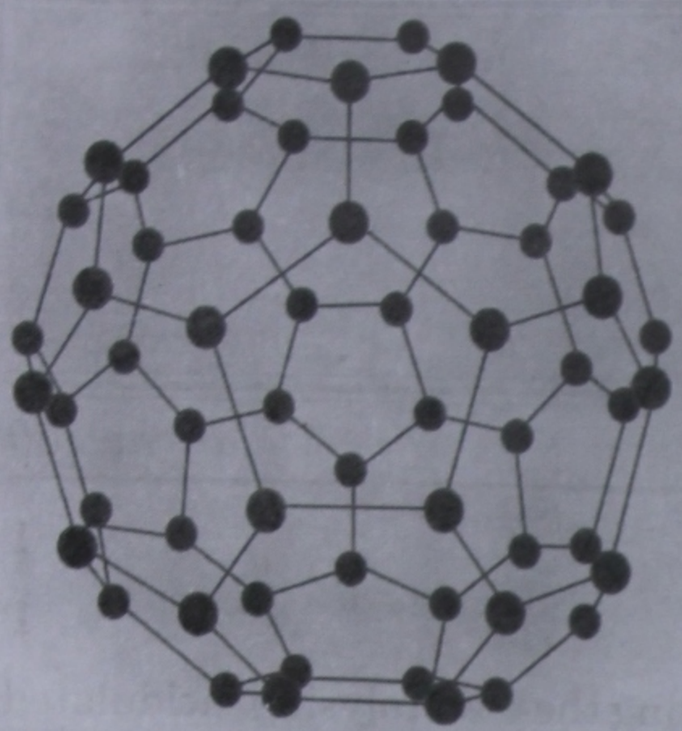


7

ATOMIC STRUCTURE

SCOPE OF SYLLABUS

Structure of an Atom, mass number and atomic number, Isotopes and Octet Rule.
Definition of an element, definition of an atom; constituents of an atom – nucleus (protons, neutrons) with associated electrons; mass number, atomic number. Electron distribution in the orbits - $2n^2$ rule, Octet rule. Reason for chemical activity of an atom. Definition and examples of isotopes (hydrogen, carbon, chlorine).

IMPORTANT POINTS TO REMEMBER

1. **Atom** is the **tiniest particle** which **cannot** be further **divided**. The concept of **indivisibility** of **atom** is given by **John Dalton**.
2. After the **discovery** of **electron** by **J.J. Thomson**, the concept of **indivisibility** of **atom** was proved **wrong**. The **electrons** are the **negatively charged particles** bearing a **unit negative charge**.
3. **Protons** were **discovered** by **Goldstein**. **Protons** are the **positively charged particles** bearing a **unit positive charge**.
4. **Neutrons** were **discovered** by **Chadwick**. **Neutrons** are **chargeless**.
5. An **atom** is **electrically neutral**, *i.e.*, the **number** of **positively charged particles** (protons) is equal to the **number** of **negatively charged particles** (electrons).
6. **Nucleus** was **discovered** by **Rutherford** when he conducted the **scattering experiment**. He **bombarded alpha particles** over **gold foil**. It was observed that **most** of the **particles** passed **undeflected** and **some** of the **particles** suffered a major **deflection**.

   The following **conclusions** were **made** upon the above **observations** :

   (*i*) **Atom** as a whole is an **empty space**.

   (*ii*) The **positively charged mass** (called nucleus) is **concentrated** in a **very small portion**.
7. On the basis of the above **experiment Rutherford** proposed the **model** of an **atom** :

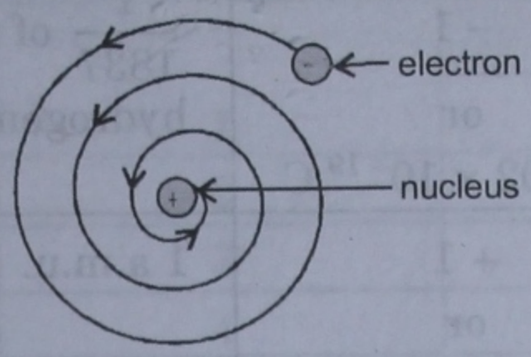
   (*i*) The **size** of **nucleus** is **very small** as compared to the **size** of an **atom**.

   (*ii*) **Atom** as a whole is an **empty space**.

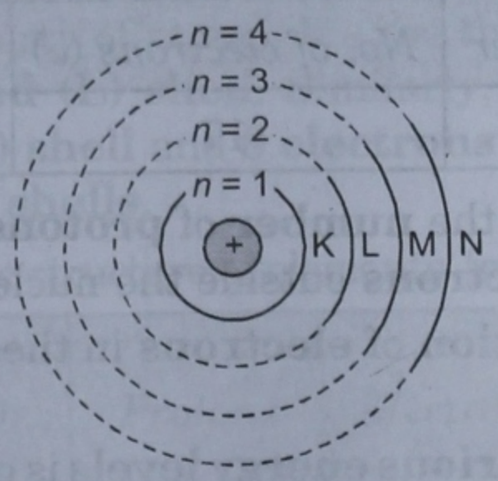
   (*iii*) **Nucleus** is present at the **centre** of the **atom** and it consists of **positively charged particles**. The **particles** present **inside** the **nucleus** are called **nucleons**.

   (*iv*) The **electrons** present in an **atom** are **revolving around** the **nucleus** at a **very high speed** at various distances (not fixed).
8. The **Rutherford model** of **atom could not** provide **stability** to the **nucleus**. As according to the **electromagnetic theory** a **charged particle** moving in a **circular path** continuously **loses energy**

in the form of **electromagnetic radiations** and hence it gradually **moves towards the nucleus** and **falls** into the **nucleus** following a spiral path.



