पुना International School

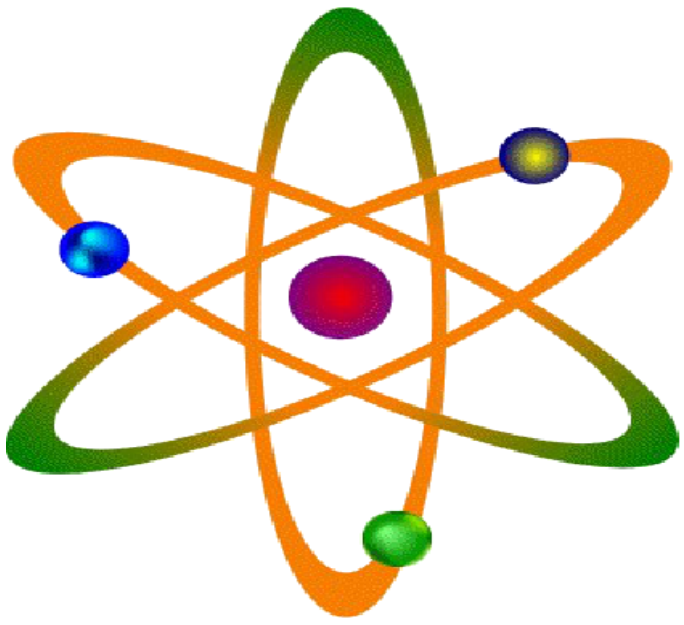
Shree Swaminarayan Gurukul, Zundal

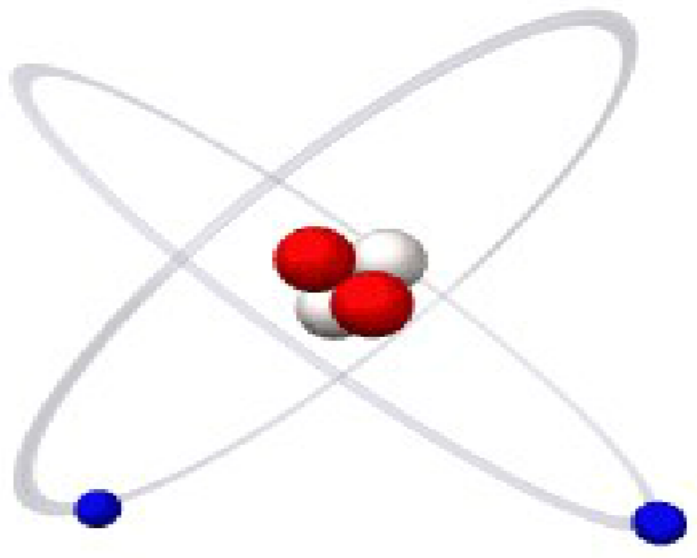
Class -IX

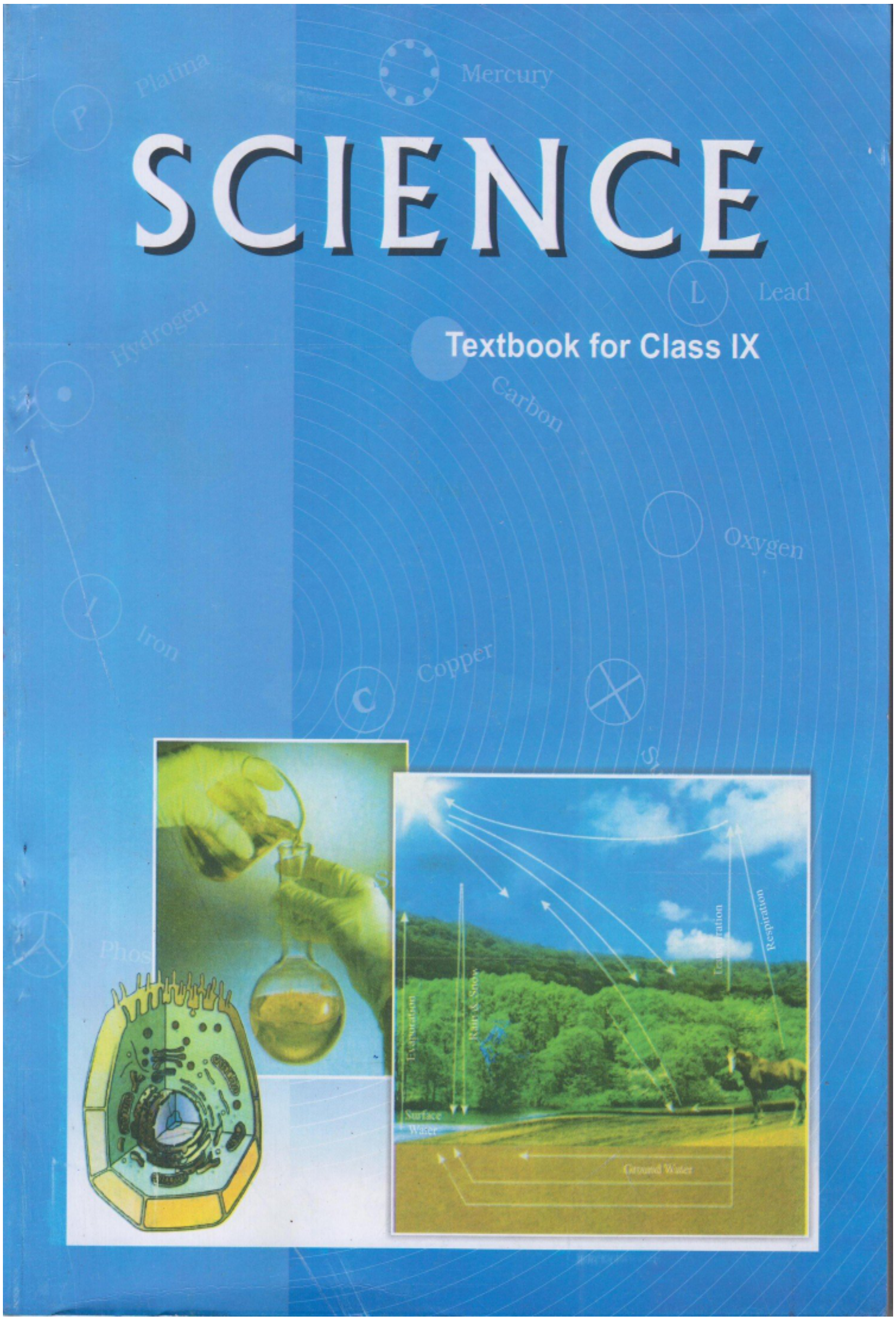
Science (Chemistry)

Specimen Copy

Year- 2020-21






Platina
Mercury
SCIENCE
Lead
Textbook for Class IX
Hydrogen
Carbon
Oxygen
Iron
Copper
Evaporation
Rain & Snow
Surface Water
Ground Water

INDEX

CHAPTER – 3
ATOMS AND MOLECULES

❖ Facts that Matter

- **Law of Chemical Combination**

Given by Lavoisier and Joseph L. Proust as follows:

(i) Law of conservation of mass: Mass can neither be created nor destroyed in a chemical reaction.

e.g.,A+B-C+D

Reactants R Products

Mass of reactants = Mass of products

(ii) Law of constant proportion: In a chemical substance the elements are always present in definite proportions by mass.

E.g., in water, the ratio of the mass of hydrogen to the mass of oxygen is always 1 : 8 respectively.

These laws lacked explanation. Hence, John Dalton gave his theory about the matter. He said that the smallest particle of matter is called 'atom'.

❖ Dalton's Atomic Theory

1. Every matter is made up of very small or tiny particles called atoms.
2. Atoms are not divisible and cannot be created or destroyed in a chemical reaction.
3. All atoms of a given element it are same in size, "mass and chemical properties.
4. Atoms of different elements are different in size, mass and chemical properties.
5. Atoms combine in the ratio of small whole number to form compounds.
6. The relative number and kinds of atoms are constant in a given compound.

❖ Atom :-

An atom is the smallest particle of an element that may or may not exist independently and retains all its chemical properties.

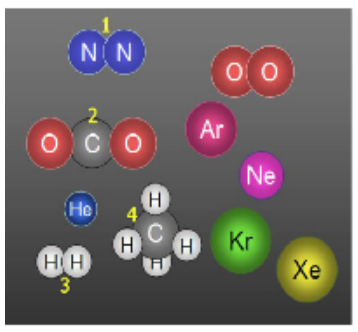
Atoms are very small in size and smaller than anything we can imagine or compare with.

