international trade of endangered species.

During the Earth Convention which was held in the City of Rio de Janeiro in Brazil in 1992, the **Biodiversity Treaty (CBD - Convention on Biodiversity)** came into existence. Till today it has been accepted by the 193 countries. Through this treaty, all the nations expressed their commitment to protect the biodiversity.

19.7.2 National Efforts

Keeping in mind the commitment of India towards the International Treaty on Biodiversity - CBD (Convention on Biodiversity), the Central Government in 2002 made the **Biodiversity Act 2002**, with the following three main objectives.

(1) Protection of biodiversity.

(2) Use of biodiversity in such a way that it can remain available for a long time (Sustainable use).

(3) Even distribution of the benefits obtained from utilization of biological resources of the country, so that it can reach to as many people as possible.

In order to achieve these objectives, there is a provision of a three-tier organization in the Biodiversity Act 2002 -**National Biodiversity Authority (NBA)** at the national level, **Biodiversity Board** at the state level and **Biodiversity Management Committees** at the local level.

In India, the **National Green Tribunal** has been formed on 2 June 2010 with an objective of bringing the environment, forest, water, air and biodiversity laws into the same lap. Now, the appeal under the said laws are filed in the National Green Tribunal but not in the High Court. This will resolve the disputes related to these matters faster. The National Green Tribunal has been headquartered in Bhopal.

19.7.3 Types of Biodiversity Conservation

The conservation of biodiversity refers to efforts made to protect the genes, species, habitats and ecosystems. Therefore, the best way to conserve biodiversity is to keep the whole ecosystem in its natural form. Biodiversity is currently preserved in two different ways.

(1) In-situ Conservation

The most suitable environment for the growth and development of an organism is provided by its natural habitat.The onsite conservation of the living organisms in their natural habitat which is maintained by the man is called **In situ conservation**.The endangered species which is to be protected is provided with its own natural habitat, favorable conditions and safety. For this, the Biosphere Reserves, the National Parks, the Wild Life sanctuaries and Conservation Reserves have been established. At present, 14 Biospheres Reserves, 99 National Parks and 523 Wildlife Sanctuaries and 47 protected reserves have been set up in India. A total of 1,58,745sq.km area of the country has been preserved in these reserves. This makes approximately 4.83 percentage of the total geographical area of the country.

(2) Ex- Situ Conservation

In this method of biodiversity conservation, the endangered plant and animal species are protected in artificial housing outside their natural habitat. For the protection of the plant species, Botanical Garden, Seed Bank, Tissue Culture Laboratories etc. have been established. Bird houses, aquarium etc. are established for the protection of the animals. The germplasm of the endangered plants and animals like seeds, fruits, pollens, spores, sperm and ovums are protected with the help of cryopreservation and slow culture technique. Moreover, the genes of the endangered plants and animals are preserved in their germination stage in the gene banks.

Important points

1. The diversity, asymmetry and ecological complexity found among the organism is called biodiversity.
2. Biodiversity is observed at three levels - species diversity, genetic diversity and ecological diversity.
3. A group of organisms whose members are identical in appearance and have the ability to produce their offspring's by reproduction in natural conditions is called a species.
4. The diversity found among the members of a species caused due to the genetic makeup of the individuals is called Genetic Diversity.
5. The diversity found among the members inhabiting in different ecosystems due the differences in geographical and environmental conditions is called ecological diversity.
6. As per an estimate, scientists have identified only 7 percent of the species found in the world.
7. On account of its biodiversity, India has been included in the list of 17 mega biodiversity rich countries.
8. The regions where enormous biodiversity is found are called biodiversity hotspots.
9. Total 34 biodiversity hotspots are found in the world.
10. Two biodiversity hotspots exclusively found in India are - East Himalaya biodiversity and Western Ghats. The Indo Burma Biodiversity hotspot is spread in many countries. Some part of India is also covered in it.
11. In 2009, the GangeticDolphin was declared as the National Aquatic Animal of India.
12. Species which are found in a particular area, i.e., whose distribution or extension is limited to a specific area, are called endemic species.
13. 22 May has been declared as the International Biodiversity Day by the United Nations.
14. Biodiversity is very important for the humans. It is not only important for the economy but also important for the environment, society, medical and other reasons.
15. Presently due to the human activities and exploitation of the natural resources, the extinction rate of many species has enhanced.
16. The climate change, habitat fragmentation, habitat loss, over exploitation of the natural resources, commercial agriculture and forestry practices, superstition and ignorance etc are the main reasons for the loss of biodiversity.
17. A number of efforts are being made at International, National and Local level to protect the Biodiversity.
18. An international organization called International Union for Conservation of Nature (IUCN) was formed in 1968. After an extensive study, this Union has published a book called Red Data Book.
19. For their conservation the IUCN has classified the organisms into five categories - Extinct species, Endangered species, Vulnerable species, Rare Species and Insufficiently known species.
20. India made a Biodiversity act in 2002 in which a three-tier organization (National Biodiversity Authority, State Biodiversity Authority and Biodiversity management committee) was proposed.

