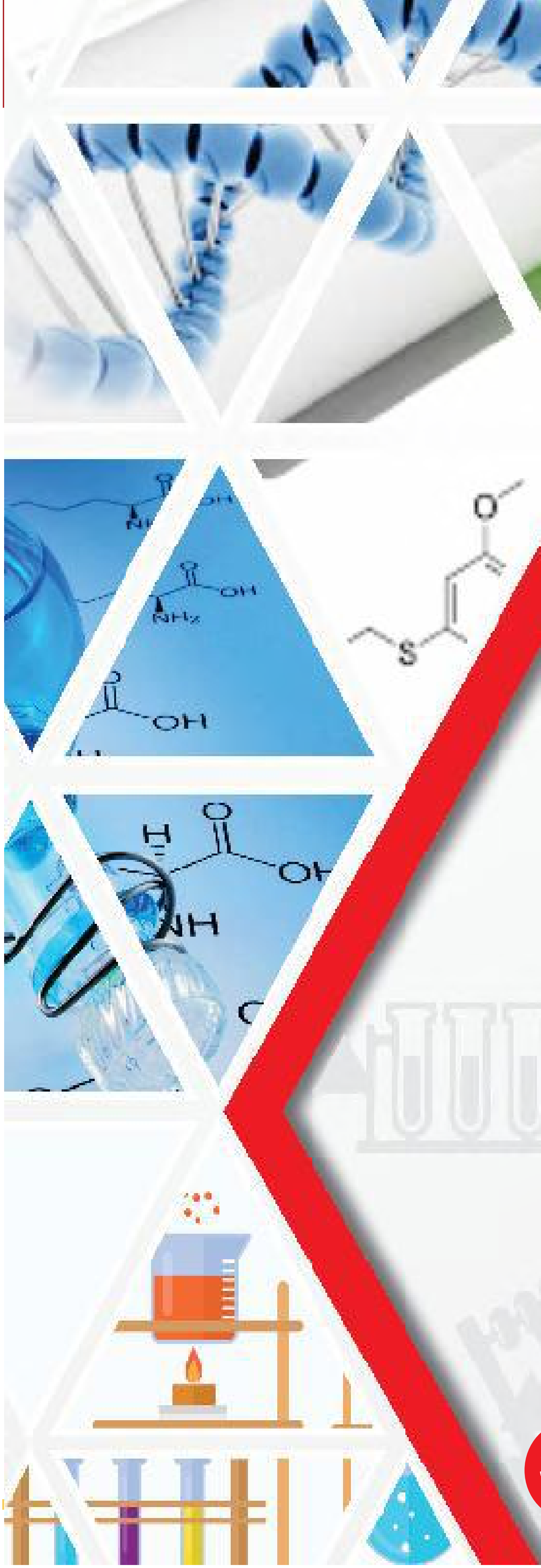


Ranjan Singh
Chemistry Classes
JEE (Main & Advanced)• NEET• XI • XII

Study Package

Ranjan Singh
M.Sc. Bio-Chemistry(P.U)
Ex-Faculty : Narayana & Goal

PHYSICAL CHEMISTRY

Some Basic Concept of Chemistry

Director's Message

Ranjan Singh
M.Sc.(Biochemistry), P.U.

Chemistry plays a central and important role in all competitive examinations as well as in day to day life. For last so many years, I have constantly been in touch with students, guiding them in Chemistry and looking into their difficulties for them to succeed in their board as well as competitive examinations JEE(Mains & Advance) | NEET.

I have felt a need for a good coaching centre to fulfil the requirements of students. Students need a highly experienced and qualified faculty in chemistry, who can guide them well, clear their doubts, provide them the effective & tricky notes, and make them do much needed practice. More importantly they should also be provided Classroom Monitoring, Periodical & Surprise Tests to guide them in the proper direction. I realize that, it is very important to diagnose the basic weaknesses and problems of students not succeeding in JEE(Mains & Advance) | NEET and Board exams. In fact, as question patterns are changing, now they need to have a different approach for these Examinations.

At RANJAN SINGH CHEMISTRY CLASSES, we have our own way to prepare students for Competitive Examinations as well as Board Examination at a time so they can crack the entrance exam like JEE(Mains & Advance) and NEET as well as 12th Board simultaneously. We act as a medium to provide the simplest, easiest and a comfortable way to make students achieve their target. At RANJAN SINGH CHEMISTRY CLASSES(RSCC), we guide our students with the best motivational classes so weak students are also able to believe that, They can do it.

When you join RANJAN SINGH CHEMISTRY CLASSES you become a part of the powerful force which propels you towards your goal and if you get a position among the rankers with my excellent guidance, I will think that our efforts have borne fruits.

M.Sc(Biochemistry), P.U.
Ex-faculty : Narayana IIT Academy
& Goal Institute

Ranjan Singh

Introduction :

Chemistry is that branch of science which the composition of matter, its properties and structure. It also deals with the relation between changes in composition and changes in energy. The scope of the subject is as vast as the universe.

The word "Chemistry" has evolved from the old name "*chemia*" of Egypt. The word "chemia" means "*black colour*". The colour of the soil of Egypt is black, hence, its old name was chemia. In the olden times the Egyptian Art was at its zenith. Most probably the word, "Chemistry" was used for the Egyptian Art. But now chemistry is a science, not an Art. Chemistry is an experimental science which concerns itself with the study of matter. Due to its abnormal development, chemistry has been divided into a number of branches. Important branches of chemistry are:

- **Inorganic Chemistry :** Under this title we study all the elements and their compounds. Compounds of carbon are not dealt with in this branch of chemistry.
- **Organic Chemistry :** The study of carbon compounds is done in this branch of chemistry. Carbon oxides, carbonates, etc., are studied in inorganic chemistry because they have mineral origin.
- **Physical Chemistry :** The laws and principles of chemical reactions are studied in this branch of chemistry.
- **Analytical Chemistry :** This branch emphasizes the techniques that are used to find out the composition of matter.