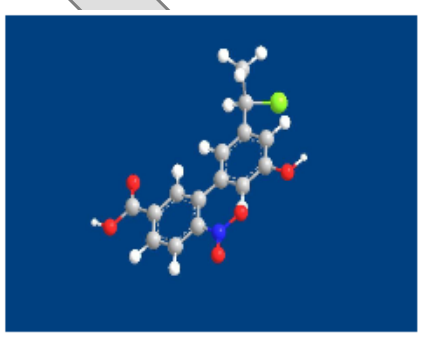
Atomic radius is measured in nanometres (nm)

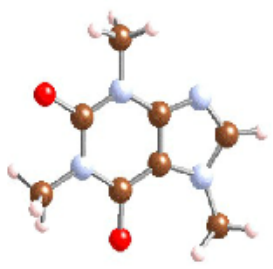
1 nanometer = 10^{-9} m or 1 meter = 10^{9} nm

Eg :- The atomic radius of an atom of hydrogen is 10^{-10} m.

The radius of a molecule of water is 10-9 m.

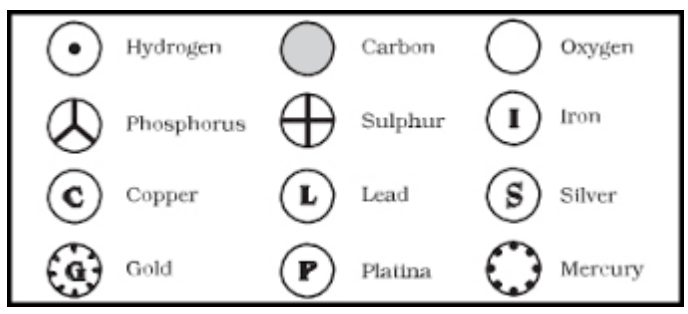






❖ Symbols of atoms:

(a) Symbols for some elements as proposed by Dalton:



(b) Symbols of some common elements:

Name of the element	Latin name	Symbol
Hydrogen		H
Helium		He
Carobon		C
Copper	Cuprum	Cu
Cobalt		Co

Chlorine		Cl
Cadmium		Cd
Boron		B
Barium		Ba
Bromine		Br
Bismuth		Bi
Sodium	Natrium	Na
Potassium	Kalium	K
Iron	Ferrum	Fe
Gold	Aurum	Au
Silver	Argentum	Ag
Mercury	Hydragyrum	Hg

❖ **Atomic mass** :-

Since atoms are very small in size its mass is very small and determining its mass is very difficult. So the mass of an atom is compared with the mass of a standard atom.

The atom which is considered as a standard atom for comparing the masses of other atoms is carbon – 12 atom whose atomic mass is 12 u (atomic mass unit).

One atomic mass unit (u) is the mass of 1/12th the mass of a carbon – 12 atom.

The atomic mass of an element is defined as the average mass of one atom of the element compared with 1/12th the mass of a carbon – 12 atom.

Atomic masses of some elements :-

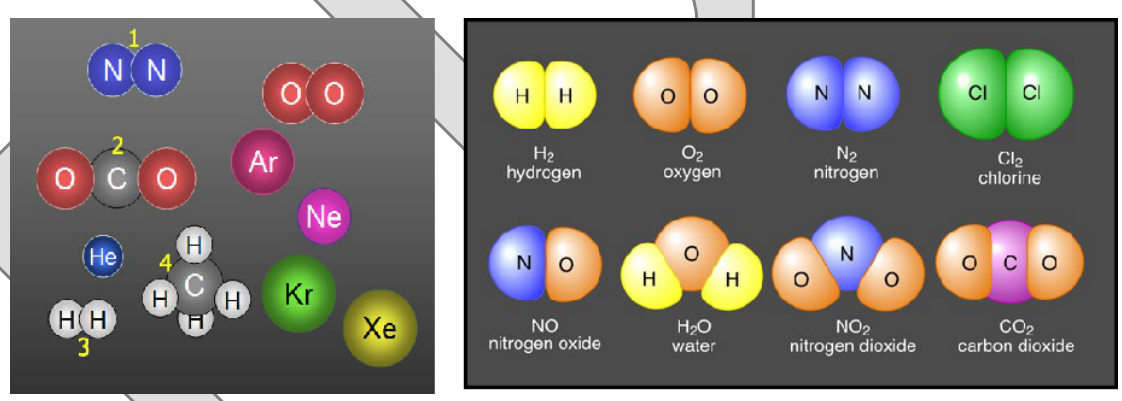
Element	Atomic mass (u)	Element	Atomic mass (u)
Hydrogen	1	Magnesium	24
Carbon	12	Aluminium	27
Nitrogen	14	Sulphur	32
Oxygen	16	Chlorine	35.5
Sodium	23	Calcium	40

❖ **Molecule** :-

A molecule is the smallest particle of an element or compound which exists independently and shows all the properties of that substance.

