1 Elements and Compounds

Things around us, like air, water and gold, are all made of matter. Yet they differ from each other. Matter exists in different forms. To make the study of matter easier, scientists have classified it into *three* groups—elements, compounds and mixtures.

Elements, Compounds and Mixtures

An element is a substance that cannot be split into simpler substances by a chemical means.

A large number of elements—about 114—are known at present. Carbon, nitrogen, oxygen, chlorine, sodium, iron, gold, copper, zinc, etc., are all elements. They cannot be split into simpler substances by a chemical means.

A compound is a substance that can be split into two or more simpler substances by a chemical means.

For example, water can be split into two simpler substances—hydrogen and oxygen—which are elements. Similarly, sand is a compound, called silica, which can be split into the elements silicon and oxygen. And the common salt we eat is a compound, called sodium chloride, which can be split into the elements sodium and chlorine.

The amounts of different elements in a given amount of a compound are always fixed. For example, 9 g of *pure* water will always contain 1 g of hydrogen and 8 g of oxygen—no matter from which source the water has been obtained.

Elements combine among themselves in definite proportions to form compounds.

Remember that compounds differ in properties and appearance from the elements that make them up. (See Figure 1.1.) The metallic red copper turnings (element) are very different from the blue, crystalline copper sulphate (a compound formed by copper). Also, the greyish iron (element) pins are very different from the green crystals of ferrous sulphate (a compound formed by iron).

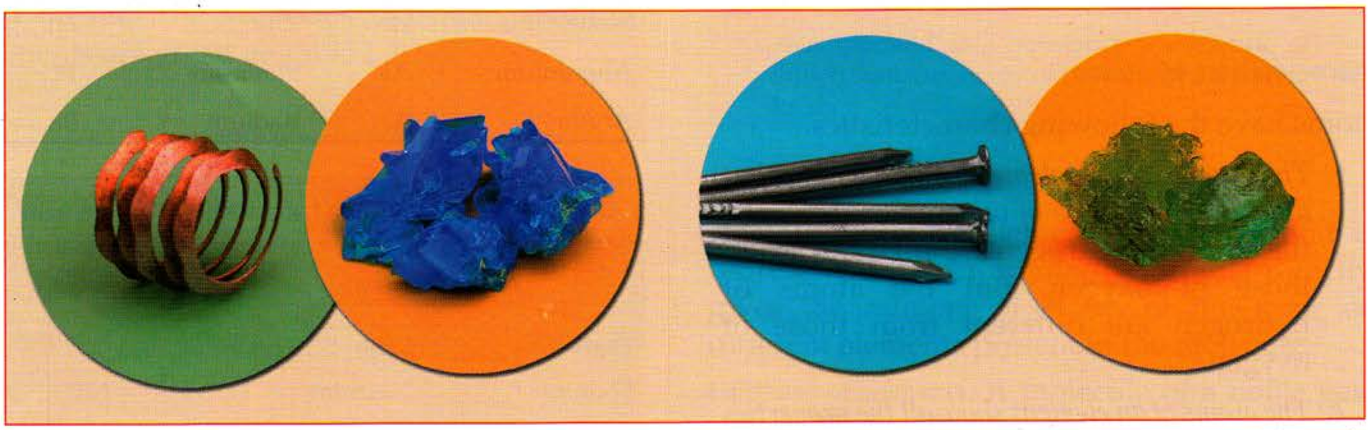


Fig. 1.1 Elements and compounds—red copper turnings (element) and blue crystals of copper sulphate (compound), and greyish iron nails (element) and green crystals of ferrous sulphate (compound)

A mixture is a substance containing more than one element or compound in any proportion. The components of a mixture can be separated by physical means like filtration, sublimation, distillation, etc.

Air is a mixture that contains elements (like oxygen and nitrogen) as well as compounds (like carbon dioxide and water vapour). Unlike compounds, the composition of a mixture may vary. For example, the air in cities has more carbon dioxide than does the air in villages. Also, mixtures of sand and water may contain the two components in any proportion.

Atoms and Molecules

Matter is not continuous. It consists of extremely small parts called atoms and molecules

Atoms

If we keep dividing a given mass of an element, we will finally get an indivisible part that has all the properties of the element.

Such an indivisible part is called an atom (derived from the Greek word *atomos*, meaning indivisible). It is the atoms that take part in a chemical reaction.

An atom is the smallest part of an element that takes part in a chemical reaction.

Characteristics of atoms

Atoms have the following characteristics.

1. *The atoms of an element are all alike but different from those of others.* For example, the atoms of hydrogen are alike and so are those of oxygen. But the atoms of hydrogen are different from those of oxygen.
2. *The atoms of an element show all the properties of the element.* Each atom of hydrogen or oxygen will retain all the properties of the element.
3. *One kind of atom cannot be changed into another. And an atom can neither be created nor destroyed by a chemical means.* An atom of hydrogen cannot be changed into that of oxygen or vice versa. And neither can it be destroyed.