CLASSIFICATION OF UNIVERSE :

- Matter
- Energy

Matter

The thing which occupy space and having mass which is feel by our five senses is called as matter.

CLASSIFICATION OF MATTER (2 basis)

- Physical classification
- Chemical classification

Physical Classification :

It is based on physical state under ordinary conditions of temperature and pressure, matter is classified into the following three types :

(a) Solid (b) Liquid (c) Gas

Solid :

A substance is said to be solid if it possesses a definite volume and a definite shape

e.g. sugar, iron, gold, wood etc.

Liquid :

A substance is said to be liquid if it possesses a definite volume but not definite shape. They take up the shape of the vessel in which they are put.

e.g. water, milk, oil, mercury, alcohol etc.

Gas :

A substance is said to be gas if it neither possesses a definite volume nor a definite shape. This is because they fill up the whole vessel in which they are put.

e.g. hydrogen(H_2), oxygen(O_2), carbon dioxide(CO_2), etc.'

Chemical Classification of matter : (2 Types)

- **Pure Substance**
- **Mixture**

- **Pure Substance :**

A material containing only one type of substance. Pure Substance can not be seperated into simpler substance by physical method.

e.g. : Element = Na, Mg, Ca .... etc.

Compound = HCl, H_2O, CO_2, HNO_3 .... etc.

Kind of Pure Substance (2 types)

(i) Element **(ii) Compound**

(i) **Element :** The pure substance containing only one kind of atoms **.**

3 types (depend on physical and chemical property)

(a) Metal (b) Non-metal (c) Metalloids

(ii) **Compound :**

It is defined as pure substance containing more than one kind of atoms which are combined together in a fixed ratio by weight and which can be decomposed into simpler substance by the suitable chemical method. The properties of a compound are differnt from those of its components.

e.g. : H_2O , HCl, HNO_3 .... etc.

2 : 16

1 : 8 **by wt.**

Classification of Compound (2 types)

- Organic Compound
- Inorganic Compound

Mixture :

A material which contain more than one type of substances and which is mixed any ratio by wt.is called as mixture.

The property of the mixture is the property of its components

The mixture is seperated by simple physical method.

Classification of Mixture (2 types)

(i) Homogeneous mixture (ii) Hetrogeneous mixture

(i) **Homogeneous mixture :**

The mixture, in which all the components are present in **uniform** is called as homogeneous mixture.

e.g. : Water + Salt, Water + Sugar, Water + alcohol,

(ii) **Hetrogeneous mixture :**

The mixture in which all the components are present in **nonuniform** is called as Hetrogeneous mixture.

e.g. : Water + Sand, Water + Oil,

About Atom

- The word atom was first introduced by Ostwald (1803 - 1807) in scientific world.
- According to him matter is ultimately made up of extremely small indivisible particles called atoms.
- It takes part in chemical reactions.
- Atom is neither created nor destroyed

It was ***John Dalton*** who firstly developed a theory on the structure of matter, later on which is known as ***Dalton's atomic theory.***

Dalton's Atomic Theory

Dalton proposed the atomic theory on the basis of the law of conservation of mass and law of definite proportions. He also proposed the law of multiple proportion as a logical consequence of this theory. The salient features of this theory are

- Each element is composed by extremely small particles called atoms.
- Atoms of a particular element are all alike but differ with the atoms of other elements.
- Atom of each element is an ultimate particle, and has a characteristic mass but is structureless.
- Atom is indestructible i.e. it can neither be destroyed nor created by simple chemical reactions.
- Atom of an element takes part in chemical reaction to form molecule.
- In a given compound, the relative number and kind of atom are same.
- Atoms of different elements combine in fixed ratio of small whole numbers to form compound atoms (now called molecules).

Merits and Demerits of Dalton's theory :

Merits :

- Dalton's theory explains the law of conservation of mass and some other laws of chemical combination.
- Atoms of elements take part in chemical reaction is true till today.

Demerits :

- There is no mention of atomic weights of elements.
- He could not explain that why do atoms of same element combined with each other.
- The law of definite proportion fails if different isotopes are used.

<u>Mole Concept :</u>

Mole is a chemical counting SI unit and defined as follows :

A mole is the amount of a substance that contains as many entities (atoms, molecules or other particles) as there are atoms in exactly 0.012 kg (or 12 gm) of the carbon-12 isotope.

From mass spectrometer we found that there are 6.023×10^{23} atoms are present in 12 gm of C-12 isotope.

The number of entities in 1 mol is so important that it is given a separate name and symbol known as Avogadro constant denoted by N_A.

i.e. on the whole we can say that 1 mole is the collection of 6.02×10^{23} entities. Here entities may represent atoms, ions, molecules or even pens, chair, paper etc also include in this but as this number (N_A) is very large therefore it is used only for very small things.

1 mole x mass of 1 atom of C^{12} isotope = 12g

1 mole x 12 x mass of one nucleon = 12 g

} Alternatively value of N_A can be found in this fashion

$\Rightarrow$ 1 mole = $\dfrac{1}{1.66 \times 10^{-24}}$ = 6.023×10^{23}

Note : In modern practice gram-atom and gram-molecule termed as mole.

Relative atomic mass :

It is the ratio of the mass of 1 atom of a substance and 1/12 of mass of 1 atom of C^{12} isotope. For atoms this is done by expressing mass of one atom with respect to a fixed standard. Dalton used hydrogen as the standard (H = 1). Later on oxygen (O = 16) replaced hydrogen as the reference.