9. **Bohr's model** of **atom** could give **stability** to the **nucleus** as Bohr suggested that at the **centre** of the atom, **nucleus** is present and **outside** the **nucleus** in the **fixed orbits** the **electrons** are **revolving around** the **nucleus**.
10. As long as electron is **revolving** in its certain **fixed orbit**, it will **neither lose energy nor** it will **gain energy**.
11. The **orbits** are also called as **energy levels** or **shells** as they are **associated** with the certain **fixed amount** of **energy**.
12. The **shells** or **orbits** or **energy levels** are numbered as **1, 2, 3, 4,** ..... or designated as **K, L, M, N,** ..... . respectively.
13. The **electron cannot move** in the **space** between the **orbits** as it is a **forbidden area** or **territory**.
14. **Electrons** absorb **definite amount** of **energy** in the form of **quanta**. **Quanta** are the **packets** of **energy**.
15. If the **electron jumps** from **lower level** to **higher level**, then it **absorbs** the **energy** in the form of **quanta**.
16. The **energy** of the electron **increases** as it moves **away** from the **nucleus**, *i.e.,* the **electron** present in **K-shell** has the **minimum energy** and the **electron** present in **N-shell** has the **maximum energy**.



17. **Mass** of an **atom** is **concentrated inside** the **nucleus** of an **atom** and the **electrons** around the nucleus in **fixed path** are of **negligible mass**. Thus, **mass** of the **atom** must be equal to the **mass** of total number of **protons** present **inside** the **nucleus** of an atom. But, it was **experimentally** found out that the **mass** of an **atom** is far more than the **mass** of total number of **protons** in the nucleus. Thus, inside the nucleus there must be another **neutral sub-atomic** particles present which are contributing towards the **increase** in **mass** of the **nucleus**. This **electrically neutral particle** was discovered by **Chadwick** and it was named as **neutron**.
18. The **modern view** about the **structure** of **atom** suggests :
    (*i*) **Inside** the **nucleus, protons** and **neutrons** are present which are collectively called **nucleons**.
    (*ii*) The **electrons** are **revolving around** the **nucleus** in **fixed orbits**.
    (*iii*) The **mass** of an **atom** is **concentrated inside** the **nucleus** of an atom.
    (*iv*) Atom is **electrically neutral**.

Particle	*Symbol*	*Charge*	*Mass (amu)*	*Property*
Electron	e or ${}_{-1}^{0}e$	-1 or -1.602×10^{-19} C	$\frac{1}{1837}$ of mass of hydrogen atom	They possess a unit negative charge and has negligible mass.
Proton	p or ${}_{1}^{1}p$	$+1$ or $+1.602 \times 10^{-19}$ C	1 a.m.u.	They possess a unit positive charge and mass is nearly equal to that of hydrogen.
Neutron	n or ${}_{0}^{1}n$	nil	1 a.m.u.	These are electrically neutral particles and mass is almost equal to that of hydrogen.

19. **Atomic number** is denoted by '**Z**'. It is the **number** of **protons** present **inside** the **nucleus** of an atom. **Atomic number** is also **equal** to **number** of **electrons** in the neutral atom.

Atomic number = Number of protons = Number of electrons.

20. **Mass number** of an atom is denoted by '**A**'. It is the **sum** of **number** of **protons** and **number** of **neutrons** present **inside** the **nucleus** of an atom.

Mass number = No. of protons + No. of neutrons.

Number of neutrons = Mass number – Atomic number.

21. In an atom of an element, the **superscript** denotes the **mass number** and **subscript** denotes the **atomic number**.

${}_{Z}^{A}X$ where, A = mass number

Z = atomic number.

For example : ${}_{17}^{35}Cl$

Mass number	*Atomic number*	*No. of electrons (e)*	*No. of protons (p)*	*No. of neutrons (n)*
35	17	17	17	35 – 17 = 18

22. **Mass** of an **atom** is contributed by the **number** of **protons** and the **number** of **neutrons** present in the nucleus of an atom and the **electrons** outside the nucleus are of **negligible mass**.

23. The **arrangement** or the **distribution** of **electrons** in the **various energy levels** or **shells** is called **electronic configuration**.

24. The **distribution** of **electrons** in **various energy levels** is governed by **Bohr-Bury scheme**. According to this scheme there are **three important rules**.

(*i*) **Maximum number** of **electrons** that can be **accommodated** in **each shell** is given by, $\mathbf{2n^2}$ where n = number of shells or energy levels.

K-shell	$n = 1$	$2 \times 1 \times 1 = 2e^-$
L-shell	$n = 2$	$2 \times 2 \times 2 = 8e^-$
M-shell	$n = 3$	$2 \times 3 \times 3 = 18e^-$
N-shell	$n = 4$	$2 \times 4 \times 4 = 32e^-$

(*ii*) The **outermost shell** of an atom **cannot** have **more than eight electrons**, even though it may have the capacity to hold more and hence the **penultimate shell**, *i.e.*, **second last shell cannot** have **more than eighteen electrons**.

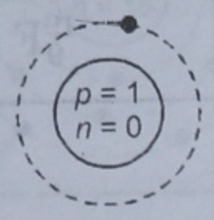
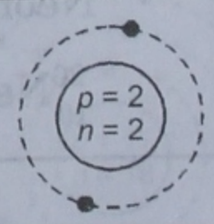
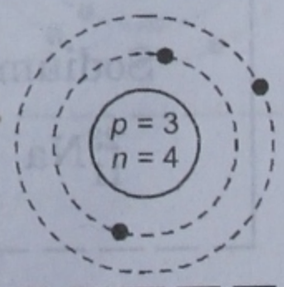
(*iii*) The **new shell begins** as soon as the **outermost shell** attains **8 electrons**.