Atoms are Represented by Symbols

A symbol is an abbreviation for the name of an element.

It represents an atom of an element. The symbols of different elements have been derived in three ways.

1. The first letter (in capital) of the English name of an element

Name	Symbol	Name	Symbol
Hydrogen	H	Oxygen	O
Boron	B	Fluorine	F
Carbon	C	Phosphorus	P
Nitrogen	N	Sulphur	S

2. The first letter along with one more letter of the English name of an element

Name	Symbol	Name	Symbol
Helium	He	Calcium	Ca
Neon	Ne	Chromium	Cr
Nickel	Ni	Cobalt	Co
Magnesium	Mg	Chlorine	Cl
Manganese	Mn	Zinc	Zn
Aluminium	Al	Platinum	Pt
Argon	Ar	Radium	Ra

3. One or two letters of the Latin name of an element

Name		Symbol
English	Latin	
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Copper	Cuprum	Cu

Name		Symbol
English	Latin	
Silver	Argentum	Ag
Tin	Stannum	Sn
Gold	Aurum	Au
Lead	Plumbum	Pb
Mercury	Hydrargyrum	Hg

Valency—the Combining Capacity of an Element

The combining capacity of an element with other elements is known as its valency.

The valency of hydrogen is considered to be 1. Therefore, the valency of an element is given by the number of hydrogen atoms that combine with one atom of the element. It is also given by the number of hydrogen atoms that an atom of an element displaces from a compound.

One atom of chlorine combines with one atom of hydrogen to form one molecule of hydrogen chloride. So, the valency of chlorine is 1. On the other hand, an atom of zinc displaces two atoms of hydrogen from an acid. So, the valency of zinc is 2.

Elements with valencies 1, 2, 3, etc., are said to be *monovalent*, *divalent* (or *bivalent*), *trivalent*, and so on. The valencies of some common elements are given in Table 1.1.

Table 1.1 Valencies of some common elements

Monovalent	Divalent	Trivalent	Tetravalent
Hydrogen	Oxygen	Nitrogen	Carbon
Fluorine	Sulphur	Aluminium	Silicon
Chlorine	Magnesium		
Bromine	Calcium		
Iodine	Zinc		
Sodium			
Potassium			

Molecules

Atoms usually do not exist independently. They generally combine among themselves to form molecules.

A molecule is the smallest part of an element or a compound that can exist independently.

When an atom of an element combines with another atom(s) of the same element, a molecule of the element is formed.

For example, two atoms of hydrogen combine to form a molecule of hydrogen. Similarly, two atoms of nitrogen combine to form a molecule of nitrogen.

Not all molecules contain more than one atom. A molecule of a noble gas, i.e., helium, neon, argon, krypton or xenon, contains only one atom of the element. When a noble-gas atom exists independently, for example, in a sample of the gas, it is called a molecule.

When atoms of two or more elements combine among themselves, a molecule of a compound results. For example, two atoms of hydrogen combine with one atom of oxygen to form a molecule of water. A molecule of water can exist independently.

Elements and compounds can now be redefined as follows.

An element is a substance a molecule of which contains atom(s) of the same kind.

A compound is a substance a molecule of which contains atoms of two or more different kinds.

Molecules are represented by formulae

A molecule of an element or a compound is represented by a formula. A formula directly gives the number of atoms of the same or different elements present in the molecule.

Formulae of elements A molecule of a noble gas, e.g., helium (He), neon (Ne) or argon (Ar), contains only one atom of the element. Hence the molecules of these elements are represented as He, Ne and Ar. These gases are said to be monoatomic. However, a molecule of hydrogen, nitrogen, oxygen or chlorine contains two atoms of the element. They are diatomic and are represented as H_2, N_2, O_2 and Cl_2 respectively. A common example of a triatomic gas is ozone (O_3).

> The number of atoms contained in a molecule of an element is called its atomicity.

Table 1.2 **Atomicities of some elements**

Monoatomic	Diatomic	Triatomic	Tetratomic	Octatomic
Helium (He)	Hydrogen (H_2)	Ozone (O_3)	Phosphorus (P_4)	Sulphur (S_8)
Neon (Ne)	Nitrogen (N_2)			
Argon (Ar)	Oxygen (O_2)			
Krypton (Kr)	Fluorine (F_2)			
Xenon (Xe)	Bromine (Br_2)			
	Iodine (I_2)			

The atomicity of phosphorus is 4 (P_4) and that of sulphur is 8 (S_8).

Formulae of compounds The formula of a compound formed by two elements is obtained by transposing their valencies. Suppose an element A has a valency y and element B has a valency x. Then the compound formed between A and B will have the formula A_xB_y. The subscripts should be divided by a common factor, if any.