Practice questions

Objective type questions

1. Unit to measure the balance of an ecosystem is
   (a) Species (b) Biodiversity
   (c) Animal diversity (d) None of the Above
2. In terms of its agriculture input, India acquires ……..place
   (a) Eight (b) Ninth
   (c) Seventh (d) Tenth

3. The total number of Biodiversity hotspots in the world are
   (a) 25 (b) 20
   (c) 34 (d) 33
4. National Aquatic Animal of India is
   (a) Gangetic Dolphin (b) Whale
   (c) Star Fish (d) None of the above
5. Which among the following hotspot is present in India?
   (a) Madagascar Hotspot
   (b) East Malaysia Islands
   (c) Indo Burma Hotspot
   (d) None of the above
6. International biodiversity day is observed on
   (a) 21 May (b) 23 May
   (c) 22 May (d) 24 May
7. International biodiversity year was observed on
   (a) 2012 (b) 2010
   (c) 2011 (d) 2009
8. Presently how many animal species are on the verge of extinction?
   (a) 8000 (b) 2000
   (c) 2800 (d) 4000
9. Due to misconception, which of the following organism is killed by the villagers?
   (a) Monitor lizard
   (b) Godawan (Great Indian Bustard)
   (c) Frog (d) Dodo
10. At which of the following place does the earth summit in 1992 was held?
    (a) New Delhi (b) Paris
    (c) Perth (d) Rio-de-Janeiro

Very short type questions

11. Write three levels of biodiversity.
12. What percentage of the total species found in the world have been identified by the scientists?
13. What are Biodiversity hotspots?
14. Which is National Aquatic Animal of India?
15. Write names of Biodiversity hotspots of India.
16. Write names of two endemic species.
17. Write names of two endangered species.
18. Which position does India has in terms of its biodiversity?

Short type questions

19. What is Biodiversity? Explain.
20. Explain the biodiversity found in East Himalayan Biodiversity Hotspot.
21. Which countries are included in Indo- Burma Biodiversity Hotspot?
22. What is the impact of invasion of foreign species on the Biodiversity?
23. "Export of frof legs has adversily effected the biodiversity". Explain this statement.
24. Illustrate the National level efforts made for the conservation of biodiversity.
25. Write the types of biodiversity conservation.

Essay type questions

26. Explain the levels of biodiversity.
27. Explain the biodiversity hotspots.
28. Illustrate the importance of Biodiversity.
29. Explain the reasons responsible for the loss of biodiversity.
30. Write an essay on efforts made for the conservation of biodiversity.

Answer key

1. (a) 2. (c) 3. (c) 4. (a) 5. (c) 6. (c)
7. (b) 8. (d) 9. (a) 10. (d)

Chapter - 20
Road Safety Education

Objective :

This chapter explains aout the chemistry of alchol and its harmful effects. Drunken Driving is a major cause of road accidents.