☞ C-12 ISOTOPE OF CARBON IS LATEST CHOSEN STANDARD SINCE 1961

Therefore relative atomic mass is given as

Relative atomic mass (R.A.M) = $\dfrac{\text{mass of one atom of the element}}{\frac{1}{12} \times \text{mass of one } C^{12} \text{ atom}}$

$= \dfrac{\text{total number of nucleons} \times \text{mass of 1 nucleon}}{\frac{1}{12} \times 12 \times \text{mass of 1 nucleon}}$ = Total Number of nucleons

On Hydrogen scale :

Relative atomic mass (R.A.M) = $\dfrac{\text{mass of one atom of the element}}{\text{mass of one } H_2 \text{ atom}}$

Oxygen scale :

Relative atomic mass (R.A.M) = $\dfrac{\text{mass of one atom of the element}}{\frac{1}{16} \times \text{mass of one O} - 16 \text{ atom}}$

Atomic Mass Unit (or amu)

The atomic mass unit (amu) is equal to one twelfth $\left(\dfrac{1}{12}\right)$ of the mass of one atom of carbon-12 isotope.

$\therefore$ 1 amu = $\dfrac{1}{12}$ × mass of one C-12 atom

$\simeq$ mass of one neucleon in C-12 atom.

= 1.66×10^{-24} gm or 1.66×10^{-27} kg

☞ **one amu is also called one Dalton (Da).*TODAY , AMU HAS BEEN REPLACED BY ‘u’ WHICH IS KNOWN AS UNIFIED MASS***

Atomic Mass

It is the mass of 1 atom of a substance it is expressed in AMU.

Atomic mass = R.A.M × 1 amu

Note : Relative atomic mass is nothing but the number of nucleons present in the atom.

Ques. Find the relative atomic mass of ‘O’ atom and its atomic mass.

Sol. The number of neucleons present in ‘O’ atom is 16.

$\therefore$ relative atomic mass of ‘O’ atom = 16.

Atomic mass = R.A.M × 1 amu = 16 × 1 amu = 16 amu

Gram atomic mass :

The atomic mass of an element expressed in gram is called gram atomic mass of the element.

For example for oxygen atom :

Atomic mass of 'O' atom = mass of one 'O' atom = 16 amu

gram atomic mass = mass of 6.02×10^{23} 'O' atoms

$= 16 \text{ amu} \times 6.02 \times 10^{23}$

$= 16 \times 1.66 \times 10^{-24} \text{ g} \times 6.02 \times 10^{23} = 16 \text{ g}$

($\because$ $1.66 \times 10^{-24} \times 6.02 \times 10^{23} \simeq 1$)

Molecules :

It is the smallest particle of matter which has free existence. Molecules can be further divided into its constituents atoms by physical & chemical process.

Number of atoms presents in molecule is called its atomicity.

Element : H_2, O_2, O_3 etc.

Compound : H_2SO_4, SO_3 etc.

Molecule		Atomicity
H_2SO_4	-	7
O_3	-	3
H_2	-	2

Molecular Mass :

It is the mass of one molecule

Ex.	Molecule	Molecular mass
	H_2	2 amu
	H_2SO_4	(2 + 32 + 64) = 98 amu.

Gram molecular mass :

The molecular mass of a substance expressed in gram is called the gram-molecular mass of the substance.

or

It is also defined as mass of 6.02×10^{23} molecuels

or

It is also defined as the mass of one mole molecuels. (molar mass)

For example for 'O_2' molecule :

Molecular mass of 'O_2' molecule = mass of one 'O_2' molecule

= 2 × mass of one 'O' atom

= 2 × 16 amu

= 32 amu

gram molecular mass = mass of 6.02×10^{23} 'O_2' molecules = $32 \text{ amu} \times 6.02 \times 10^{23}$

$= 32 \times 1.66 \times 10^{-24} \text{ gm} \times 6.02 \times 10^{23} = 32 \text{ gm}$

Use the Y-map in the following example.

The law of chemical combination

Atoine Lavoisier, ***John Dalton*** and other scientists formulate certain law concerning the composition of matter and chemical reactions. Thses laws are known as the law of chemical combination.

1. The law of conservation of mass :

In a chemical change total mass remains conserved.

i.e. mass before reaction is always equal to mass after reaction.

Example :

$$H_2(g) + \frac{1}{2} O_2(g) \longrightarrow H_2O(l)$$

	$H_2(g)$	$\frac{1}{2} O_2(g)$	$H_2O(l)$
Before reaction initialy	1 mole	$\frac{1}{2}$ mole	
After the reaction	0	0	1 mole

mass before reaction = mass of 1 mole $H_2(g)$ + $\frac{1}{2}$ mole $O_2(g)$

= 2 + 16 = 18 gm

mass after reaction = mass of 1 mole water = 18 gm

2. Law of constant or Definite proportion :

All chemical compounds are found to have constant composition irrespective of their method of preparation or sources.

Ques. In water (H_2O), Hydrogen and Oxygen combine in 2 : 1 molar ratio, this ratio remains constant whether it is tap water, river water or sea water or produced by any chemical reaction.

Ques. 1.80 g of a certain metal burnt in oxygen gave 3.0 g of its oxide. 1.50 g of the same metal heated in steam gave 2.50 g of its oxide. Show that these results illustrate the law of constant proportion.