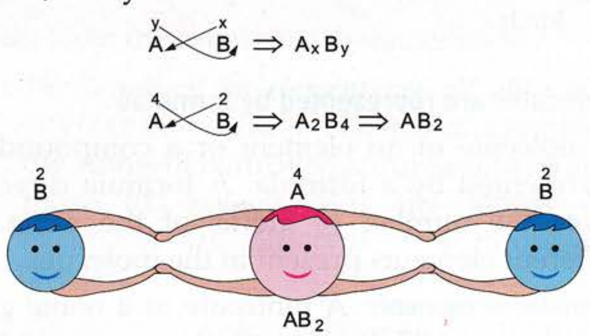


Fig. 1.2

There are some exceptions like H_2O_2 (hydrogen peroxide) in which the numeral subscripts are not divided by the common factor. You will understand the reasons for this in higher classes.

The formulae of some common compounds are given in Table 1.3.

Table 1.3 **Formulae of some common compounds**

Elements with valencies	Formula	Name of the compound
$\overset{1}{Na}\ \overset{1}{Cl}$	$NaCl$	Sodium chloride
$\overset{2}{Mg}\ \overset{1}{Cl}$	$MgCl_2$	Magnesium chloride
$\overset{3}{Al}\ \overset{1}{Cl}$	$AlCl_3$	Aluminium chloride
$\overset{1}{Na}\ \overset{2}{O}$	Na_2O	Sodium oxide
$\overset{2}{Mg}\ \overset{2}{O}$	MgO	Magnesium oxide
$\overset{2}{Ca}\ \overset{2}{O}$	CaO	Calcium oxide
$\overset{2}{Zn}\ \overset{2}{O}$	ZnO	Zinc oxide
$\overset{2}{Zn}\ \overset{2}{S}$	ZnS	Zinc sulphide
$\overset{2}{Mg}\ \overset{3}{N}$	Mg_3N_2	Magnesium nitride
$\overset{3}{Al}\ \overset{3}{N}$	AlN	Aluminium nitride

Variable Valency

In some elements the valencies vary. Such elements are said to have variable valency. For example, iron has a variable valency of 2 (as in $FeCl_2$) and 3 (as in $FeCl_3$). To distinguish between them, $FeCl_2$ is named iron(II) chloride and $FeCl_3$ is named iron(III) chloride. This method of naming a compound is adopted if it contains an element with variable valency.

Table 1.4 **Some elements with variable valencies**

Metal	Nonmetal
Copper—1, 2	Phosphorus—3, 5
Iron—2, 3	Sulphur—2, 4, 6
Tin—2, 4	
Lead—2, 4	

Thus, knowing the valencies, we can write the formulae of the corresponding compounds.

Copper(I) chloride $\overset{1}{\mathrm{Cu}}\ \overset{1}{\mathrm{Cl}} \Rightarrow \mathrm{CuCl}$

Copper(II) chloride $\overset{2}{\mathrm{Cu}}\ \overset{1}{\mathrm{Cl}} \Rightarrow \mathrm{CuCl_2}$

Iron(II) oxide $\overset{2}{\mathrm{Fe}}\ \overset{2}{\mathrm{O}} \Rightarrow \mathrm{FeO}$

Iron(III) oxide $\overset{3}{\mathrm{Fe}}\ \overset{2}{\mathrm{O}} \Rightarrow \mathrm{Fe_2O_3}$

Can you guess the valencies of phosphorus in PCl_3 and PCl_5, and of sulphur in H_2S, SO_2 and SO_3?

The World of Atoms

When the atom was thought of, it was considered to be indivisible. However, from the experiments of Sir J J Thomson, Lord Rutherford, James Chadwick and others, it was proved that atoms are made up of still smaller particles—electrons, protons and neutrons. They are called subatomic or fundamental particles.

Characteristics of Fundamental Particles

The fundamental particles have different characteristics.

The electron An electron carries a negative electrical charge, which is considered as the unit of negative charge. It is extremely light—1840 times lighter than the lightest of all atoms, i.e., a hydrogen atom. So its mass is negligible.

The proton A proton carries a positive electrical charge, which is taken as the unit of positive charge. Its mass is the same as that of a hydrogen atom, i.e., 1 amu.

The atomic mass unit

An atom is so light that you cannot weigh it on a balance. Scientists use the mass of the hydrogen atom as the standard for measuring the masses of other atoms. According to this scale, the mass of the hydrogen atom is 1 atomic mass unit (amu).

The neutron A neutron carries no electrical charge. In other words, it is electrically neutral. So the name neutron. Its mass is almost the same as that of a proton, i.e., 1 amu.

Table 1.5 Characteristics of fundamental particles

Particle	Mass	Charge
Electron	Negligible	– 1 unit
Proton	1 amu	+1 unit
Neutron	1 amu	0

How are the Fundamental Particles Arranged?

At the centre of an atom, there is a nucleus, made up of protons and neutrons (except the nucleus of a hydrogen atom, which has a proton only). The electrons revolve in their orbits round the nucleus, just as planets do round the sun in our solar system (Figure 1.3).