Content :

Alcohol is a depressant that slows down the mental processes. It affects thinking and performance. It affects the brains's ability to control and coodinate the body's movements- It impairs the ability to judge speed and distances, restricts the view and makes accidents occur. It impairs reaction time, coordintation and balance. You know the simple rule: Don't Drink and Drive

Impact of Drunken Driving

'Don't Drink and Drive'

The blood alcholol concentration (BAC) is critical. The legal limit is below 30 mg of alcohol in every 100ml of blood. It can be analyzed through a breath analyzer and if found more than the prcscribed limit, it is punishable.

Some medicines may also affect the driver's concentration.

Medicines

Section 185 of Motor Vehicle Act can punish a driver who is under the infulence of alcohol with a fine upto Rs. 2000 or imprisonment with a term which may extend upto 6 months. With a subsequent offence within 3 years, imprisonment increases to 2 years and a fine of Rs. 3000.

Exercise :

1. Can the level of alchol in your blood be reduced by exercise, coffee, medicines etc?

2. Does alchol build one's confidence in driving or only gives a deceptive feelings?

Activity :

Find out how many people have been prosecuted by Delhi Police for drunken driving in 2012.

Life Processes

Objective :

Importance of good eyesight has been brought out in safe driving

Content :

At night or in conditions of poor visibility, you cannot

see people and objects around you, as you can in day light. If eyesight is weak or a person suffers from night blindness, driving at night can be dangerous. Inconsiderate drivers, often blind us with dazzling headlights, making objects in front of us not visible. Drive slowly at night so as to gain reaction times. The four wheeler wind screen should be kept clean at night, because dirty wind screen may impair your vision and lead to accidents.

Good Eye Sight important for Drivers

In conditions of low visibility, make use of lamp or dipper beams.

Similarly in dense fog, a driver cannot see beyond his own vehicle's limit. You can stick yellow cellophane paper to your vehicle headlights with cello-tape.

Vission while overtaking large vehicle and at sharp road bends is limited. The trafic authority carries out mandatory check of vision, along with colour and night blindness, before issuing a driving license. Eyes are the most sensitive part of the face and need to be protected.

Dipper Beams Help in driving in night

Headlight of a car

It is difficult to drive on the slopes of mountain roads

Exercise :

1. What type of bulb is used in fog lamps ?

2. How does yellow cellophane paper help to drive on a foggy day?

Driving in fog

Activity :

Prepare a list of students who are myopic. Find out the power of the lens they are wearing. Look for information that helps in the upkeep of our eyes.

Control and Coordination

Objective :

Importance of good cyesight has been brought out in safe driving.

Content :

All activites of daily life require a great deal of control and coordination like walking hearing, driving, playing swimming etc. Driving requires a great deal of

control and coordination of our body parts. Our reflexes will be greatly affected it one is not healthy and one's mind is not in control. Driving is affected by a variety of factors like fatigue, unwillingness to work, alcohol, drugs. state of mind, distractions of children and loud music in the vehicle etc.

Driver feeling tired and sleepy

Driving is a motor skill associated with information stored in the brain. It is a voluntry action requiring time to respond. Emotionally unstable people may engage thmeselves in undesirable behaviour on roads and this is called road rage. They may abuse, hurt others and themselves also. Certan incidents which are fresh in your memory also cause accidents.

The conditions may be different for drivers of two wheelers. Why are people challaned for not wearing helmets? Since authorities are concerned for their lives and the head may be saved from injuries Injuries may be fatal for pillion riders also. You must follow the rules of the road for your own safety. Think of a situation in which a member of the family becomes permanently disabled in an accident. The whole family is affected because the tretment costs a lot of money.

It is always difficult to keep the morale of disabled persons high. It is an irony that for your own safety, the laws have to be framed and enforced.

Driver can get distractracted by Mobile or children in the Vehicle

Everybody must be aware of the emergency first aid situation. Ignorance is not a bliss in this case.

In case of a road accident the type of injuries may be.

Head injury
Spinal injury
Chest injury
Fractures, cuts, burns, amputation of limbs

Road rage

Man talking on phone while driving

Casualties can be prevented through proper administration of First-aid and breathing. Bleeding and other injuries should be taken care of excess loss of blood even from the limbs can prove fatal.