Sol. In the first sample of the oxide,

Wt. of metal = 1.80 g,

Wt. of oxygen = (3.0 – 1.80) g = 1.2 g

$$\therefore \quad \frac{\text{wt. of metal}}{\text{wt. of oxygen}} = \frac{1.80\text{g}}{1.2\text{g}} = 1.5$$

In the second sample of the oxide,

Wt. of metal = 1.50 g,

Wt. of oxygen = (2.50 – 1.50) g = 1 g.

$$\therefore \quad \frac{\text{wt. of metal}}{\text{wt. of oxygen}} = \frac{1.50\,\text{g}}{1\text{g}} = 1.5$$

Thus, in both samples of the oxide the proportions of the weights of the metal and oxygen a fixed. Hence, the results follow the law of constant proportion.

3. The law of multiple proportion :

When one element combines with the other element to form two or more different compounds, the mass of one elements, which combines with a constant mass of the other, bear a simple ratio to one another.

Note : Simple ratio here means the ratio between small natural numbers, such as 1 : 1, 1 : 2, 1 : 3, later on this simple ratio becomes the valency and then oxidation state of the element.

Note : See oxidation number of carbon also have same ratio 1 : 2 in both the oxide.

Ques. Carbon is found to form two oxides, which contain 42.9% and 27.3% of carbon respectively. Show that these figures illustrate the law of multiple proportions.

Sol. **Step-1**

To calculate the percentage composition of carbon and oxygen in each of the two oxides.

	First oxide	Second oxide	
Carbon	42.9 %	27.3 %	(Given)
Oxygen (by difference)	57.1%	72.7 %	

Step-2

To calculate the masses of carbon which combine with a fixed mass i.e., one part by mass of oxygen in each of the two oxides.

In the first oxide, 57.1 parts by mass of oxygen combine with carbon = 42.9 parts.

$\therefore$ 1 part by mass of oxygen will combine with carbon = $\frac{42.9}{57.1}$ = 0.751.

In the the second oxide. 72.7 parts by mass of oxygen combine with carbon = 27.3 parts.

$\therefore$ 1 part by mass of oxygen will combine with carbon = $\frac{27.3}{72.7}$ = 0.376

Step-3.

To compare the masses of carbon which combine with the same mass of oxygen in both the oxides.

The ratio of the masses of carbon that com–bine with the same mass of oxygen (1 part) is .

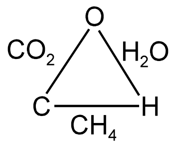
0.751 : 0.376 or 2 : 1

Since this is simple whole number ratio, so the above data illustrate the law of multiple proportions.

4. Law of reciprocal proportions [Ritche, 1792-94]

When two elements combines separately with third element and form different types of molecules, their combining ratio is directly reciprocated if they combine directly

Example :



C with H form methane and with O form CO_2. In CH_4 , 12 grams of C reacts with 4 grams of H whereas in CO_2 12 gram of C reacts with 32 grams of O. Therefore when H combines with O they should combine in the ratio of 4 : 32 (i.e. = 1 : 8) or in simple multiple of it. The same is found to be true in H_2O molecule. The ratio of weights of H and O in Water is 1 : 8

5. Avogadro's hypothesis :

Equal volume of all gases have equal number of molecules (not atoms) at same temperature and pressure condition.

mathematically, for ideal gases, $V \propto n$ (CONSTANT T & P)

S.T.P. (Standard Temperature and Pressure):

At S.T.P. / N.T.P. condition :

temperature = 0°C or 273 K

pressure = 1 atm = 760 mm of Hg

volume of one mole of an ideal gas = 22.4 litres (experimentally determined)

6. Gay-Lussac's Law of Combining Volume :

Gases combine in a simple ratio of their volumes provided all measurements should be done at the same temperature and pressure

$$\underset{1\text{ vol}}{H_2(g)} + \underset{1\text{ vol}}{Cl_2(g)} \longrightarrow \underset{2\text{ vol}}{2HCl}$$

Percentage Composition and Molecular Formula :

Here we are going to find out the percentage of each element in the compound by knowing the molecular formula of compound.

We know that according to law of definite proportions any sample of a pure compound always possess constant ratio with their combining elements.

Ques. Every molecule of ammonia always has formula NH_3 irrespective of method of preparation or sources. i.e. 1 mole of ammonia always contains 1 mol of N and 3 mole of H. In other wards 17 gm of NH_3 always contains 14 gm of N and 3 gm of H. Now find out % of each element in the compound.

Mass % of N in NH_3 $= \dfrac{\text{Mass of N in 1 mol } NH_3}{\text{Mass of 1 mol of } NH_3} \times 100 = \dfrac{14\text{ gm}}{17} \times 100 = 82.35\ \%$

Mass % of H in NH_3 $= \dfrac{\text{Mass of H is 1 mol } NH_3}{\text{Mass of 1 mole of } NH_3} \times 100 = \dfrac{3}{17} \times 100 = 17.65\ \%$

Empirical and Molecular Formula :

We have just seen that knowing the molecular formula of the compound we can calculate percentage composition of the elements. Conversely if we know the percentage composition of the elements initially, we can calculate the relative number of atoms of each element in the molecules of the compound. This gives as the empirical formula of the compound. Further if the molecular mass is known then the molecular formula can easily de determined.

Thus, the empirical formula of a compound is a chemical formula showing the relative number of atoms in the simplest ratio, the molecular formula gives the actual number of atoms of each element in a molecule. The molecular formula is generally an intergal multiple of the empirical formula.

i.e. molecular formula = empirical formula × n

where $n = \dfrac{\text{molecular formula mass}}{\text{empirical formual mass}}$

Ques. Acetylene and benzene both have the empirical formula CH. The molecular masses of acetylene and benzene are 26 and 78 respectively. Deduce their molecular formulae.