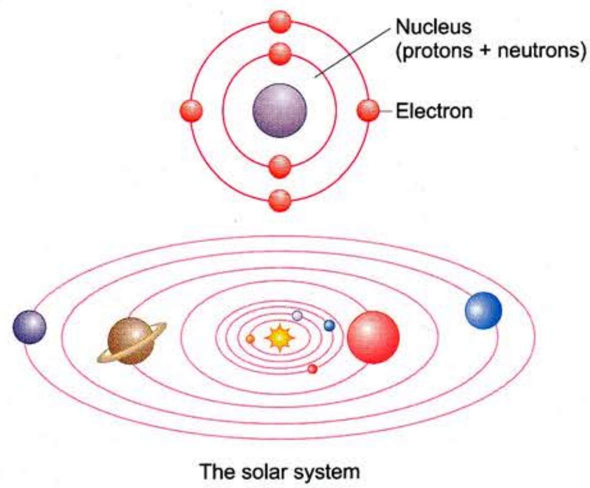


Fig. 1.3 Electrons revolve round the nucleus.

The nucleus of an atom is positively charged due to the protons in it. But the atom as a whole is electrically neutral, meaning that the charge on an atom is zero. This means that the positive charge of the protons is cancelled by the negative charge of the electrons. This can happen only when the number of protons equals that of electrons. The number of protons contained in an atom of an element is fixed. This number is called the atomic number or the proton number of the element and is represented by the symbol Z.

> The atomic number or the proton number of an element is the number of protons present in the nucleus of an atom of the element.

Thus, in an atom,

the number of electrons

= the number of protons = Z.

It is the protons and neutrons that make up the mass of an atom, since the mass of the electrons is negligible.

> The sum of the numbers of protons and neutrons in an atom is known as the mass number of the atom.

The mass number of an atom is represented by the symbol A.

So, in an atom,

the number of neutrons

= mass number − number of protons

= mass number − atomic number

= $A - Z$.

Thus, the numbers of the fundamental particles in an atom are given as follows.

> The number of electrons = Z.
>
> The number of protons = Z.
>
> The number of neutrons = $A - Z$.

The atomic and mass numbers of an atom, X, are often shown as ${}^{A}_{Z}X$, called the nuclide symbol. For example, ${}^{12}_{6}C$ means that the atomic number of the carbon atom is 6 and the mass number is 12.

In an atom, the electrons revolve round the nucleus in shells, called K, L, M, N, ... shells. They are named in this order starting from the innermost shell. The first shell is called the K shell, the second is called the L shell, and so on. The numbers of electrons in these shells follow a set of rules. You will learn about the arrangement of electrons in detail in higher classes.

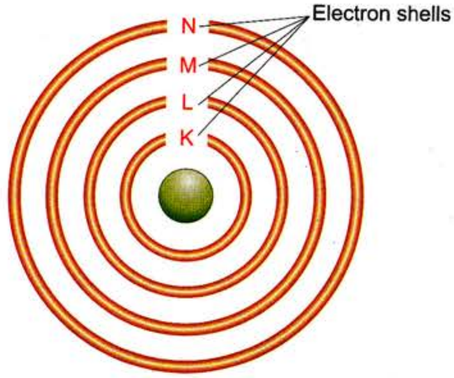


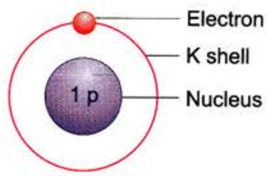
Fig. 1.4 The electron shells in an atom

Let us now look into the structures of the atoms of some common elements.

1. Hydrogen (${}^{1}_{1}H$)

The number of electrons = Z = 1.

The number of protons = Z = 1.



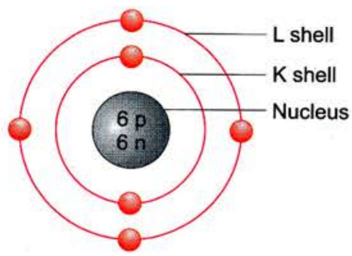
The number of neutrons = $A - Z = 1 - 1 = 0$.

2. Carbon (${}^{12}_{6}C$)

The number of electrons = $Z = 6$.

The number of protons = $Z = 6$.

The number of neutrons = $A - Z = 12 - 6 = 6$.

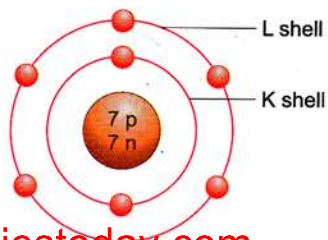


3. Nitrogen (${}^{14}_{7}N$)

The number of electrons = $Z = 7$.

The number of protons = $Z = 7$.

The number of neutrons = $A - Z = 14 - 7 = 7$.