Control yourself and coordinate mentally with other drivers on the road by following the laws of the road, Traffic rules help us on the road by regulating warning and guiding the traffic

Man injured in a road accident

Exercise :

1. Why is a cell phone prohibited by the law for a person driving ?
2. What is the punishment for using a cell phone during driving ?
3. How do we make children below the age of 10 travel in a vehicle?
4. Draw two other shapes which give mandatory signs.

Activity :

1. An accident happens in which three persons are fatally injured, drivers of two vehicles and a co-passenger. How will you respond in such a sutuation? Draw a schematic diagram of the actions taken by you as an ideal road user ?

2. Call a doctor and undergo a first and training course.

3. Look up the 1989 judgment of the Supreme Court of India which made it clear that there car be no legal impedimens to save human life. Discuss the role of citizens in saving life of a road accident victim. Also cite the importance of the Golden Hour.

Accident victim on a wheelchair

People helping accident victim

Do You Know ?

Anyone CAN HELP accident victims to reach hospital

Police will NOT ask you any question

Doctors SHOULD attend the accident victims immediately

OBEY this Supreme Court Directive to SAVE LIVES

Light

Objective :

You have studied in this chapter that various type of mirrors are used in vehicles. These mirrors help the driver to drive safely on road.

Content :

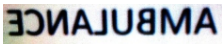
In the previous classes you have learned that the image formed by a plane mirror is virtual and erect. This plane mirror fitted near the driver helps him to see an erect image of the near by objects.

A virtual and erect image is formed which helps the driver to react correctly.

What is this phemomenon called ?

Ambulance

The word AMBULANCE is written as



You have read in this lesson that concave mirrors are used in the headlights of vehicles to get parallel beam of light. This helps the driver to see objects at far and distant places.

Headlight of a car

However driving in busy traffic with powerful beam blinds the driver coming from the opposite side during the night. Drivers therfore should use low intensity beam on busy roads at night.

High beams are used on highway where the speed is more and the driver needs to see objects at far off distances, in advance. The street lights used to illuminate roads use concave mirrors. The use of convex mirrors for rear view is done by the driver of bigger vehicles like bus. Truck trailer etc. The car driver should also use it for safe driving.

Exercise :

1. Which type of mirror is used in the headlight of vehicles?

2. Why is a convex mirror used as a rear view mirror?

Rear view mirror

Activity :

1. Find out the phone numbers of all emergency vehicles.

2. Discuss the various types of indicators available in a vehicle.

Indicator

Electricity

Objective :

Vehicle care is most important for safety. A battery is the most important component of a vehicle.

Content :

The source of electric current in an automobile is the battery, depending upon the size of the vehicle. The battery is used to draw cuurent to start the motor, to use the horn, to light the various bulbs used in the vehicle. The current given by a battery is a D.C. current.

Car batteries

Maintenance of vehicle is important

Exercise :

1. A bulb used in car Headlamps is marked 12V/ 60W. Calculate the current flowing through it when lit?
2. One Horsepower is 746 Watt and a car is labeled 75Hp. How many joules of energy does it use in one second?
3. Why does the battery of a vehicle get discharged if not in use for a long period of time?

Bulb used in car

Activity :

Visit a near by work shop to see a battery used in a vehicle.