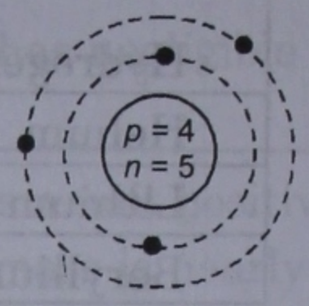
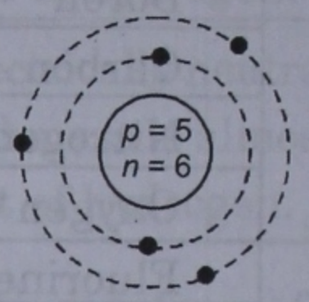
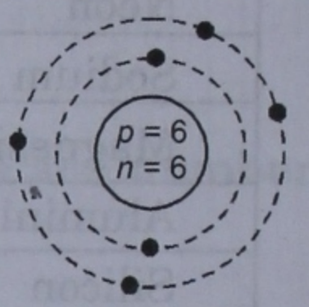
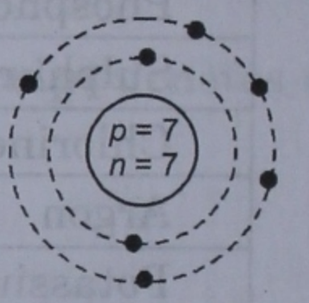
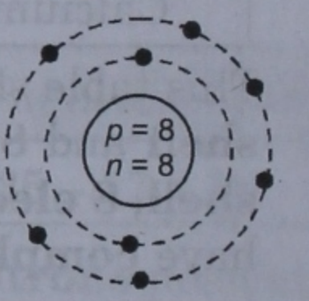
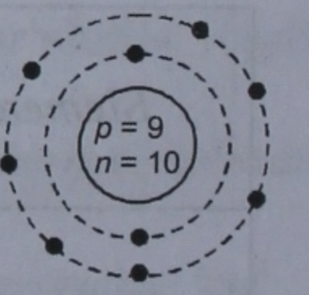
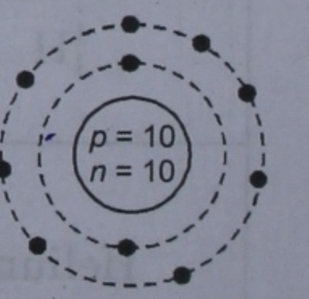
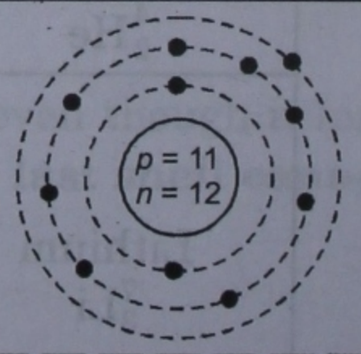
25. Electronic configurations of the elements from atomic number 1 to 20 are given below :

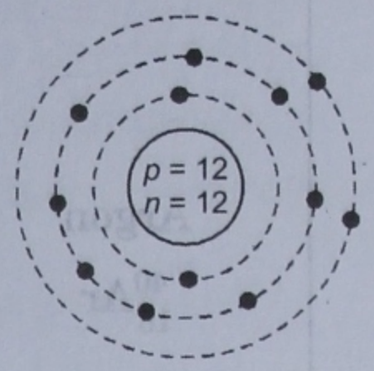
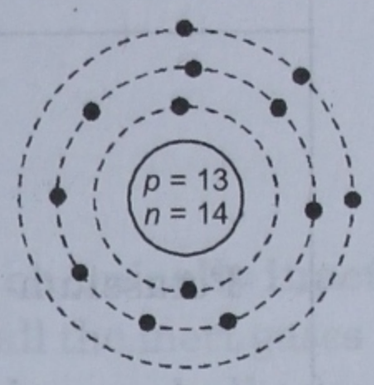
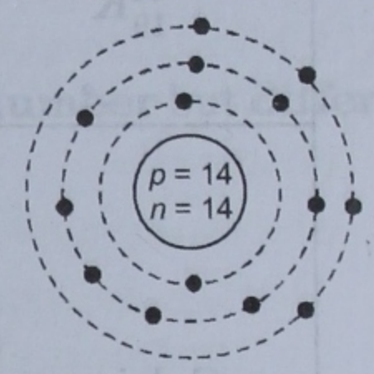
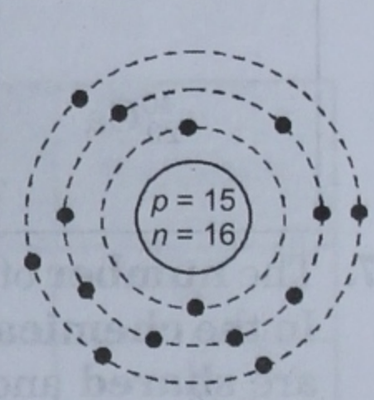
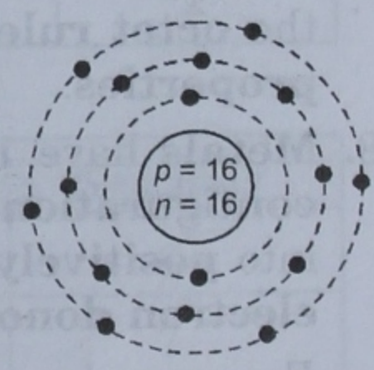
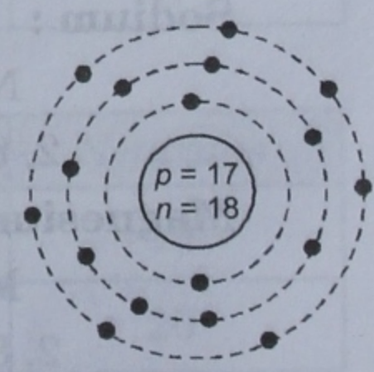
Element	*Symbol*	*Atomic number*	*Electronic configuration*			
			K	*L*	*M*	*N*
Hydrogen	H	1	1			
Helium	He	2	2			
Lithium	Li	3	2	1		
Beryllium	Be	4	2	2		
Boron	B	5	2	3		
Carbon	C	6	2	4		
Nitrogen	N	7	2	5		
Oxygen	O	8	2	6		
Fluorine	F	9	2	7		
Neon	Ne	10	2	8		
Sodium	Na	11	2	8	1	
Magnesium	Mg	12	2	8	2	
Aluminium	Al	13	2	8	3	
Silicon	Si	14	2	8	4	
Phosphorus	P	15	2	8	5	
Sulphur	S	16	2	8	6	
Chlorine	Cl	17	2	8	7	
Argon	Ar	18	2	8	8	
Potassium	K	19	2	8	8	1
Calcium	Ca	20	2	8	8	2