A molecule is a group of two or more elements that are held together by attractive forces.

Atoms of the same element or different elements can join together to form molecules.



❖ **Molecule of elements** :-

Molecule of an element contains atoms of the same element.

Molecules of some elements contain only one atom and molecules of some elements contain two or more atoms.

Atomicity of an element :- is the number of atoms present in one molecule of the element.

Atomicity of some elements :-

Atomicity of some elements :-

Type of element	Name		Atomicity
Non metal	Argon	Ar	1 – Monatomic
Non metal	Helium	He	1 – Monatomic
Non metal	Oxygen	O_2	2 – Diatomic
Non metal	Hydrogen	H_2	2 – Diatomic
Non metal	Nitrogen	N_2	2 – Diatomic
Non metal	Chlorine	Cl_2	2 – Diatomic
Non metal	Phosphorus	P_4	4 – Phosphorus
Non metal	Sulphur	S_8	Poly atomic
Metal	Sodium	Na	1 – Monatomic
Metal	Iron	Fe	1 – Monatomic
Metal	Aluminum	Al	1 – Monatomic
Metal	Copper	Cu	1 – Monatomic

ii) Molecule of compounds :-

Molecule of a compound contains atoms of two or more different types of elements.

Molecules of some compounds :-

Molecules of some compounds :-

Compound	Combining elements	Number of atoms of each elements
Water – H_2O	Hydrogen, Oxygen	2 - Hydrogen, 1 - Oxygen
Ammonia – NH_3	Nitrogen, Hydrogen	1 - Nitrogen, 3 - Hydrogen
Carbon dioxide CO_2	Carbon, Oxygen	I - Carbon, 2 - Oxygen
Hydrochloric acid HCl	Hydrogen, Chlorine	1 - Hydrogen, 1 - Chlorine
Nitric acid HNO_3	Hydrogen, Nitrogen, Oxygen	1 - Hydrogen, 1 - Nitrogen, 3 - Oxygen
Sulphuric acid H_2SO_4	Hydrogen, Sulphur, Oxygen	2 - Hydrogen, 1 - Sulphur, 4 - Oxygen

❖ **Ions** :-

Compounds containing metal and non metal elements contain charged particles called ions.

An ion is a charged particle having positive or negative charge. A positively charged ion is called 'cation' and a negatively charged ion is called 'anion'.

Valency :- is the combining capacity of an element.

Some common ions and their valencies :-

Table 4.1: Composition of Atoms of the First Eighteen Elements with Electron Distribution in Various Shells

Name of Element	Symbol	Atomic Number	Number of Protons	Number of Neutrons	Number of Electrons	Distribution of Electrons K	L	M	N	Valency
Hydrogen	H	1	1	-	1	1	-	-	-	1
Helium	He	2	2	2	2	2	-	-	-	0
Lithium	Li	3	3	4	3	2	1	-	-	1
Beryllium	Be	4	4	5	4	2	2	-	-	2
Boron	B	5	5	6	5	2	3	-	-	3
Carbon	C	6	6	6	6	2	4	-	-	4
Nitrogen	N	7	7	7	7	2	5	-	-	3
Oxygen	O	8	8	8	8	2	6	-	-	2
Fluorine	F	9	9	10	9	2	7	-	-	1
Neon	Ne	10	10	10	10	2	8	-	-	0
Sodium	Na	11	11	12	11	2	8	1	-	1
Magnesium	Mg	12	12	12	12	2	8	2	-	2
Aluminium	Al	13	13	14	13	2	8	3	-	3
Silicon	Si	14	14	14	14	2	8	4	-	4
Phosphorus	P	15	15	16	15	2	8	5	-	3.5
Sulphur	S	16	16	16	16	2	8	6	-	2
Chlorine	Cl	17	17	18	17	2	8	7	-	1
Argon	Ar	18	18	22	18	2	8	8		0

❖ **chemical formulae** :-

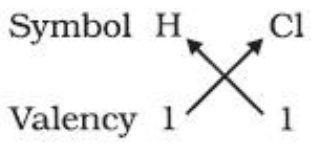
-Write the symbols / formula of the elements or ions so that the symbol of the metal or positive ion is on the left and symbol / formula of the non metal or negative ion is on the right.

-Write the valencies of the elements or ions below the elements or ions.

-Cross over the valencies of the combining ions.