Glossary

Abiotic - अजैविक
Absorption - अवशोषण
Acceleration - त्वरण
Acid Rain - अम्लीय वर्षा
Acquired - उपार्जित प्रतिरक्षा
Activity - गतिविधि
Adaptation - अनुकूलन
Adolescent - किशोर
Adsorption - अधिशोषण
Aerobic - ऑक्सीश्वसन
Air resistance - वायु प्रतिरोध
Airsac or alveoli - वायुकोश
Algal blooming - शैवाल प्रस्फुटन
Alimentary - आहारनाल
Allele - युग्म विकल्पी
Alveoli - कूपिका
Amphibia - उभयचर
Amplitude - आयाम
Anabolic - उपचयी या संश्लेषी
Anaerobic - अवायवीय श्वसन
Anemia - रक्त क्षीणता
Angiosperm - आवृतबीजी
Angle of - परावर्तन कोण
Anti clockwise - वामावर्त
Antibody - प्रतिरक्षी
Antigen - प्रतिजन
Antigenic - एण्टीजनी निर्धारक
Anus - मलद्वार
Arteries - धमनियाँ
Arteries - धमनी
Artificial statellite - कृत्रिम उपग्रह
Asexual - अलैंगिक जनन
Ash - राख
Asteroids - क्षुद्र ग्रह
Astronomer - खगोलविद्
Astrophysics - खगोल भौतिकी
Atmosphere - वायुमण्डल
Atomic theory - परमाणु सिद्धान्त
Atomic weight - परमाणु भार
Atomicity - परमाणुकता
Atrium - अलिंद
Attractive - आकर्षक
Auricle - आलिन्द
Autologous blood - समजीवी आधान
Autotrophs - स्वपोषी
Average velocity - औसत वेग
Axon - तंत्रिकाक्ष
Back cross - संकरपूर्णज संकरण
Bacteria - जीवाणु
Balance diet - संतुलित आहार
Binary fission - द्विविखण्डन
Bio Medical - जैव चिकित्सकीय अपशिष्ट
Biodegradable - जैव निम्नीकरणीय
Biodiversity - जैवविविधता
Biological - जैविक आवर्धन
Biosphere - जीव मण्डल
Biosphere - जीवाश्म
Biotic - जैविक
Blood - रक्ताधान
Blood pressure - रुधिर दाब
Blue green - नीले, हरे शैवाल
Boiling point - क्वथनांक
Bolide - उल्काश्म
Bone marrow - अस्थि मज्जा
Brittle - भंगुर
Bronchi - वसनी
Bronchioles - वसनीकाएँ
Bronchitis - अस्थमा

Buccal cavity - मुखगुहा
Buoyancy - उत्प्लावकता
Canines - रदनक
Cannula - प्रवेशनी
Carbohydrate - कार्बोहाइड्रेट
Catabolic - अपघटनी या अपचयी
Cecum - अधांन्त्र
Centrifugal force- अभिकेन्द्र बल
Cerebellum - अनुमस्तिष्क
Cerebrum - प्रमस्तिष्क
Characteristics - अभिलक्षण
Chemical - रासायनिक संयोग
Chemoautotrophs- रसायन–संश्लेषी
Chlorosis - हरिमाहीनता
Chordata - पृष्ठवंशी
Chromoplast - वर्णीलवक
Chromosomes - गुणसूत्र
Cilia - पक्ष्माभ
Circular motion - वृत्ताकार गति
Circulation - परिसंचरण
Cleavage - विदलन
Clock wise - दक्षिणावर्त
Colon - वृहदान्त्र
Combustible - दहनशील
Comets - धूमकेतु
Component - अवयव
Compressibility - सम्पीड्यता
Concentration - एकाग्रता
Concentration - सान्द्रता
Conductivity - चालकता
Conductor - चालक
Conservation - प्रकृति का संरक्षण
Constellations - तारामण्डल
Constipation - कब्ज
Consumer - उपभोक्ता
Contraction - संकुचन
Controversial - विवादास्पद
Controversial - विवादास्पद
Covalent radius - सहसंयोजक त्रिज्या
Crossing over - जीन विनिमय
Cryophyte - शीतोद्भिद
Curse - अभिशाप
Dam - बाँध
Deaf - बहरा
Decomposer - अपघटक
Deformity - विकृति
Degree - अंश
Dendrite - द्रुमाश्य
Dendrone - द्रुमाक्ष्य
Density - घनत्व
Dependent - आश्रित
Desertification - मरूस्थलीकरण
Detergent - अपमार्जक
Developing - विकासशील
Diabetes - मधुमेह
Dicot - द्विबीजपत्री
Digestion - पाचन
Diphyodent - द्विबारदंती
Direct current - दिष्ट धारा
Disease - रोग
Displacement - विस्थापन
Disposal - विसर्जन
Distance - दूरी
Distillation - आसवन
Dominant - प्रभावी
Double - दोहरा परिसंचरण तंत्र
Drought - सूखा
Duodenum - ग्रहनी
Echo - प्रतिध्वनि
Ecology - परिस्थितिकी
Economic cycle - आर्थिक चक्र
Ecosystem - पारिस्थितिक तंत्र
Ectoparasite - बाहा परजीवी
Electric - विद्युत विसर्जन नलिका