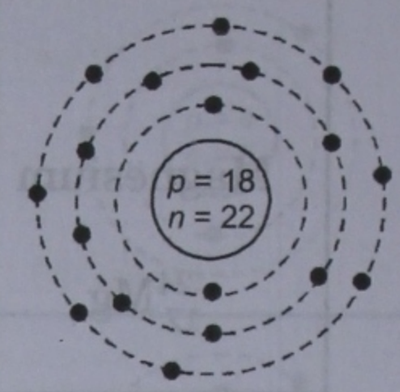
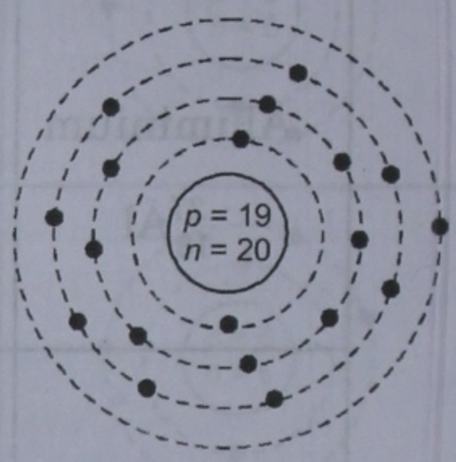
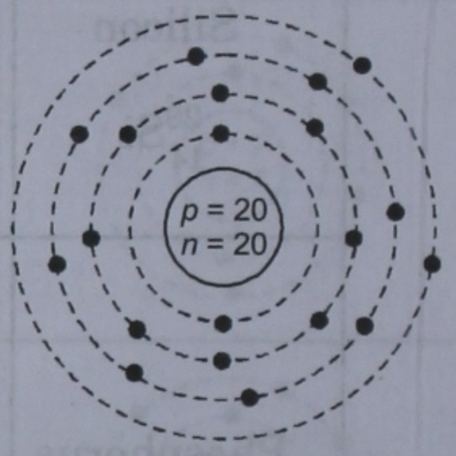
This table shows an interesting property of atoms. We see that **neon** has **2 electrons** in the **first (K) shell** and **8 electrons** in the **second (L) shell**. Similarly, **argon** has **2 electrons** in the **first (K) shell**, **8 electrons** in the **second (L) shell** and **8 electrons** in the **third (M) shell**. **Neon** and **argon** have **completely filled outermost shells**.

26. Geometrical representation of atomic structure of elements from atomic number 1 to 20.

Element	*Mass number*	*Atomic number*	*Protons*	*Electrons*	*Neutrons*	*Geometrical representation of atomic structure*
Hydrogen $^{1}_{1}H$	1	1	1	1	1 – 1 = 0	
Helium $^{4}_{2}He$	4	2	2	2	4 – 2 = 2	
Lithium $^{7}_{3}Li$	7	3	3	3	7 – 3 = 4	

Element	*Mass number*	*Atomic number*	*Protons*	*Electrons*	*Neutrons*	*Geometrical representation of atomic structure*
Beryllium $^{9}_{4}Be$	9	4	4	4	9 – 4 = 5	
Boron $^{11}_{5}B$	11	5	5	5	11 – 5 = 6	
Carbon $^{12}_{6}C$	12	6	6	6	12 – 6 = 6	
Nitrogen $^{14}_{7}N$	14	7	7	7	14 – 7 = 7	
Oxygen $^{16}_{8}O$	16	8	8	8	16 – 8 = 8	
Fluorine $^{19}_{9}F$	19	9	9	9	19 – 9 = 10	
Neon $^{20}_{10}Ne$	20	10	10	10	20 – 10 = 10	
Sodium $^{23}_{11}Na$	23	11	11	11	23 – 11 = 12	

Element	*Mass number*	*Atomic number*	*Protons*	*Electrons*	*Neutrons*	*Geometrical representation of atomic structure*
Magnesium $^{24}_{12}Mg$	24	12	12	12	24 – 12 = 12	
Aluminium $^{27}_{13}Al$	27	13	13	13	27 – 13 = 14	
Silicon $^{28}_{14}Si$	28	14	14	14	28 – 14 = 14	
Phosphorus $^{31}_{15}P$	31	15	15	15	31 – 15 = 16	
Sulphur $^{32}_{16}S$	32	16	16	16	32 – 16 = 16	
Chlorine $^{35}_{17}Cl$	35	17	17	17	35 – 17 = 18	

Element	*Mass number*	*Atomic number*	*Protons*	*Electrons*	*Neutrons*	*Geometrical representation of atomic structure*
Argon $^{40}_{18}Ar$	40	18	18	18	40 – 18 = 22	
Potassium $^{39}_{19}K$	39	19	19	19	39 – 19 = 20	
Calcium $^{40}_{20}Ca$	40	20	20	20	40 – 20 = 20	

27. The **number** of **electrons** present in the **outermost shell** of an atom are called the **valence electrons.** In the **chemical reactions** only the **valence electrons** are **involved**, *i.e.*, only the **valence electrons** are **shared** and **transferred**. Each and every atom tries to **attain** the **configuration** of the **nearest inert gas**, *i.e.*, having **eight electrons** in its **valence shell**, having **stable configuration** following the **octet rule**. **Elements** having **same number** of **valence electrons** exhibit **same chemical properties**.

28. **Metals** have **1**, **2** or **3 electrons** in their **valence shell** or **outermost shell**. To attain **stable configuration** (*i.e.*, eight electrons in the outermost shell) they easily **lose electrons** and get converted into **positively charged particles** called **cations**. Hence **metals** are **good reducing agents**, *i.e.*, **electron donors**.

For example :

Sodium :

$$Na - e^- \longrightarrow Na^+$$
$$2, 8, 1 \qquad\qquad 2, 8$$

Magnesium :

$$Mg - 2e^- \longrightarrow Mg^{2+}$$
$$2, 8, 2 \qquad\qquad 2, 8$$

Aluminium :

$$Al - 3e^- \longrightarrow Al^{3+}$$
$$2, 8, 3 \qquad\qquad 2, 8$$

29. Non-metals have **5, 6** or **7 electrons** in their **outermost shell** or **valence shell**. To attain **stable configuration** (*i.e.*, eight electrons in their outermost shell) they easily **gain** electrons and get converted to **negatively charged particles** called **anions**. Hence **non-metals** are **good oxidizing agents**, *i.e.*, **electron acceptors**.