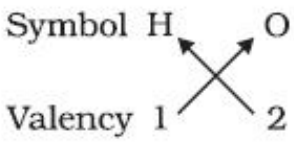
-Polyatomic ions should be enclosed in bracket before writing the formula.

1. Formula of hydrogen chloride

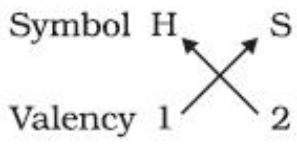


Formula of the compound would be HCl.

2. Formula of hydrogen sulphide

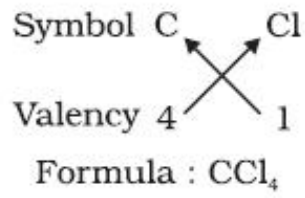


Formula : H_2O



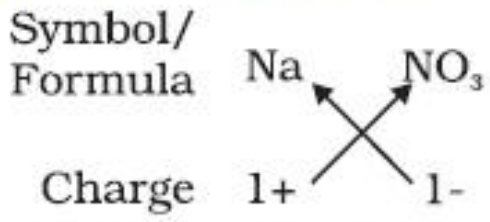
Formula : H_2S

3. Formula of carbon tetrachloride



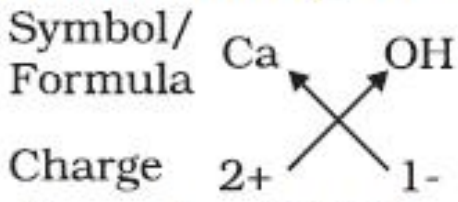
Formula : CCl_4

(c) Formula of sodium nitrate:



Formula : $NaNO_3$

(d) Formula of calcium hydroxide:



Formula : $Ca(OH)_2$

❖ **Molecular mass / Formula unit mass:-**

The molecular mass of a substance is the sum of the atomic masses of all the atoms in a molecule of the substance.

-Molecular mass is expressed in atomic mass units (u).

Eg:-1) Molecular mass of water – H_2O
Atomic mass of H = I u
Atomic mass of O = 16 u
Molecular mass of H_2O = 1x2+10 = 2+16 = 18 u

2) Molecular mass of Nitric acid – HNO_3 Atomic mass of H = 1 u
Atomic mass of N = 14 u
Atomic mass of O = 16 u
Molecular mass of HNO_3 = 1+14+16x3 = 1+14+48 = 63 u

Formula Unit Mass

It is the sum of the atomic masses of all atoms in a formula unit of a compound. The constituent particles are ions.

e.g., $Na^+ + Cl^- \rightarrow NaCl$
$1 \times 23 + 1 \times 35.5 = 58.5$ u

❖ **Mole concept :-**

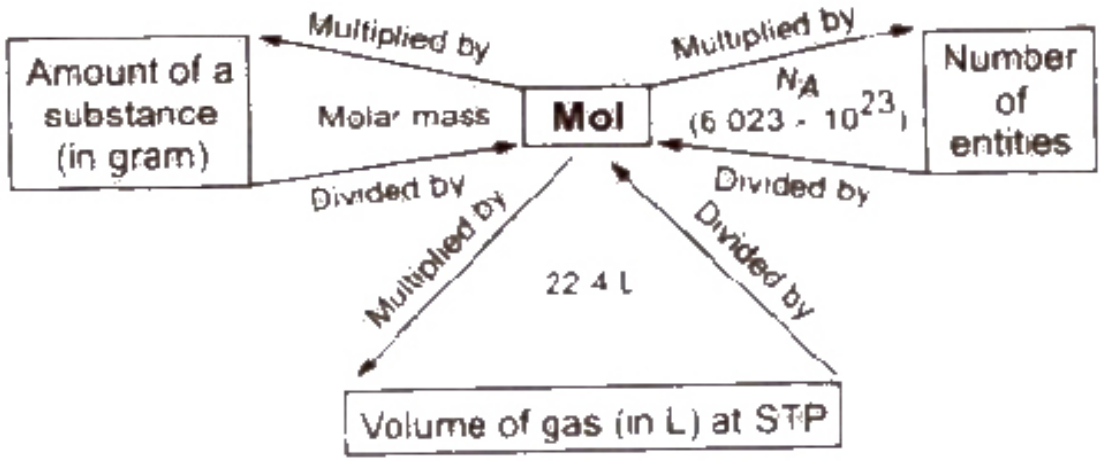
-A mole of a substance is that amount of the substance which contains the same number of particles (atoms, molecules or ions) that are present in 12g of Carbon – 12.