Electric current - विद्युत धारा
Electrolysis - वैद्युत अपघटन
Electromagnet - विद्युत चुम्बक
Emasculation - विपुसंन
Endangered - संकटग्रस्त
Endemic - स्थानबद्ध
Endocrine glands- अन्तःस्त्रावी ग्रंथियों
Endocrine system- अन्तःस्त्रावी तंत्र
Endoparasite - अंतःपरजीवी
Environment - पर्यावरण
Epiglottis - घाटी ढवकन
Eugenics - सुजननिकी
Eutrophic - सुपोषी
Evolution - जीव–विकास
Exhalation - उच्छवास
Ex-situ - बहिस्थाने–संरक्षण
Extinct - विलुप्त
Faint - मूछों
Fallopian tubes - अंड वाहिनी
Fat - वसा
Fat - वसा
Fermentation - खमीरीकरण
Fertilizer - उर्वरक
Flood - बाढ
Food chain - खासव श्रृंख्ला
Force - बल
Forest products- वनोपज
Fossil fuel - जीवाश्म ईंधन
Free fall - मुक्त पतन
Frequency - आवृत्ति
Full moon day - पूर्णिमा
Fund - कोष
Fungicide - कवकनाशी
Galaxy - आकाश गंगा
Gamete - युग्मक
Gastric juice - जठर रस
Generator - जनित्र
Genetic diversity- आंनुवांशिक विविधता
Genetics - आनुवांशिकी
Genotype - जीनप्रारूप
Geography - भूगोल
Gill - क्लोम
Global warming- वैश्विक ऊष्मीकरण
Goitre - गलगंड
Gonads - जनद
Gravitational - गुरूत्वीय बल
Gravity - गुरूत्व
Grazing land - चरागाह
Habitat - आवास विखण्डन
Haemolysis - रुधिरलयनता
Halophyte - लवणोद्भिद
Health - स्वास्थ्य
Heart disease - हृदय रोग
Heart - हृदय
Herbicide - शाकनाशी
Hereditary - आनुवांशिक
Heredity - वंशागति
Heterotrophs - परपोषी
Heterozygous - विषमयुग्मजी
Holozoic - प्राणीसमभोजी जीव
Homozygous - समयुग्मजी
Hot spot - तप्त स्थल
Humidity - आर्द्रता
Hybridization - संकरण
Hydrophyte - जलोद्भिद
Hydrosphere - जैविक
Hydrosphere - जलमण्डल
Ileum - क्षुदात्रं
Immunity - प्रतिरक्षा
Incisors - कृतंक
Incompatibility - अनिशेच्यता या असंगतता
Indicator - सूचक