For example :

Phosphorus :

$$\underset{2, 8, 5}{P + 3e^-} \longrightarrow \underset{2, 8, 8}{P^{3-}}$$

Sulphur :

$$\underset{2, 8, 6}{S + 2e^-} \longrightarrow \underset{2, 8, 8}{S^{2-}}$$

Chlorine :

$$\underset{2, 8, 7}{Cl + e^-} \longrightarrow \underset{2, 8, 8}{Cl^-}$$

30. Elements having **eight electrons** in their **outermost shell** or **valence shell** are **chemically inactive** and they fall under the category of **inert gases** or **noble gases**. Except **helium**, all the inert gases like **neon, argon, krypton, xenon** and **radon** have **eight electrons** in their **valence shell** whereas **helium** has only **two electrons** in its **K-shell**.

31. Isotopes of an **element** are the **atoms** of **same element** having **same atomic number** but **different mass number**.

For example : Hydrogen has three isotopes

Carbon has three isotopes

Chlorine has two isotopes

Isotopes of hydrogen

Isotopes		*Mass no.*	*Atomic no.*	*Protons*	*Electrons*	*Neutrons*
Name	*Symbol*					
(*i*) Protium	$^{1}_{1}H$	1	1	1	1	0
(*ii*) Deuterium	$^{2}_{1}H$	2	1	1	1	1
(*iii*) Tritium	$^{3}_{1}H$	3	1	1	1	2

Isotopes of carbon

Symbol	*Mass no.*	*Atomic no.*	*Protons*	*Electrons*	*Neutrons*
$^{12}_{6}C$	12	6	6	6	6
$^{13}_{6}C$	13	6	6	6	7
$^{14}_{6}C$	14	6	6	6	8

Isotopes of chlorine

Symbol	*Mass no.*	*Atomic no.*	*Protons*	*Electrons*	*Neutrons*
$^{35}_{17}Cl$	35	17	17	17	18
$^{37}_{17}Cl$	37	17	17	17	20

This shows that **isotopes** have **different number** of **neutrons**.

32. Isotopes have the **same chemical properties** as they have the **same atomic number**.

33. **Isotopes** have **same number** of **valence electrons** as their **atomic number** is **same.**

34. **Isotopes** have **different physical properties** as their **mass number** is **different.**

35. **Fractional atomic masses** of the **elements** are because of the **presence** of **Isotopes.**

For example : Natural chlorine has two isotopes $^{35}_{17}Cl$ and $^{37}_{17}Cl$ in the ratio of 3 : 1.

So, the atomic mass can be calculated as follows :

Atomic mass of 3 atoms of $^{35}_{17}Cl = 3 \times 35 = 105$ a.m.u.

Atomic mass of 1 atom of $^{37}_{17}Cl = 1 \times 37 = 37$ a.m.u.

$$\therefore \text{ Average atomic mass of chlorine} = \frac{3\times 35 + 1\times 37}{4}$$

$$= \frac{105 + 37}{4} = \frac{142}{4} = 35.5 \text{ a.m.u.}$$

36. The **chemical bond** is the **force of attraction** which **holds** the **different** or the **same particles together** in a **molecule**.

37. The **chemical bonding results** in the **decrease** of the **energy** of the **participating elements** and thus acquiring a comparatively **stable state** in a **molecule** than the participating elements. For example, a **molecule** of **hydrogen (H_2)** is **more stable** than the **two atoms** of **hydrogen**. As the energy of hydrogen molecule is less than the individual hydrogen atoms.

38. While undergoing **chemical bond** formation each and every atom tries to attain the **valence configuration** of **nearest inert gas**, *i.e.*, having **eight electrons** in their **valence shell** following **octet rule**.

39. The **outermost octet** can be achieved by the following two ways :

(*i*) By the **transference** of **electrons**, *i.e.*, by **losing electrons** from the outermost shell or by **gaining electrons** in the outermost shell.

(*ii*) By the **mutual sharing** of **electrons**.

40. On the basis of the above two categories the **chemical bonds** are **classified** as follows :

(*i*) By the **transference** of **electrons** : **Ionic** or **Electrovalent bond.**

(*ii*) By the **mutual sharing** of **electrons** : **Covalent bond**.

IMPORTANT QUESTIONS

Q1. Fill in the blanks :

(*i*) The maximum number of electrons that can be accommodated in each shell according to Bohr-Bury scheme is _____.

(*ii*) The first shell is _____ shell. It can accommodate only _____ electrons.

(*iii*) Atomic number is equal to number of _____ present inside the nucleus of an atom.

(*iv*) Number of neutrons are calculated by taking difference of _____ and _____ .

(*v*) An atom is electrically _____ as the number of _____ are equal to the number of _____.

(*vi*) Mass of an atom is concentrated inside the _____ of an atom.

(*vii*) Size of the _____ is very small as compared to the size of an atom.

(*viii*) Atom as a whole is an _____ space.

(*ix*) Electrons are _____ charged particles.

(*x*) Protons are _____ charged particles.

(*xi*) Neutrons are electrically _____.

(*xii*) Nucleus was discovered by _____.

(*xiii*) Electrons possess unit _____ charge.

(*xiv*) Protons possess unit _____ charge.

(*xv*) The electrons are of _____ mass.

Ans. (*i*) $2n^2$ (*ii*) K, 2 (two)

(*iii*) protons

(*iv*) mass number and atomic number

(*v*) neutral, protons, electrons
(*vi*) nucleus (*vii*) nucleus
(*viii*) empty (*ix*) negatively
(*x*) positively (*xi*) neutral
(*xii*) Rutherford (*xiii*) negative
(*xiv*) positive (*xv*) negligible.

Q2. Give reasons why

(*i*) atom is electrically neutral.

(*ii*) mass of an atom is concentrated inside the nucleus of an atom.

(*iii*) atom as a whole is an empty space.

(*iv*) Rutherford model of atom could not provide stability to the nucleus.

Ans. (*i*) An atom is electrically neutral because the number of positively charged particles *i.e.*, protons is equal to the number of negatively charged particles *i.e.*, electrons.

(*ii*) Mass of an atom is contributed by the mass of the protons and neutrons present inside the nucleus of an atom and the electrons present outside the nucleus are of negligible mass therefore mass of an atom is concentrated inside the nucleus of an atom.

(*iii*) The size of the nucleus is very small as compared to the size of an atom, therefore, atom as a whole is an empty space.

(*iv*) According to Rutherford the protons are present inside the nucleus and electrons are revolving around the nucleus. Electron continuously loses energy and ultimately it falls into the nucleus following a spiral path and thus the nucleus of an atom gets destroyed.