-The number of particles (atoms) present in 12g of Carbon – 12 is6.022 x 1023 . This number is called Avagadro Number or Avagadro Constant.

-A mole represents two things :-

-It represents a definite number of particles (atoms, molecules or ions) equal to 6.022 x 1023 .

-It represents a definite mass of a substance equal to the gram atomic mass of an element or the gram molecular mass of a compound



INTEXT EXERCISE :-

(Page No. 32)

1. In a reaction, 5.3 g of sodium carbonate reacted with 6 g of ethanoic acid. The products were 2.2 g of carbon dioxide, 0.9 g water and 8.2 g of sodium ethanoate. Show that these observations are in agreement with the law of conservation of mass.

sodium carbonate + ethanoic acid → sodium ethanoate + carbon dioxide + water

Ans. According to the law of conservation of mass:

Mass of reactants = Mass of products

Let's calculate and find out both results –

Mass of reactants = Mass of sodium carbonate +Mass of ethanoic acid
= 5.3g + 6g
= 11.3g

Mass of products = Mass of sodium ethanoate + Mass of carbon dioxide + Mass of water
= 8.2g +2.2g + 0.9g = 11.3g

Hence it is proved that these observations are in agreement with the law of conservation of mass.

2.Hydrogen and oxygen combine in the ratio of 1:8 by mass to form water. What mass of oxygen gas would be required to react completely with 3 g of hydrogen gas?

Ans. As per the given 1:8 ratio mass of oxygen gas required to react completely with 1g of hydrogen gas is 8g.

Therefore, mass of oxygen gas required to react completely with 3g of hydrogen gas will be = 3 x 8 = 24g

3.Which postulate of Dalton's atomic theory is a result of the law of conservation of mass?

Ans. The following postulate of Dalton's atomic theory is a result of the law of conservation of mass:

"Atoms are indivisible particles which cannot be created or destroyed in a chemical reaction."

4.Which postulate of Dalton's atomic theory can explain the law of definite proportions?

Ans. The following postulate of Dalton's atomic theory can explain the law of definite proportions :

"The relative number and kinds of atoms are constant in a given compound."

(Page No. 35)

1.Define the atomic mass unit.

Ans. Atomic mass unit is defined as the mass equal to exactly one-twelfth(1/12th) of the mass of an atom of carbon-12.

2.Why is it not possible to see an atom with naked eyes?

Ans. An atom is an extremely small particle whose radius is of the order 10^{-10}m. This size is so small that our eyes are not able to see it.

(Page No. 39)

1. Write down the formulae of

(i) sodium oxide

(ii) aluminium chloride

(iii) sodium sulphide

(iv) magnesium hydroxide

Ans.

Compound	**Formula**
Sodium oxide	Na_2O
Aluminum Chloride	$AlCl_3$
Sodium Sulphide	Na_2S
Magnesium Hydroxide	$Mg(OH)_2$

2. Write down the names of compounds represented by following formulae:

(i) $Al_2(SO_4)_3$ **(iii)** K_2SO_4

(ii) $CaCl_2$ **(iv)** KNO_3

(v) $CaCO_3$

Ans.

Formula	**Compound**
$Al_2(SO4)_3$	Aluminum sulphate
$CaCl_2$	Calcium chloride
K_2SO_4	Potassium sulphate
KNO_3	Potassium nitrate
$CaCO_3$	Calcium carbonate

3. What is meant by the term chemical formula?

Ans. A chemical formula is the representation of elements present in a compound with the help of symbols and also the number of atoms of each element with those numbers only. for eg: A molecule of water (compound) contains 2 atoms of hydrogen and one atom of oxygen hence its chemical formula is H_2O.

4. How many atoms are present in a

(i) H_2S **molecule and**

(ii) PO_4^{3-} **ion?**

Ans. (i) 2 atoms of hydrogen + 1 atom of sulphur = 3 atoms

(ii)1 atom of phosphorus + 4 atoms of oxygen = 5 atoms

(Page No. 40)

1. Calculate the molecular masses of $H_2, O_2, Cl_2, CO_2, CH_4, C_2H_6, C_2H_4, NH_3, CH_3OH$

Ans. Molecular mass of H_2= atomic mass of H x 2 = 1 x 2 = 2u

Molecular mass of O_2= atomic mass of O x 2 = 16 x 2 = 32u

Molecular mass of Cl_2= atomic mass of Cl x 2 = 35.5 x 2 = 71u

Molecular mass of CO_2= atomic mass of C + (atomic mass of O x 2)
= 12 + (16 x 2)
= (12 + 32)
= 44 u