Induced - प्रेरित
Industrial products- औद्योगिक उत्पाद
Inertia - जड़त्व
Infection - संक्रमण
Infra - अपश्रव्य
Infra-red - अवरक्त
Innate immunity - स्वभाविक प्रतिरक्षा
Insecticide - कीटनाशक
In-situ - स्वः स्थाने संरक्षण
Inter auricular - अन्तर्आलिन्दीय पट
Inter ventricular - अन्तर्निलयी पट
Intersity - तीव्रता
Invertibrate - अकशेरूकी
Irrigation - सिंचाई
Isobar - सममारिक
Isotope - समस्थानिक
Jaundice - पीलिया
Jejunum - अग्रक्षुदांत्र
Judicial - न्यायिक
Kidney - वृक्क
Land fill - भूमिभराव
Landslide - भूस्खलन
Larynx - स्वरयंत्र
Launching - प्रक्षेपण
Law of motion - गति के नियम
Lead - सीसा
Life cycle - जीवन चक्र
Light year - प्रकाश वर्ष
Line of force - बल रेखा
Lithosphere - स्थल मण्डल
Liver - यकृत
Loudness - प्रबलता
Lubricant - स्नेहक
Lungs - फेफड़े
Lymph node - लसीका पर्व
Mammal - स्तनधारी
Mantle - आवरण
Mars - मंगल ग्रह
Marshy, - दलदली
Mass - द्रव्यमान
Matrix - आधात्री
Mechanical - यांत्रिक ऊतक
Medicines - औषधियाँ
Meditation - ध्यान
Memory - स्मृति
Mercury - बुध ग्रह
Mesosphere - मध्यमंडल
Metabolic - उपापचयी
Metallic radius - धात्विक त्रिज्या
Metallurgy - धातु कर्म
Meteorites - उल्कापिण्ड
Meteors - उल्का
Microorganism - सूक्ष्मजीव
Milky ways - आकाशगंगाएँ
Mineral - खनिज
Mineral - खनिज लवण
Mines - खानों
Mining - खनन
Modulator - माडुलटेर
Molecular - आणुविक
Momentum - संवेग
Monocot - एक बीज पत्री
Motion - गति
Multi cellular - बहुकोशिक जीव
Muscles - पेशियाँ
Mutation - उत्परिवर्तन
Nasal chamber - नासागुहा
Nasal passage - नासामार्ग
Natural satellite - प्राकृतिक उपग्रह
Natural science - प्राकृतिक विज्ञान
Natural - प्राकृतिक
Nervous system- तंत्रिका तंत्र
Nervous tissue - तंत्रिका ऊतक

Nervous - तंत्रिकीय
Non renewable - अनवीकरणीय
Non-Biodegradable- अजैव निम्नीकरणीय
Decompost - अपघटन
Nostril - नासाछिद्र
Nuclear - नाभिकीय
Nutrition - पोषण
Oesophagus - ग्रासनली
Omnivorous - सर्वाहारी
Orbit - कक्षा
Oscillator - दोलित्र
Paleobotanist - पुरावनस्पति शास्त्री
Pancreas - आश्रित
Parasites - परजीवी
Paratope - पैराटोप
Parenchyma - मृदूत्तक
Parotid gland - कर्णपूर्वी ग्रन्थि
Partial - आंशिक परजीवी
Particulate - कणिकीय
Pathogen - रोगजनक
Peristalsis - क्रमांकुचन
Permanant - स्थायी परजीवी
Pharynx - ग्रसनी
Phases of - चन्द्रमा की कलाएँ
Phenotype - लक्षणप्रारूप
Planets - ग्रह
Plant cell - पादप कोशिका
Plantation - वृक्षारोपण
Plastid - लवक
Platelets - बिबांणु
Pole Star - ध्रुवतारा
Poles - ध्रुव
Pollen grain - परागकण
Pollination - परागण
Pollutant - प्रदूषक
Pollution - प्रदूषण
Possible - संभाव्य
Potential - विभव
Power - शक्ति
Pregnant - गर्भवती
Premolars - अग्र चवर्णक
Pressure - दाब
Producer - उत्पादक
Propagation - प्रवर्धन
Puberty - यौवनांरभ
Radar - राडार
Radiation - विकिरण
Rare - दुर्लभ
Reaction - प्रतिक्रिया
Reading - पाठ्यांक
Recessive - अप्रभावी
Rectum - मलाशय
Recycling - पुनचक्रंण
Recycling - पुनर्चक्रण
Red blood - लाल रूधिर कणिका
Redioactive - रेडियोधर्मी
Reflected rays - परावर्तित किरण
Reflection - परावर्तन
Reflex action - प्रतिवर्ती क्रिया
Reflex arch - प्रतिवर्ती चाप
Refraction - अपवर्तन
Regeneration - पुनरूद्भवन
Regulation - नियमन
Relative - आपेक्षिक
Relativity - सापेक्षतावाद
Rendering - दारण
Renewable - नवीकरणीय
Reproduction - जनन
Reproductive - प्रजनन अंग
Reptile - सरीसर्प
Research - अनुसंधान
Resistance - प्रतिरोध