Q3. An atom of an element is represented as $^{39}_{19}X$.

(*i*) What does value 39 indicate ?

(*ii*) What does value 19 indicate ?

(*iii*) What is the number of protons in X ?

(*iv*) What is the number of electrons in X?

(*v*) What is the number of neutrons in X?

(*vi*) Give the electronic configuration of element X.

(*vii*) State the valence electrons in element X.

(*viii*) Is element X metal or non-metal ?

Ans. (*i*) Mass number of X

(*ii*) Atomic number of X

(*iii*) 19 (*iv*) 19

(*v*) 20 (*vi*) 2, 8, 8, 1

(*vii*) 1 (*viii*) Metal.

Q4. Write the electronic configurations of the following elements and write the number of valence electrons present in it.

(*i*) $^{14}_{7}N$ (*ii*) $^{16}_{8}O$ (*iii*) $^{28}_{14}Si$

(*iv*) $^{40}_{20}Ca$ (*v*) $^{40}_{18}Ar$ (*vi*) $^{9}_{4}Be$

(*vii*) $^{12}_{6}C$ (*viii*) $^{31}_{15}P$ (*ix*) $^{32}_{16}S$

(*x*) $^{35}_{17}Cl$

Ans.

		Electronic Configuration				
Element		*K*	*L*	*M*	*N*	*Valence Electrons*
(*i*)	N	2	5			5
(*ii*)	O	2	6			6
(*iii*)	Si	2	8	4		4
(*iv*)	Ca	2	8	8	2	2
(*v*)	Ar	2	8	8		8
(*vi*)	Be	2	2			2
(*vii*)	C	2	4			4
(*viii*)	P	2	8	5		5
(*ix*)	S	2	8	6		6
(*x*)	Cl	2	8	7		7

Q5. How many electrons can be accomodated in the following named shells ?

(*i*) K-shell **(*ii*) L-shell**

(*iii*) M-shell **(*iv*) N-shell.**

Ans. The maximum electrons that can be accommodated in each shell is $2n^2$ where n = number of shells.

(*i*) K-shell $n = 1$ $2 \times 1 \times 1 = 2$ electrons

(*ii*) L-shell $n = 2$ $2 \times 2 \times 2 = 8$ electrons

(*iii*) M-shell $n = 3$ $2 \times 3 \times 3 = 18$ electrons

(*iv*) N-shell $n = 4$ $2 \times 4 \times 4 = 32$ electrons.

Q6. Write the electronic configurations, number of valence electrons and classify the following as metals, non-metals and inert gases.

(*i*) $^{24}_{12}\mathbf{P}$ **(*ii*)** $^{39}_{19}\mathbf{Q}$ **(*iii*)** $^{14}_{7}\mathbf{R}$

(*iv*) $^{40}_{18}\mathbf{S}$ **(*v*)** $^{16}_{8}\mathbf{T}$.

Ans.

		Electronic Configuration					
	Element	*K*	*L*	*M*	*N*	*Valence Electrons*	*Type of Element*
(*i*)	P	2	8	2		2	Metal
(*ii*)	Q	2	8	8	1	1	Metal
(*iii*)	R	2	5			5	Non-metal
(*iv*)	S	2	8	8		8	Inert gas
(*v*)	T	2	6			6	Non-metal

Q7. Fill in the blanks :

(*i*) The electrons present in the outermost shell of an atom are called _____ electrons.

(*ii*) Inert gases have _____ electrons in the _____ shell.

(*iii*) Metals have _____, _____ or _____ electrons in their valence shell.

(*iv*) Non-metals have _____, _____ or _____ electrons in their valence shell.

(*v*) Metals are _____ in nature.

(*vi*) Non-metals are _____ in nature.

(*vii*) During chemical reaction only _____ electrons participate.

(*viii*) Inert gas not having _____ electrons in the valence shell is _____.

(*ix*) Metals form _____.

(*x*) Non-metals form _____.

Ans (*i*) Valence (*ii*) 8, outermost / valence

(*iii*) 1, 2, 3 (*iv*) 5, 6, 7

(*v*) Electropositive (*vi*) Electronegative

(*vii*) Valence (*viii*) 8, Helium

(*ix*) Cations (*x*) Anions.

Q8. Copy, complete the table and answer the questions that follows :

Element	*Mass no.*	*Atomic no.*	*Protons*	*Neutrons*	*Electrons*
A	40	20	—	—	—
B	35	—	—	18	—
C	40	—	—	22	—
D	27	13	—	—	—
E	12	6	—	—	—

(*i*) Give the electronic configurations of the elements from A to E.

(*ii*) Identify metals, non-metals and inert gases from the above elements (Do not identify the elements).

(*iii*) Identify the pair of isobars from the above element.

Ans.

Element	*Mass no.*	*Atomic no.*	*Protons*	*Neutrons*	*Electrons*
A	40	20	20	20	20
B	35	17	17	18	17
C	40	18	18	22	18
D	27	13	13	14	13
E	12	6	6	6	6

(*i*)

Element	*Electronic Configuration*			
	K	*L*	*M*	*N*
A	2	8	8	2
B	2	8	7	
C	2	8	8	
D	2	8	3	
E	2	4		

(*ii*) A Metal
B Non-metal
C Inert gas
D Metal
E Non-metal

(*iii*) A and C are the pair of isobars.

Q9. Identify metals, non-metals and inert gases from the following elements and give reasons in support of your answer.
Chlorine, Magnesium, Argon, Phosphorus, Potassium, Sulphur, Oxygen

Ans.

Element	*Electronic configuration*	*Type of metal*	*Reason*
Chlorine	2, 8, 7	Non-metal	As it has '7' electrons in its valence shell
Magnesium	2, 8, 2	Metal	As it has '2' electrons in its valence shell
Argon	2, 8, 8	Inert gas	As it has '8' electrons in its valence shell
Phosphorus	2, 8, 5	Non-metal	As it has '5' electrons in its valence shell
Potassium	2, 8, 8, 1	Metal	As it has '1' electron in its valence shell
Sulphur	2, 8, 6	Non-metal	As it has '6' electrons in its valence shell
Oxygen	2, 6	Non-metal	As it has '6' electrons in its valence shell

Note : Metals have 1, 2 or 3 electrons in their valence shell whereas non-metals have 5, 6 or 7 electrons in their valence shell.