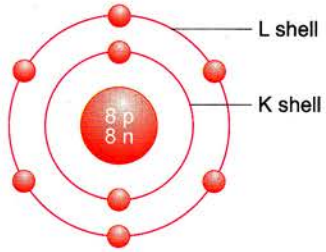


4. Oxygen ($^{16}_{8}O$)

The number of electrons = $Z = 8$.

The number of protons = $Z = 8$.

The number of neutrons = $A - Z = 16 - 8 = 8$.



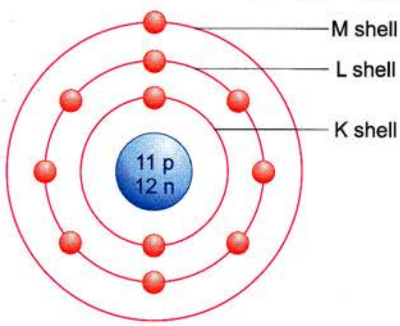
5. Sodium ($^{23}_{11}Na$)

The number of electrons = $Z = 11$.

The number of protons = $Z = 11$.

The number of neutrons

$= A - Z = 23 - 11 = 12$.



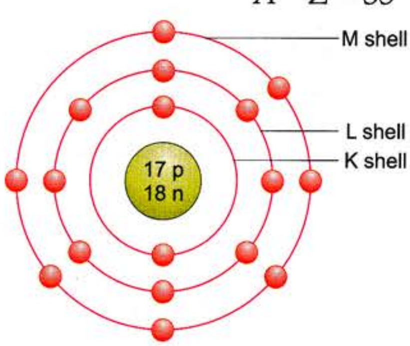
6. Chlorine ($^{35}_{17}Cl$)

The number of electrons = $Z = 17$.

The number of protons = $Z = 17$.

The number of neutrons

$= A - Z = 35 - 17 = 18$.



Isotopes

Some elements have atoms with different mass numbers. For example, chlorine (atomic number 17) has two types of atoms—with mass numbers 35($^{35}_{17}Cl$) and 37($^{37}_{17}Cl$). Such atoms are called isotopes.

> Atoms of an element having different mass numbers are called isotopes.

Hydrogen has three ($^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$) isotopes, carbon has three ($^{12}_{6}C$, $^{13}_{6}C$, $^{14}_{6}C$), chlorine has two ($^{35}_{17}Cl$, $^{37}_{17}Cl$), and so on. The isotopes of an element, as shown below in the case of carbon, differ only in the number of neutrons in their nuclei.

Table 1.6 Isotopes of carbon

Isotope	Z	A	Numbers of fundamental particles		
			Electrons (Z)	Protons (Z)	Neutrons (A − Z)
$^{12}_{6}C$	6	12	6	6	12 − 6 = 6
$^{13}_{6}C$	6	13	6	6	13 − 6 = 7
$^{14}_{6}C$	6	14	6	6	14 − 6 = 8

Isotopes find wide application in different fields. For example, uranium-235 ($^{235}_{92}U$) is used in producing nuclear energy.

Ions

An atom is electrically neutral because the charge of the protons is balanced by that of the electrons. But what happens when an atom loses or gains an electron? If an atom loses an electron, the number of protons exceeds that of electrons. So the atom gets positively charged. For example, a sodium atom has 11 protons and 11 electrons. On losing an electron, it would have 10 electrons and 11 protons. The greater number of protons causes the sodium atom to have a positive charge. Therefore, we say that Na^+ is formed.

Similarly, if an atom gains an electron, the number of electrons exceeds that of protons. So the atom becomes negatively charged. For example, a chlorine atom contains 17 protons and 17 electrons. If it gains an electron, there are

18 electrons as against 17 protons. So the chlorine atom then has a negative charge on it, i.e., Cl^- is formed.

In general, metal atoms tend to lose electron(s) and nonmetal atoms tend to gain electron(s). Some common examples are given in Table 1.7.

> Electrically charged atoms are called ions. Positive ions are known as cations and negative ions are known as anions.

Obviously, the number of positive charges on a cation will be the same as the number of electrons lost by its parent atom. Similarly, the number of negative charges on an anion will be the same as the number of electrons gained by its parent atom. For example, when a copper atom loses 2 electrons, it forms a Cu^{2+} ion. And an oxygen atom forms an O^{2-} ion on gaining 2 electrons.

Remember that an atom loses or gains a maximum of three electrons.

Table 1.7 Examples of ion formation

Cations	Anions
$Na - e \rightarrow Na^+$	$F + e \rightarrow F^-$
$K - e \rightarrow K^+$	$Cl + e \rightarrow Cl^-$
$Mg - 2e \rightarrow Mg^{2+}$	$O + 2e \rightarrow O^{2-}$
$Ca - 2e \rightarrow Ca^{2+}$	$S + 2e \rightarrow S^{2-}$
$Zn - 2e \rightarrow Zn^{2+}$	$N + 3e \rightarrow N^{3-}$
$Al - 3e \rightarrow Al^{3+}$	

Bonding by the Transfer of Electrons

We have seen how atoms lose or gain electrons to form ions. But it is important to note that *an atom loses an electron only if another atom is there to take it up*.