Resistant - प्रतिरोधक
Resistivity - प्रतिरोधकता
Resource - संसाधन
Respiration - श्वसन
Respiratory organ - श्वसन अंग
Reverberation - अनुरणन
Revolution path - क्रांति पथ
Rh (Rhesus factor) - आर एच
Rheostat - धारा नियंत्रक
Rolling - लोटनी
Roughage - रुक्षांश
Scalar - अदिश
Science - विज्ञान
Scientific - वैज्ञानिक विधि
Sewage - वाहित मल
Sex - मैथुन
Sexual - लैंगिक जनन
Shell - कोश
Sign of zodiac - राशि
Skin diseases - चर्मरोग
Smoking - धूम्रपान
Soil erosion - मृदा अपरदन
Solar system - सौर परिवार
Solenoid - परिनालिका
Sonic boom - ध्वनि बूम
Sound - ध्वनि
Species - जाति विविधता
Specific - विशिष्ट प्रतिरोध
Spectrum - वर्णक्रम
Sphincter - सवरणी पेशियाँ
Spleen - प्लीहा
Spontaneous - स्वतः जनन वाद
Squamous - शल्की उपकला
Starch - मण्ड
Stars - तारे
Stomach - आमाशय
Stone - पथरी
Stratosphere - समतापमंडल
Sublingual - अधोजिह्वा
Submandibular - अधोजंभ
Super conductor- अति चालक
Survival - उत्तरजीविता
Symbiosis - सहजीविता
Synchronisation- तुल्यकालन
Synthetic - कृत्रिम
Technology - प्रौद्योगिकी
Tension - तनाव
Test cross - परीक्षण संकरण
Test tube baby - परखनली शिशु
The global line - विषुवत रेखा
Theory of - जीव जननवाद
Thermodynamcis- ऊष्मागतिकी
Thrust - प्रणोद
Tides - ज्वारभाटा
Time period - आवर्तकाल
Tissue damage - उत्तकक्षय
Tissue - ऊतक
Toxic - विषाक्त
Trachea - श्वासनली
Transparent - पारदर्शी
Transportation - परिवहन
Trophic level - पोष स्तर
Tropical - कटिबंधीय
Troposphere - क्षोभमंडल
Turgid - स्फीत
Ultrafiltration - परानिस्यंदन
Ultrasonic - पराश्रव्य
Ultraviolet - पराबैंगनी
Unicellular - एककोशिक जीव
Unit - मात्रक
Universal law - सार्वत्रिक नियम
Universal - सर्वव्यापक

Universe - ब्रह्माण्ड
Unused land - अवक्रमित भूमि
Unwanted - अवांछित
Unwise - अविवेकपूर्ण
Ureter - मूत्रवाहिनियाँ
Uriferous tubules- मूत्र नलिकाएँ
Urinary bladder- मूत्राशय
Ursa major - सप्तर्षि
Vaccum - निर्वात
Valency - संयोजकता
Variation - विभिन्नता
Vas difference - शुक्रवाहिनी
Vascular tissue - संवहन ऊतक
Vector - सदिश
Veins - शिराएँ
Velocity - वेग
Vena cava - महाशिरा
Ventricle - निलय
Venus - शुक्र ग्रह
Virus - विषाणु
Vitamin - विटामिन
Vivipary - जरायुज
Volcano - ज्वालामुखी
Vulnerable - अतिसंवेदनशील
Water - जल
Wavelength - तरंगदैर्ध्य
Weed - खरपतवार
Weight lessness- भारहीनता
Weight - भार
White blood - श्वेत रक्त
Yoga - योग
Zodiac - राशिचक्र
Zygote - युग्मनज