Q10. Give reasons why

(*i*) Metals are monoatomic.
(*ii*) Inert gases are monoatomic.
(*iii*) Inert gases have zero valency.
(*iv*) The valency of sodium is +1.
(*v*) The valency of chlorine is –1.
(*vi*) Inert gases are chemically inactive.
(*vii*) Isotopes have similar chemical properties.

Ans. (*i*) Metals are monoatomic because metals have 1, 2 or 3 electrons in their valence shell hence they complete their octet by losing electrons not by mutual sharing of electrons.

(*ii*) Inert gases have complete duplet or octet so, they have no tendency to gain, lose or share electrons hence they are monoatomic.

(*iii*) Inert gases have complete duplet or octet so, they can neither lose electrons nor they can gain electrons and hence their valency is zero.

(*iv*) The electronic configuration of sodium is 2, 8, 1. In order to complete its octet, sodium loses one electron and thus acquires a monopositive valency.

$$Na - e^- \longrightarrow Na^+$$
$$2, 8, 1 \qquad 2, 8$$

(*v*) The electronic configuration of chlorine is 2, 8, 7. In order to complete its octet, chlorine gains one electron and thus gets converted to mononegative ion.

$$Cl + e^- \longrightarrow Cl^-$$
$$2, 8, 7 \qquad 2, 8, 8$$

(*vi*) Inert gases have complete octet, *i.e.*, eight electrons in the outermost shell hence they have no tendency to lose, gain or share electrons hence they are chemically inert.

(*vii*) Isotopes have similar chemical properties because they have same atomic number hence same number of protons and therefore same electronic configurations leading to the same number of valence electrons.

Q11. Define the following :

(*i*) Electropositive elements
(*ii*) Electronegative elements
(*iii*) Valence electrons
(*iv*) Electronegativity
(*v*) Isotopes
(*vi*) Isobars
(*vii*) Electronic configuration
(*viii*) Chemical bond.

Ans. (*i*) **Electropositive elements.** Metals are called electropositive elements as they can lose their 1, 2 or 3 electrons present in their valence shell to complete its octet and get converted to positively charged particles called cations.

(*ii*) **Electronegative elements.** Non-metals are called electronegative elements. Non-metals have 5, 6 or 7 electrons in their valence shell so as to complete their octet they gain electrons and get converted to negatively charged particles called anions.

(*iii*) **Valence electrons.** Electrons present in the outermost shell of an atom.

(*iv*) **Electronegativity.** It is the tendency on the part of an atom to attract the shared pair of electrons towards its side during covalent bond formation.

(*v*) **Isotopes.** These are the atoms of same element having same atomic number but different mass number.

(*vi*) **Isobars.** These are the atoms of different elements having same mass number but different atomic number.

(*vii*) **Electronic configuration.** The arrangement or the distribution of electrons in various energy levels or shells is called electronic configuration.

(*viii*) **Chemical bond.** The force of attraction which holds the different particles together in a molecule is called chemical bond.

Q12. What do the following symbols convey ?

(*i*) 2H (*ii*) H_2 (*iii*) H^+

Ans. (*i*) **2H :** Two atoms of hydrogen having independent existence.

(*ii*) **H_2 :** Two atoms of hydrogen combined chemically to form a molecule of hydrogen.

(*iii*) **H^+ :** A Proton or Hydrogen ion having a positive charge.

Q13. Three elements 'A', 'B' and 'C' have atomic numbers 4, 12 and 19 respectively.

(*i*) State the number of valence electrons in each element.

(*ii*) Do these elements have similar chemical properties ? If yes, then why ?

(*iii*) Do these elements belong to metals, non-metals or inert gases ?

Ans. (*i*)

Element	*Atomic no.*	*Electronic configuration*				*Valence electrons*
		K	*L*	*M*	*N*	
A	4	2	2			2
B	12	2	8	2		2
C	19	2	8	8	1	1

(*ii*) Yes, they have the similar chemical properties as they are metals, *i.e.,* they have 1 or 2 electrons in their valence shell.

(*iii*) These elements are metals.

Q14. Elements A, B, C and D have atomic numbers 8, 9, 11 and 12 respectively.

(*i*) Write the electronic configurations of the elements.

(*ii*) Choose the electropositive and electronegative elements from the above elements.

Ans. (*i*)

Element	*Atomic no.*	*Electronic configuration*		
		K	*L*	*M*
A	8	2	6	
B	9	2	7	
C	11	2	8	1
D	12	2	8	2

(*ii*) Electropositive elements are C and D

Electronegative elements are A and B.

Q15. Give differences between atom and ion.

Ans. Differences :

Atom	*Ion*
(*i*) It is electrically neutral.	(*i*) It is electrically charged particle.
(*ii*) The valence shell is incomplete except inert gases.	(*ii*) The valence shell has complete octet or doublet.
(*iii*) Atoms may or may not exist independently.	(*iii*) Ions exist independently.

Q16. Which electron has maximum and minimum energy.

(*i*) Electron present in K-shell

(*ii*) Electron present in N-shell

Ans. (*i*) The electron present in K-shell has the minimum energy

(*ii*) The electron present in N-shell has the maximum energy.

Q17. An atom of an element has three electrons in the M-shell. What is

(*i*) The atomic number of this element ?

(*ii*) The number of protons present in this element ?

Ans. (*i*) Atomic number = 13 (*ii*) Number of protons = 13.

Q18. Study the table given below and answer the following questions :

Element	*Mass number*	*Atomic number*
A	**1**	**1**
B	**14**	**7**
C	**40**	**20**
D	**32**	**16**
E	**20**	**10**

(*i*) Identify an element having five valence electrons.

(*ii*) Identify an element having no neutron.

(*iii*) Identify an element exhibiting +2 valency.

(*iv*) Identify an element having zero valency.

(*v*) Identify an element exhibiting –2 valency.