Sol. ∵ Empirical Formula is CH

Step-1

The empirical formula of the compound is CH

∴ Empirical formula mass

= (1 × 12) + 1 = 13.

Molecular mass = 26

Step-2

To calculate the value of 'n'

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{26}{13} = 2$$

Step-3

To calculate the molecular formula of the compound.

Molecular formula = n × (Empirical formula of the compound)

$= 2 \times CH = C_2H_2$

Thus the molecular formula is $\mathbf{C_2H_2}$

Similarly for benzene

To calculate the value of 'n'

$$n = \frac{\text{Molecular mass}}{\text{Empirical formula mass}} = \frac{78}{13} = 6$$ thus the molecular formula is 6 × CH = $\mathbf{C_6H_6}$

Density :

It is of two type.

1. Absolute density
2. Relative density

For liquid and solids

$$\text{Absolute density} = \frac{\text{mass}}{\text{volume}}$$

$$\text{Relative density or specific gravity} = \frac{\text{density of the substance}}{\text{density of water at } 4°C}$$

For gases :

Absolute density (mass/volume) = Molar mass
Molar volume

where P is pressure of gas, M = mol. wt. of gas, R is the gas constant, T is the temperature.

Vapour density :

Vapour density is defined as the density of the gas with respect to hydrogen gas at the same temperature and pressure.

$$\text{Vapour density} = \frac{d_{gas}}{d_{H_2}} = \frac{PM_{gas/RT}}{PM_{H_2/RT}}$$

$$\text{V.D.} = \frac{M_{gas}}{M_{H_2}} = \frac{M_{gas}}{2}$$

$$\mathbf{M_{gas} = 2\ V.D.}$$

Chemical Equation :

All chemical reaction are represented by chemical equations by using chemical formule of reactants and products. Qualitatively a chemical equation simply describes what the reactants and products are. However, a balanced chemical equation gives us a lot of quantative information mainly the molar ratio in which reactants combine and the molar ratio in which products are formed.

Example :

When potassium chlorate ($KClO_3$) is heated it gives potassium chloride (KCl) and oxygen (O_2).

$$KClO_3 \xrightarrow{\Delta} KCl + O_2 \quad \text{(unbalanced chemical equation)}$$

$$2KClO_3 \xrightarrow{\Delta} 2\ KCl + 3\ O_2 \quad \text{(balanced chemical equation)}$$

☞ Remember a balnced chemical equation is one which contains an equal number atoms of each element on both sides of equation.

Interpretation of Balanced Chemical Equations :

Once we get a balanced chemical equation then we can interpret a chemical equation by following ways

1. Mass - mass analysis
2. Mass - volume analysis
3. Mole - mole analysis
4. Vol - Vol analysis (separately discussed as **ediometry or gas analysis**)

Now you can understand the above analysis by following example

1. Mass-mass analysis :

Consider the reaction

$$2KClO_3 \longrightarrow 2KCl + 3O_2 \quad \text{According to stoichiometry of the reaction}$$

mass-mass ratio: $2 \times 125.5 \ : \ 2 \times 74.5 \ : \ 3 \times 32$

or $$\frac{\text{Mass of } KClO_3}{\text{Mass of KCl}} = \frac{2 \times 122.5}{2 \times 74.5}$$

$$\frac{\text{Mass of } KClO_3}{\text{Mass of } O_2} = \frac{2 \times 122.5}{2 \times 32}$$

Ques. 367.5 gram $KClO_3$ (M = 125.5) when heated. How many gram KCl and oxygen is produced.

Sol. Balance chemical equation for heating of $KClO_3$ is

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

mass-mass ratio : $2 \times 122.5 \text{ gm} \ : \ 2 \times 74.5 \text{ gm} \ : \ 3 \times 32 \text{ gm}$

$$\frac{\text{mass of } KClO_3}{\text{mass of KCl}} = \frac{2 \times 122.5}{2 \times 74.5}$$

$$\frac{367.5}{W} = \frac{122.5}{74.5}$$

W = 3 × 74.5 = 223.5 gm

$$\frac{\text{Mass of KClO}_3}{\text{Mass of O}_2} = \frac{2\times 122.5}{3\times 32}$$

$$\frac{367.5}{W} = \frac{2\times 122.5}{3\times 32}$$

W = 144 gm

2. Mass - volume analysis :

Now again consider decomposition of $KClO_3$

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

mass volume ratio : 2 × 122.5 gm : 2 × 74.5 gm : 3 × 22.4 lt. at STP

we can use two relation for volume of oxygen

$$\frac{\text{Mass of KClO}_3}{\text{volume of O}_2\text{ at STP}} = \frac{2\times 122.5}{3\times 22.4\text{ lt}} \quad \text{...(i)}$$

and $$\frac{\text{Mass of KCl}}{\text{volume of O}_2\text{ at STP}} = \frac{2\times 74.5}{3\times 22.4\text{ lt}} \quad \text{...(ii)}$$

Ques. 367.5 gm $KClO_3$ (M = 125.5) when heated, how many litre of oxygen gas is produced at STP

Sol. You can use here equation (1)

$$\frac{\text{mass of KClO}_3}{\text{volume of O}_2\text{ at STP}} = \frac{2\times 122.5}{3\times 22.4\text{ lt}} \Rightarrow \frac{367.5}{V} = \frac{2\times 122.5}{3\times 22.4\text{ lt}}$$

V = 3 × 3 × 11.2

V = 100.8 lt

3. Mole-mole analysis :

This analysis is very much important for quantative analysis point of view. Students are advised to clearly understand this analysis.

Now consider again the decomposition of $KClO_3$.