For example, the electron lost by a sodium atom can be grabbed by a chlorine atom. This results in the formation of Na^+ and Cl^- ions. You know that unlike charges attract each other. So Na^+ and Cl^- ions attract each other and remain together. The electrical charges are exactly balanced and a new species NaCl, i.e., sodium chloride, is formed.

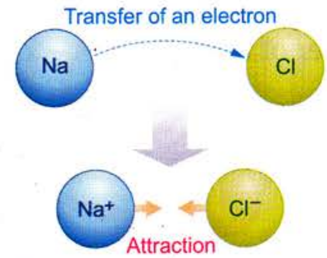


Fig. 1.5 The formation of NaCl

> The force that holds any two atoms to form a new entity (species) is called a chemical bond.

So, the force that holds the Na^+ and Cl^- ions in sodium chloride is a chemical bond.

> A chemical bond formed by the transfer of electron(s) is known as an ionic or electrovalent bond.

And a compound thus formed, e.g., sodium chloride, is called an **ionic** or **electrovalent compound**.

Similarly, an atom of magnesium loses two electrons to form an Mg^{2+} ion. These two electrons can be taken up by an oxygen atom to form an O^{2-} ion. Now an ionic bond is formed between the two and the compound MgO is formed. The charges are exactly balanced.

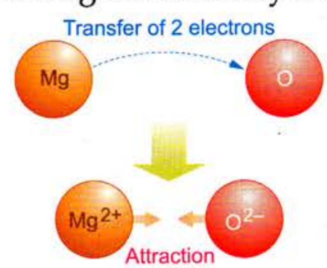


Fig. 1.6 The formation of MgO

You have seen the importance of charge balance. So, it is easy for you to understand that one Mg^{2+} will require two Cl^- ions for balancing the charge. And so will an O^{2-} ion require two Na^+ ions. The resulting compounds will be $MgCl_2$ and Na_2O.

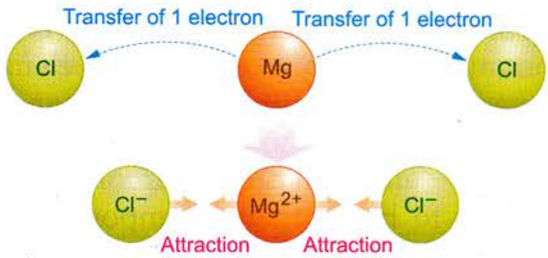


Fig. 1.7 The formation of $MgCl_2$

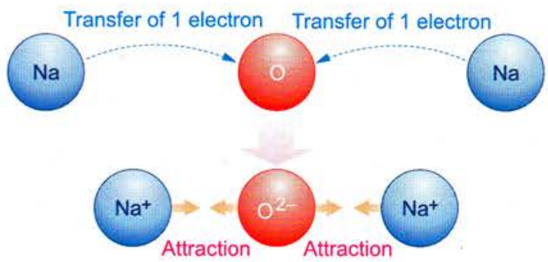


Fig. 1.8 The formation of Na_2O

Valency in Terms of Electrons

As you know, sodium and chlorine have a valency of 1, and magnesium and oxygen have a valency of 2. These numbers are the same as the number of electrons lost or gained by an atom of the element in forming an ionic compound. So we can conclude the following.

> The valency of an element taking part in the formation of an ionic compound is the number of electrons lost or gained by an atom of the element.

The valency of such an element is also then the number of charges on the ion derived from the element.

The formula of an ionic compound is written by transposing the number of charges on the two ions, and dividing by a common factor, if any.

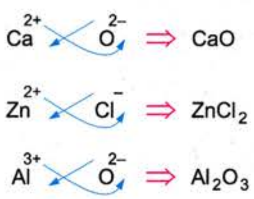


Fig. 1.9

Radicals

Ions are also called radicals. Na^+, K^+, Ca^{2+}, etc., are positive radicals, whereas Cl^-, O^{2-}, S^{2-}, etc., are negative radicals.

There are certain groups of atoms that behave like single atoms. They have a valency and usually remain intact in a chemical reaction. They are called compound radicals. Such radicals also carry positive or negative charges. Some common compound radicals are mentioned in Table 1.8.

Table 1.8 Some common compound radicals

Monovalent	Divalent	Trivalent
Ammonium (NH_4^+)	Sulphate (SO_4^{2-})	Phosphate (PO_4^{3-})
Hydroxide (OH^-)	Carbonate (CO_3^{2-})	
Nitrate (NO_3^-)		
Nitrite (NO_2^-)		
Hydrogencarbonate (or bicarbonate) (HCO_3^-)		

The formulae of compounds containing radicals can also be written by transposing the valencies, and dividing them by a common factor, if any.