Ans. (*i*) B (*ii*) A (*iii*) C (*iv*) E (*v*) D

Q19. Copy and complete the table given below :

Isotope	*Symbolic representation*	*Protons*	*Electrons*	*Neutrons*
Protium	$^{1}_{1}H$	**(*i*)** _____	**(*ii*)** _____	**(*iii*)** _____
Deuterium	$^{2}_{1}H$	**(*iv*)** _____	**(*v*)** _____	**(*vi*)** _____
Tritium	$^{3}_{1}H$	**(*vii*)** _____	**(*viii*)** _____	**(*ix*)** _____

Ans. (*i*) 1 (*ii*) 1 (*iii*) 0

(*iv*) 1 (*v*) 1 (*vi*) 1

(*vii*) 1 (*viii*) 1 (*ix*) 2

LET'S RECALL

Fill Your Answer in the Space Given for Each Question.

Q1. Match the following :

A.

Column I (Shells)		**Column II (Maximum electrons)**
(*i*) K-shell	(*a*)	8
(*ii*) L-shell	(*b*)	32
(*iii*) M-shell	(*c*)	2
(*iv*) N-shell	(*d*)	18

Ans. (*i*) ☐ (*ii*) ☐ (*iii*) ☐ (*iv*) ☐

B.

Column I (Element)		**Column II (Electronic configuration)**
(*i*) Phosphorus	(*a*)	2, 8, 8
(*ii*) Argon	(*b*)	2, 8, 8, 2
(*iii*) Sodium	(*c*)	2, 8, 4
(*iv*) Calcium	(*d*)	2, 8, 5
(*v*) Silicon	(*e*)	2, 8, 1

Ans. (*i*) ☐ (*ii*) ☐ (*iii*) ☐ (*iv*) ☐ (*v*) ☐

Q2. Fill in the blanks.

(*i*) The maximum number of electrons that can be accommodated in each shell is _____ .

(*ii*) Metals have _____, _____ or _____ electrons in their valence shell.

(*iii*) Isotopes are the atoms of _____ having same _____ but different _____.

(*iv*) Isotopes differ in the number of _____ .

(*v*) _____ and _____ are collectively called nucleons.

Q3. State whether the following statements are True or False.

(*i*) Atomic number is the total number of electrons present inside the nucleus of an atom. ☐

(*ii*) The protons are negatively charged particles. ☐

(*iii*) Mass of an atom is concentrated inside the nucleus of an atom. ☐

(*iv*) Helium has a complete octet. ☐

(*v*) Deuterium is the isotope of hydrogen. ☐

Q4. Each question has four options out of which only one option is correct. Dark the bubble for correct answer.

(*i*) The charged particles are called

(*a*) molecules (*b*) atoms

(*c*) ions (*d*) None of these

Ans. (a) (b) (c) (d)

(*ii*) Electron acceptors are

(*a*) oxidizing agents (*b*) reducing agents

(*c*) Both of these (*d*) None of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*iii*) The electrons present in the outermost shell are called

(*a*) valence electrons (*b*) excited electrons

(*c*) ground state electrons (*d*) None of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*iv*) In the element $^{23}_{11}Na$, 11 represents

(*a*) mass number (*b*) atomic number

(*c*) number of neutrons (*d*) None of these

Ans. (*a*) (*b*) (*c*) (*d*)

(*v*) The only inert gas with a complete duplet is

(*a*) Helium (*b*) Argon

(*c*) Krypton (*d*) Neon

Ans. (*a*) (*b*) (*c*) (*d*)

Q5. Complete the following table.

S.No.	*Element*	*Electronic configuration*
(*i*)	Potassium	2, 8, —,—
(*ii*)	_____	2, 8, 2
(*iii*)	Chlorine	2, —, —
(*iv*)	Neon	2, —
(*v*)	_____	1

Answers

1. A.	(*i*) *c*	(*ii*) *a*	(*iii*) *d*	(*iv*) *b*	
B.	(*i*) *d*	(*ii*) *a*	(*iii*) *e*	(*iv*) *b*	(*v*) *c*
2.	(*i*) $2n^2$	(*ii*) 1, 2, 3			
	(*iii*) Same element, atomic number, mass number				
	(*iv*) neutrons	(*v*) protons, neutrons			
3.	(*i*) False	(*ii*) False	(*iii*) True	(*iv*) False	(*v*) True
4.	(*i*) *c*	(*ii*) *a*	(*iii*) *a*	(*iv*) *b*	(*v*) *a*
5.	(*i*) 8, 1	(*ii*) magnesium	(*iii*) 8, 7	(*iv*) 8	(*v*) hydrogen

SELF EVALUATION TEST

***Time** : 30 minutes* ***Marks** : 30*

Q1. What common feature in electronic configuration is seen in argon and neon ? **1**

Q2. Define electronic configuration. **1**

Q3. Why Rutherford's model of atom was rejected whereas the Bohr's model of atom was accepted ? **2**

Q4. Why the electronic configurations of potassium and calcium are 2, 8, 8, 1 and 2, 8, 8, 2 respectively but not 2, 8, 9 and 2, 8, 10 respectively ? **2**

Q5. Why isotopes have same chemical properties ? **2**

Q6. What are valence electrons ? How valence electrons help to predict the nature of the element ? **2**

Q7. Name the scientists who discovered **4**

(*i*) electron. (*ii*) proton.

(*iii*) neutron. (*iv*) nucleus.

Q8. An element 'X' is represented as $^{35}_{17}X$. **5**

(*i*) What is the atomic number and mass number of 'X' ?

(*ii*) How many protons, neutrons and electrons are there in element 'X' ?

(*iii*) Give the electronic configuration of element 'X'.

(*iv*) How many valence electrons are present in element 'X'.

(*v*) Identify element 'X'. What is its actual mass number ? Give reason for your answer. **5**

Q9. Give reasons why **6**

(*i*) Mass of an atom is concentrated inside the nucleus of an atom.

(*ii*) During the scattering experiment conducted by Rutherford

(*a*) many particles passed undeflected

(*b*) some particles experienced a minor deflection.

(*c*) very few particles were deflected to such an extent that they retraced their own path.

(*iii*) Atom is electrically neutral.

Q10. Copy and complete the following table. **6**

Isotopes of hydrogen	*Mass no.*	*Atomic no.*	*Protons*	*Electrons*	*Neutrons*
Protium	1	1	—	—	—
—	2	1	—	—	—
—	3	—	—	—	—