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

In very first step of mole-mole analysis you should read the balanced chemical equation like ***2 moles $KClO_3$ on decomposition gives you 2 moles KCl and 3 moles O_2.*** and from the stoichiometry of reaction we can write

$$\frac{\text{Moles of KClO}_3}{2} = \frac{\text{Moles of KCl}}{2} = \frac{\text{Moles of O}_2}{3}$$

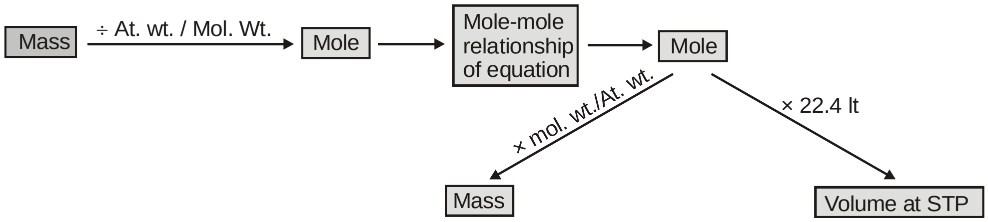
Now for any general balance chemical equation like

$$aA + bB \longrightarrow cC + dD$$

you can write.

$$\frac{\text{Mole of A reacted}}{a} = \frac{\text{moles of B reacted}}{b} = \frac{\text{moles of C reacted}}{c} = \frac{\text{moles of D reacted}}{d}$$

Note : In fact mass-mass and mass-vol analysis are also interprected in terms of mole-mole analysis you can use following chart also.



Principle of Atom Conservation (POAC) :

Infact POAC is nothing but the conservation of mass, expressed before in the concepts of atomic theory. And if atoms are conserved, moles of atoms shall also be conserved.

This principle is fruitful for the students when they don't get the idea of balanced chemical equation in the problem. This principle can be under stand by the following example.

Consider the decomposition of $KClO_3$ (s) → KCl (s) + O_2 (g) (unbalanced chemical reaction)

Apply the principle of atom conservation (POAC) for K atoms.

Moles of K atoms in reactant = moles of K atoms in products

or moles of K atoms in $KClO_3$ = moles of K atoms in KCl.

Now, since 1 molecule of $KClO_3$ contains 1 atom of K

or 1 mole of $KClO_3$ contains 1 mole of K, similarly,1 mole of KCl contains 1 mole of K.

Thus, moles of K atoms in $KClO_3$ = 1 × moles of $KClO_3$

and moles of K atoms in KCl = 1 × moles of KCl.

∴ moles of $KClO_3$ = moles of KCl

or $$\frac{\textbf{wt. of KClO}_3\textbf{ in g}}{\textbf{mol. wt. of KClO}_3} = \frac{\textbf{wt. of KCl in g}}{\textbf{mol. wt. of KCl}}$$

⇨ The above equation gives the mass-mass relationship between $KClO_3$ and KCl which is important in stoichiometric calculations.

Again, applying the principle of atom conservation for O atoms,

moles of O in $KClO_3$ = 3 × moles of $KClO_3$

moles of O in O_2 = 2 × moles of O_2

∴ 3 × moles of $KClO_3$ = 2 × moles of O_2

or $$3 \times \frac{\text{wt. of KClO}_3}{\text{mol. wt. of KClO}_3} = 2 \times \frac{\text{vol. of O}_2\text{ at NTP}}{\text{standard molar vol. (22.4 lt.)}}$$

⇨ The above equations thus gives the mass-volume relationship of reactants and products.

Limiting reagent :

The reactant which consumed first into the reaction

When you are dealing with balance chemical equation then if number of moles of reactants are not in the ratio of stoichiometric coefficient of balalnced chemical equation, then there should be one reactant which should be limiting reactant.

Ques. Three mole of Na_2CO_3 is reacted with 6 moles of HCl solution. Find the volume of CO_2 gas produced at STP. The reaction is

$$Na_2CO_3 + 2HCl \longrightarrow 2\,NaCl + CO_2 + H_2O$$

Sol. From the reaction : $Na_2CO_3 + 2HCl \longrightarrow 2\,NaCl + CO_2 + H_2O$

given moles	3 mol		6 mol
given mole ratio	1	:	2
Stoichiometric coefficient ratio	1	:	2

⇨ See here given moles of reactant are in stoichiometric coefficient ratio therefore none reactant left over. Now use Mole-mole analysis to calculate volume of CO_2 prdouced at STP

$$\frac{\text{Moles of } Na_2CO_3}{1} = \frac{\text{Mole of } CO_2 \text{ Produced}}{1}$$

Moles of CO_2 produced = 3
volume of CO_2 produced at STP = 3 × 22.4 L = 67.2 L

Ques. 6 moles of Na_2CO_3 is reacted with 4 moles of HCl solution. Find the volume of CO_2 gas produced at STP. The reaction is

$$Na_2CO_3 + 2HCl \longrightarrow 2\,NaCl + CO_2 + H_2O$$

Sol. From the reaction : $Na_2CO_3 + 2HCl \longrightarrow 2\,NaCl + CO_2 + H_2O$

given mole of reactant	6	:	4
give molar ratio	3	:	2
Stoichiometric coefficient ratio	1	:	2

⇨ See here given number of moles of reactants are not in stoichiometric coefficient ratio. Therefore there should be one reactant which consumed first and becomes limiting reagent.
But the question is how to find which reactant is limiting, it is not very difficult you can easily find it. According to the following method.

How to find limiting reagent :

Step : I

Divide the given moles of reactant by the respective stoichiometric coefficient of that reactant.

Step : II

See for which reactant this division come out to be minimum. The reactant having minimum value is limiting reagent for you.