For example, the compound formed by Cu^{2+} and CO_3^{2-} is $CuCO_3$ and not $Cu_2(CO_3)_2$. We have divided the valencies (2) by the common factor (2).

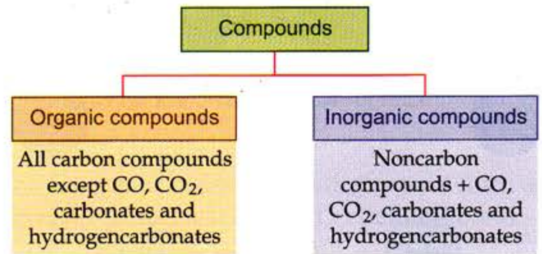
Table 1.9 The formulae of some compounds

Compound	Radical	Formula
Sodium hydroxide	Na^+ OH^-	$NaOH$
Ammonium hydroxide	NH_4^+ OH^-	NH_4OH
Ammonium nitrate	NH_4^+ NO_3^-	NH_4NO_3
Potassium sulphate	K^+ SO_4^{2-}	K_2SO_4
Ammonium sulphate	NH_4^+ SO_4^{2-}	$(NH_4)_2SO_4$
Copper carbonate	Cu^{2+} CO_3^{2-}	$CuCO_3$
Sodium hydrogencarbonate	Na^+ HCO_3^-	$NaHCO_3$

Organic and Inorganic Compounds

In the olden days, compounds were obtained either from living organisms (plants and animals) or from minerals. For example, sucrose (cane sugar) was obtained from the sugar cane plant, whereas common salt (sodium chloride) was obtained from the mineral rock salt. The compounds obtained from living organisms were called organic compounds and those from minerals were called inorganic compounds. It was believed at that time that organic compounds could not be prepared in the laboratory.

Later, organic compounds were prepared in the laboratory in large numbers. They contain carbon and one or more of the elements hydrogen, oxygen, nitrogen, sulphur, etc. However, carbon monoxide, carbon dioxide, carbonates and hydrogencarbonates are considered to be inorganic compounds even though they contain carbon, as they are obtained from mineral sources.



Points to Remember

- An *element* is a substance that cannot be split into simpler substances by a chemical means.
- A *compound* is a substance that can be split into two or more substances by a chemical means.
- A *mixture* is a substance containing more than one element or compound in any proportion.
- An *atom* is the smallest part of an element that can take part in a chemical reaction.
- An atom of an element cannot be changed into that of another element by a chemical means.
- An atom of an element can neither be created nor destroyed.
- A *molecule* is the smallest part of an element or a compound that is capable of existing independently.
- The combining capacity of an element with other elements is known as its *valency*.
- Some elements show different valencies in different compounds. Such elements are said to have *variable valency*.
- The number of atoms contained in a molecule of an element is known as the *atomicity* of the element.
- Atoms are made up of *electrons*, *protons* and *neutrons*. These particles are known as *subatomic* or *fundamental particles*.

Characteristics of fundamental particles

Particle	Mass	Charge
Electron	Negligible	– 1 unit
Proton	1 amu	+1 unit

- At the centre of an atom, there is a *nucleus* made up of protons and neutrons. The electrons revolve round the nucleus.
- The nucleus of a hydrogen atom contains only a proton and no neutrons.
- The *atomic number* (Z) or the *proton number* of an element is the number of protons present in the nucleus of an atom of the element.
- The sum of the numbers of protons and neutrons in an atom is known as the *mass number* (A) of the atom.

- In an atom,
  the number of electrons = Z, the number of protons = Z, and the number of neutrons = *A* – Z.
- The atoms of an element with different mass numbers are called *isotopes*.
- Electrically charged atoms are called *ions*.
- Positive ions are known as *cations*. An atom can form a cation by losing electron(s).
- Negative ions are known as *anions*. An atom can form an anion by gaining electron(s).
- The force that holds any two atoms to form a new entity (species) is called a *chemical bond*.
- The transfer of electrons from one atom to another causes the formation of a chemical bond, called an *ionic* or *electrovalent bond*.
- The valency of an element taking part in the formation of an ionic compound is the number of electrons lost or gained by an atom of the element.
- Ions are also called *radicals*.
- Certain groups of atoms behave like single atoms. They have a valency and usually remain intact in a chemical reaction. They are called *compound radicals*.
- Carbon compounds except CO, CO_2, carbonates and hydrogencarbonates are called organic compounds.
- Noncarbon compounds and CO, CO_2, carbonates and hydrogencarbonates are called inorganic compounds.