Molecular mass of CH_4= 12 + atomic mass of hydrogen x 4
= 12 (1 x 4)
= 12 + 4
= 16 u

Molecular mass of C_2H_6= 12 x 2 + 6 x 1= 24+6 = 30 u

Molecular mass of C_2H_4= 12 x 2 + 4 x 1=24 + 4 = 28 u
Molecular mass of NH_3= 14 + 3= 17 u
Molecular mass of CH_3OH= 12+1x3+16+1=12+3+16+1=32 u

2. Calculate the formula unit masses of ZnO, Na_2O, K_2CO_3, given atomic masses of Zn = 65 u, Na = 23 u, K = 39 u, C = 12 u, and O = 16 u.

Ans. Formula unit mass of:

i) ZnO = Atomic mass of Zn + atomic mass of O = (65 + 16) u = 81 u

ii) Na_2O= Atomic mass of Na + atomic mass of O= 23 x 2 + 16= 46 + 16 = 62 u

iii) K_2CO_3= Atomic mass of K + atomic mass of C + atomic mass of O= 39 x 2 + 12 + 3 x 16= 78 + 12 + 48 = 138 u

(Page No. 42)

1. If one mole of carbon atoms weighs 12 grams, what is the mass (in grams) of 1 atom of carbon?

Ans. Weight of one mole of carbon = atomic mass of carbon (1 atom of carbon) = 12 u

Therefore, one mole of carbon contains = 12 g = 6.022 x 10^{23}atoms (Avogadro number)

So, 1 atom of Carbon = $\frac{12}{6.022\times10^{23}}$
= 1.993 x 10^{-23} g

2.Which has more number of atoms, 100 grams of sodium or 100 grams of iron (given ,atomic mass of Na = 23 u, Fe = 56 u)?

Ans. We can find out the element with more number of atoms by calculating number of moles of each of them:

Number of moles of sodium in 100 g = 100/23 = 4.34
Number of moles of iron in 100g= 100/56 = 1.78
Therefore, the number of atoms is more for sodium as compared to iron.

EXERCISE :-

1. A 0.24 g sample of a compound of oxygen and boron was found by analysis to contain 0.096 g of boron and 0.144 g of oxygen. Calculate the percentage composition of the compound by weight.

Ans. Mass of the given sample compound = 0.24g

Mass of boron in the given sample compound = 0.096g

Mass of oxygen in the given sample compound = 0.144g

% composition of compound = % of boron and % of oxygen

Therefore % of boron = mass of boron ×100/mass of the sample compound
$= 0.096\times\frac{100}{0.24}$
= 40%

Therefore % of oxygen = mass of oxygen × 100/mass of the sample compound
$= 0.144\times\frac{100}{0.24}$
= 60%

2. When 3.0 g of carbon is burnt in 8.00 g oxygen, 11.00 g of carbon dioxide is produced. What mass of carbon dioxide will be formed when 3.00 g of carbon is burnt in 50.00 g of oxygen? Which law of chemical combination will govern your answer?

Ans. According to the law of chemical combination of constant proportions “In a chemical compound the elementary constituents always combine in constant proportions by weight/mass”. Therefore, whether 3 g carbon is burnt in 8 g oxygen or 3g carbon is burnt in 50g oxygen ,in both the cases only 11g carbon dioxide will be formed. The remaining 42g oxygen (50g-8g) will remain unreacted.

3. What are polyatomic ions? Give examples.

Ans. A group of atoms containing positive or negative charge on them are called polyatomic ions. For ^{eg} : NH_4^+, NO_3^- etc.

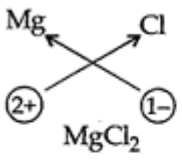
4. Write the chemical formulae of the following.

(a) Magnesium chloride **(b) Calcium oxide** **(c) Copper nitrate**

(d) Aluminium chloride **(e) Calcium carbonate.**

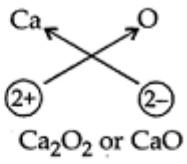
Ans.

(a) Magnesium chloride



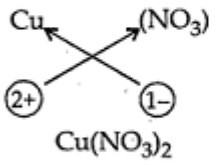
$MgCl_2$

(b) Calcium oxide



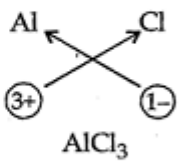
Ca_2O_2 or CaO

(c) Copper nitrate



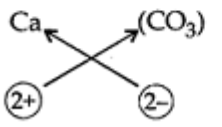
$Cu(NO_3)_2$

(d) Aluminium chloride



$AlCl_3$

(e) Calcium carbonate



$Ca_2(CO_3)_2$ or $CaCO_3$

5.Give the names of the elements present in the following compounds.