Step : III

Now once you find limiting reagent then your focus should be on limiting reagent

From Step I & II $\quad Na_2CO_3 \quad\quad HCl$

$$\frac{6}{1} = 6 \qquad \frac{4}{2} = 2 \text{ (division is minimum)}$$

∴ **HCl is limiting reagent**

From Step III

From $\dfrac{\text{Mole of HCl}}{2} = \dfrac{\text{Moles of } CO_2 \text{ produced}}{1}$

∴ mole of CO_2 produced = 2 moles
∴ volume of CO_2 produced at S.T.P. = 2 × 22.4 = 44.8 lt.

Solutions

A mixture of two or more substances can be a solution. We can also say that a solution is a homogeneous mixture of two or more substances 'Homogeneous' means 'uniform throughout'. Thus a homogeneous mixture, i.e., a solution, will have uniform composition throughout.

Properties of a solution :

1. A solution is clear and transparent. For example, a solution of sodium chloride in water is clear and tranparent.
2. The solute in a solution does not settle down even after the solution is kept undisturbed for some time.
3. In a solution, the solute particle cannot be distinguished from the solvent particles or molecules even under a microscope. In a true solution, the particles of the solute disappear into the space between the solvent molecules.
4. The components of a solution cannot be separated by filtration.

Concentration terms :

The following concentration terms are used to expressed the concentration of a solution. These are :

1. Molarity (M) **2.** Molality (m) **3.** Mole fraction (x)
4. % calculation **5.** Normality (N) **6.** ppm

⇨ Remember that all of these concentration terms are related to one another. By knowing one concentration term you can also find the other concentration terms. Let us discuss all of them one by one.

Molarity (M) :

The number of moles of a solute dissolved in 1 L (1000 ml) of the solution is known as the molarity of the solution.

i.e., Molarity of solution = $\dfrac{\text{number of moles}}{\text{volume of solution in litre}}$

Let a solution is prepared by dissolving w gm of solute of mol.wt. M in V ml water.

∴ Number of moles of solute dissolved = $\dfrac{w}{M}$

∴ V ml water have $\dfrac{w}{M}$ mole of solute

∴ 1000 ml water have $\dfrac{w \times 1000}{M \times V_{inml}}$

∴ Molarity (M) = $\dfrac{w \times 1000}{(\text{Mol. wt of solute}) \times V_{inml}}$

Some other relations may also useful.

Number of millimoles = $\dfrac{\text{mass of solute}}{(\text{Mol. wt. of solute})} \times 1000$ = (Molarity of solution × V_{inml})

⇨ Molarity of solution may also given as :

$$\dfrac{\text{Number of millimole of solute}}{\text{Total volume of solution in ml}}$$

Ques. 149 gm of potassium chloride (KCl) is dissolved in 10 Lt of an aqueous solution. Determine the molarity of the solution (K = 39, Cl = 35.5)

Sol. Molecular mass of KCl = 39 + 35.5 = 74.5 gm

∴ Moles of KCl = $\dfrac{149 \text{ gm}}{74.5 \text{ gm}} = 2$

∴ Molarity of the solution = $\dfrac{2}{10} = 0.2$ M

Ques. 117 gm NaCl is dissolved in 500 ml aqueous solution. Find the molarity of the solution.

Ans. **0.4 M**

Molality (m)

The number of moles of solute dissolved in1000 gm (1 kg) of a solvent is known as the molality of the solution.

i.e., molality = $\dfrac{\text{number of moles of solute}}{\text{mass of solvent in gram}} \times 1000$

Let y gm of a solute is dissolved in x gm of a solvent. The molecular mass of the solute is m. Then Y/m mole of the solute are dissolved in x gm of the solvent. Hence

$$\text{Molality} = \frac{Y}{m \times x} \times 1000$$

Ques. 225 gm of an aqueous solution contains 5 gm of urea. What is the concentration of the solution in terms of molality. (Mol. wt. of urea = 60)

Sol. Mass of urea = 5 gm

Molecular mass of urea = 60

$$\text{Number of moles of urea} = \frac{5}{60} = 0.083$$

Mass of solvent = (255 – 5) = 250 gm

$$\therefore \quad \text{Molality of the solution} = \frac{\text{Number of moles of solute}}{\text{Mass of solvent in gram}} \times 1000$$

$$= \frac{0.083}{250} \times 1000 = 0.332.$$

Ques. 518 gm of an aqueous solution contains 18 gm of glucose (mol.wt. = 180). What is the molality of the solution.

Ans. **0.2 m**

Mole Fraction (x) :

The ratio of number of moles of the solute or solvent present in the solution and the total number of moles present in the solution is known as the mole fraction of substances concerned.

Let number of moles of solute in solution = n

Number of moles of solvent in solution = N

$$\therefore \quad \text{Mole fraction of solution } (x_1) = \frac{n}{n+N}$$

$$\therefore \quad \text{Mole fraction of solvent } (x_2) = \frac{N}{n+N}$$

☞ also $x_1 + x_2 = 1$

% Calculation :

The concentration of a solution may also expressed in terms of percentage in the following way.

(i) % weight by weight (w/w) : It is given as mass of solute present in per 100 gm of solution.

$$\text{i.e.} \quad \% \text{ w/w} = \frac{\text{mass of solute in gm}}{\text{mass of solution in gm}} \times 100$$

(ii) % weight by volume (w/v) : It is given as mass of solute present in per 100 ml of solution.

$$\text{i.e.,} \quad \% \text{ w/v} = \frac{\text{mass of solute in gm}}{\text{mass of solution in ml}} \times 100$$

(iii) % volume by volume (V/V) : It is given as volume of solute present in per 100 ml solution.

$$\text{i.e.,} \quad \% \text{ V/V} = \frac{\text{Volume of solution in ml}}{\text{Volume of solution}} \times 100$$

Ques. 0.5 g of a substance is dissolved in 25 g of a solvent. Calculate the percentage amount of the substance in the solution.