Exercise

Short-Answer Questions

1. Can an element be split into simpler substances by a chemical means?
2. Can a compound be split into simpler substances by a chemical means?
3. Are the atoms of an element all alike?
4. Can an atom be destroyed by a chemical means?
5. Can an electron reside inside the nucleus of an atom?
6. Define atomic number.
7. What are isotopes?
8. Can the number of electrons be different from that of protons in an atom?
9. Calculate the numbers of electrons, protons and neutrons in the following atoms.
   (a) $^{16}_{7}N$ (b) $^{19}_{9}F$ (c) $^{35}_{17}Cl$
10. Select the pair of isotopes from among the following species.
    ^{12}C, ^{16}O, ^{18}O, ^{19}F
11. What are the following called?
    (a) The combining capacity of an element with other elements
    (b) The number of atoms contained in a molecule of an element
    (c) The force that holds any two atoms to form a new entity (species)
    (d) The bond formed by the transfer of electrons from one atom to another
12. What is the valency of the underlined element or radical in each of the following compounds?
    (a) $\underline{P}Cl_3$ (b) $\underline{P}Cl_5$ (c) $\underline{Fe}O$ (d) $\underline{Fe}_2O_3$ (e) $\underline{Ca}CO_3$
    (f) $\underline{Cu}Cl$ (g) $\underline{Cu}Cl_2$ (h) $\underline{Cu}O$ (i) $Na\underline{HSO_4}$ (j) $Na\underline{HCO_3}$

Long-Answer Questions

1. What are the characteristics of the fundamental particles?
2. Describe how the fundamental particles are arranged in an atom.
3. Describe the formation of the bond between sodium and chlorine giving sodium chloride.

Objective Questions

Choose the correct option.

1. Which of the following species can exist independently?
   (a) H (b) Cl (c) O (d) Ne
2. Which of the following species cannot exist independently?
   (a) H_2O (b) CO_2 (c) N (d) HCl
3. Which of the following has an atomicity of 3?
   (a) Nitrogen (b) Chlorine (c) Bromine (d) Ozone
4. Carbon has an atomic number of 6. Which of the following isotopes of carbon will have the same number of neutrons as that of protons?
   (a) ^{12}C (b) ^{13}C (c) ^{14}C

Fill in the blanks.

1. An atom is the smallest part of ...... that takes part in a chemical reaction. (an element/a compound)
2. A molecule is the smallest part of an element or a ...... that can exist independently. (compound/mixture)
3. Complete the following table.

Element	Atomic number (Z)	Mass number (A)	Numbers of fundamental particles		
			Electrons	Protons	Neutrons
Carbon	6	13	6	6	7
Magnesium	12	24			
Aluminium				13	14
Phosphorus		31	15		16

4. An aluminium atom ...... three electrons to form an Al^{3+} ion. (loses/gains)
5. An oxygen atom ...... two electrons to form an O^{2-} ion. (loses/gains)
6. Complete the following table.

Cation	Anion	Formula of the compound	Name of the compound
Na^+	O^{2-}	Na_2O	Sodium oxide
Ca^{2+}	S^{2-}		
Ca^{2+}		$Ca(NO_3)_2$	Calcium nitrate
	SO_4^{2-}	$ZnSO_4$	
Al^{3+}	O^{2-}		
Cu^{2+}		$CuCO_3$	
Na^+	HSO_4^-		
Ca^{2+}	HCO_3^-		

Indicate which of the following statements are true and which are false.

1. An atom can be changed from one kind to another by a chemical means.
2. Neutrons reside in the nucleus and so they are positively charged.
3. Protons revolve round the nucleus of an atom.
4. It is the number of electrons that differs in the isotopes of an element.

Modelling a Molecule

You have learnt that if an element A has a valency *y* and another element B has a valency *x*; the compound formed by A and B will have the formula A_xB_y. You can check for yourself why this is so.

Let us suppose an element A with a valency 3 combines with an element B having a valency 2.

Take a few potatoes in two sizes. Colour the bigger ones in one colour and the smaller ones in another colour. Call the bigger ones A and the smaller ones B. These potatoes will represent the atoms of A and B in your model. Also, take a few broomsticks of equal size. The broomsticks will represent the valencies of A and B.

Take a potato A and fix three broomsticks into it as its valency is 3. Fix the free ends of two of these broomsticks into a potato B. B will not take any more sticks as it has a valency of 2 only. So the free end of the third stick of A will require another B. Take another B and fix the free end of the third stick into it. But as B has a valency 2, fix one fresh stick to it, the free end of which will go into a fresh A. As A has a valency of 3, fix two more sticks into it and fix the free ends of these two sticks into a fresh B. Now the valencies of both A and B are satisfied, and you need not attach any more potatoes to broomsticks. All the atoms joined together constitute a molecule. In this molecule, there are two atoms of A and three atoms of B and so the molecular formula of the compound will be A_2B_3.

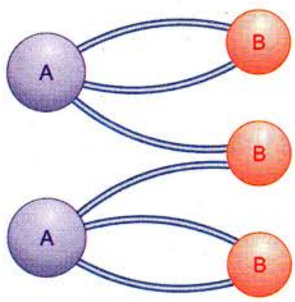


Fig. 1.9 The formation of A_2B_3

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