(a) Quick lime **(b) Hydrogen bromide**

(c) Baking powder **(d) Potassium sulphate.**

Ans.

Compound	**Formula**	**Elements present**
Quick lime	CaO	Calcium and oxygen
Hydrogen bromide	HBr	Hydrogen and bromine
Baking powder	$NaHCO_3$	Sodium, hydrogen, carbon and oxygen
Potassium sulphate	K_2SO_4	Potassium, Sulphur and oxygen

6. Calculate the molar mass of the following substances.

(a) Ethyne, C_2H_2

(b) Sulphur molecule, S_8

(c) Phosphorus molecule, P_4(Atomic mass of phosphorus= 31)

(d) Hydrochloric acid, HCl

(e) Nitric acid, HNO_3

Ans. (a) Ethyne,C_2H_2=12 x 2+ 2 x 1= 24 + 2= 26 u =26 g

(b) Sulphur molecule ,S_8= 8 x 32= 256 u= 256 g

(c) Phosphorus molecule,P_4 = 124 u= 124 g

(d) Hydrochloric acid,HCl = 1+ 35.5 = 36.5 u= 36.5 g

(e) Nitric acid,HNO_3= 1 + 14 + 16 x 3= 15 + 48 = 63 u =63 g

7. What is the mass of—

(a) 1 mole of nitrogen atoms?

(b) 4 moles of aluminium atoms (Atomic mass of aluminium= 27)?

(c) 10 moles of sodium sulphite Na_2SO_3?

Ans. (a) Atomic mass of nitrogen is 14 u.
therefore 1 mol of N = 14g

(b) Atomic mass of aluminium = 27u
therefore 1 mol of Al = 27g and so 4 mol of Al = 27 x 4 =108g

(c) molecular mass of Na_2SO_3 = 23 x 2+32+ 16 x3= 46 + 32 + 48 = 126 u
therefore 1 mol of Na_2SO_3 has weight/mass 126g.
hence, 10 mol of Na_2SO3 = 126 x 10 =1260g

8. Convert into mole.

(a) 12 g of oxygen gas

(b) 20 g of water

(c) 22 g of carbon dioxide.

Ans. (a) molecular mass of O_2= 32 u= 32g(1 mole)
since 32 g of O_2=1mole then 12g of O_2 =12/32 =0.375 mol

(b) molecular mass of H_2O = 2 x1+16 = 18 u= 18g(1mole)
20g H_2O= 20/18 = 1.11mol

(c) molecular mass of CO_2= 12 + 2 x 16 =12+32 = 44 u= 44g (1mole)
22g of CO_2 = 22/44=0.5mol

9.What is the mass of:

(a) 0.2 mole of oxygen atoms?

(b) 0.5 mole of water molecules?

Ans. (a) Since 1 mole of O = atomic mass of O = 16u=16g mol^{-1}
then 0.2mole of O_2 = 0.2 mol x 16g mol^{-1} = 3.2g

(b) Molar mass of H_2O = 2 x 1 + 16 g mol^{-1} = 18 g mol^{-1}
∴ Mass of 0.5 mole of water molecules = 0.5 mol x 18 g mol^{-1} =9.0g

10.Calculate the number of molecules of sulphur (S_8) present in 16 g of solid sulphur.

Ans. 1mol of S_8= molecular mass of S_8= 8x 32= 256u= 256g

since 256g of S_8= 6.022 x 10^{23} molecules (Avogadro number)

16g of S_8 molecules = $\frac{16\times6.022\times10^{23}}{256}$ = 3.76 x 10^{22} molecules

11.Calculate the number of aluminium ions present in 0.051 g of aluminium oxide.

(*Hint:* The mass of an ion is the same as that of an atom of the same element. Atomic mass of Al = 27 u)

Ans. 1mol of Al_2O_3= molecular mass of Al_2O_3 = 2 x 27 + 3 x 16 = 54+48= 02u=102g

aluminium ions present in Al_2O_3 = 2 Al^{3+}

102 g of Al_2O_3 contains aluminium ions 2 x 6.022 x 10^{23}

then 0.051 g Al_2O_3 contains aluminium ions $\frac{2\times6.022\times10^{23}\times0.051}{102}$ = 6.022 x 10^{20} aluminium ions