Sol. Mass of substance = 0.5 g

Mass of solvent = 25 g

$\therefore$ percentage of the substance (w/w) = $\frac{0.5}{0.5+25}\times100$ = 1.96

Ques. 20 cm^3 of an alcohol is dissolved in80 cm^3 of water. Calculate the percentage of alcohol in solution.

Sol. Volume of alcohol = 20 cm^3

Volume of water = 80 cm^3

$\therefore$ percentage of alcohol = $\frac{20}{20+80}\times100$ = 20.

TOPIC WISE MCQS

MOLE CONCEPT

01. Mass of 1 atom of Hydrogen is -
(A) 1.66×10^{-24} g (B) 10^{-22} g
(C) 10^{-23} g (D) 10^{-25} g

02. Which of the following contains the largest number of atoms -
(A) 11g of CO_2 (B) 4g of H_2
(C) 5g of NH_3 (D) 8g of SO_2

03. Four containers of 2L capacity contains dinitrogen as described below. Which one contains maximum number of molecules under similar conditions.
(A) 2.5 gm-molecules of N_2
(B) 4 gm-atom of nitrogen
(C) 3.01×10^{24} N atoms
(D) 84 gm of dinitrogen

04. What is correct for 10 g of $CaCO_3$ -
(A) It contains 1g-atom of carbon
(B) It contains 0.3 g-atoms of oxygen
(C) It contains 12 g of calcium
(D) None of these

05. The total number of electrons present in 18 mL water (density 1 g/mL) is -
(A) 6.023×10^{23} (B) 6.023×10^{24}
(C) 6.023×10^{25} (D) 6.023×10^{21}

06. 4.0 g of caustic soda (mol mass 40) contains same number of sodium ions as are present in-
(A) 10.6 g of Na_2CO_3 (mol. mass 106)
(B) 58.5 g of NaCl (Formula mass 58.5)
(C) 100 ml of 0.5 M Na_2SO_4 (Formula mass 142)
(D) 1mol of $NaNO_3$ (mol. mass 85)

07. No. of oxalic acid molecules in 100 ml of 0.02 N oxalic acid is -
(A) 6.023×10^{20} (B) 6.023×10^{21}
(C) 6.023×10^{22} (D) 6.023×10^{23}

08. One atom of an element 'X' weighs 6.664×10^{-23} gm. The number of gram atoms in 40 kg of it is -
(A) 10 (B) 100
(C) 10000 (D) 1000

09. The number of oxygen atoms present in 14.6 g of magnesium bicarbonate $[Mg(HCO_3)_2]$ is
(A) $6N_A$ (B) $0.6N_A$
(C) N_A (D) $0.5\ N_A$

10. One mole of P_4 molecules contains -
(A) 1 molecule
(B) 4 molecules
(C) $1/4 \times 6.022 \times 10^{23}$ atoms
(D) 24.088×10^{23} atoms

11. The total number of protons, electrons and neutrons in 12gm of ${}_6C^{12}$ is -
(A) 1.084×10^{25} (B) 6.022×10^{23}
(C) 6.022×10^{22} (D) 18

12. The number of sodium atoms in 2 moles of sodium ferrocyanide $Na_4[Fe(CN)_6]$, is-
(A) 2
(B) 6.023×10^{23}
(C) $8 \times 6.02 \times 10^{23}$
(D) $4 \times 6.02 \times 10^{23}$

13. Out of 1.0 g dioxygen, 1.0 g (atomic) oxygen and 1.0 g of ozone, the maximum number of oxygen atoms are contained in -
(A) 1.0 g of atomic oxygen.
(B) 1.0 g of ozone.
(C) 1.0 g of oxygen gas.
(D) All contain same number of atoms.

14. Number of Ca^{+2} and Cl^- ion in 111 g of anhydrous $CaCl_2$ are -
(A) N_A, $2N_A$ (B) $2N_A$, N_A
(C) N_A, N_A (D) None

15. 2 moles of H_2 at NTP occupy a volume of
(A) 11.2 litre (B) 44.8 litre
(C) 2 litre (D) 22.4 litre

16. 4.48 litres of methane at N.T.P. correspond to-
(A) 1.2×10^{22} molecules of methane
(B) 0.5 mole of methane
(C) 3.2 gm of methane
(D) 0.1 mole of methane

17. The weight of a substance that displaces 22.4 litre air at NTP is -
(A) Mol. wt. (B) At. wt.
(C) Eq. wt. (D) all

18. Mol. wt. = vapour density × 2, is valid for -
(A) metals (B) non metals
(C) solids (D) gases

19. 5.6 litre of a gas at N.T.P. weighs equal to 8 gm the vapour density of gas is -
(A) 32 (B) 16
(C) 8 (D) 40.

20. The maximum volume at N.T.P. is occupied by-
(A) 12.8 gm of SO_2
(B) 6.02 x 10^{22} molecules of CH_4
(C) 0.5 mol of NO_2
(D) 1 gm-molecule of CO_2

21. Equal masses of O_2 , H_2 and CH_4 are taken in a container. The respective mole ratio of these gases in container is -
(A) 1 : 16 : 2 (B) 16 : 1 : 2
(C) 1 : 2 : 16 (D) 16 : 2 : 1

22. Number of moles of water in 488 gm of $BaCl_2.2H_2O$ are - (Ba = 137)
(A) 2 moles (B) 4 moles
(C) 3 moles (D) 5 moles

23. 16 gm of SO_x occupies 5.6 litre at STP. Assuming ideal gas nature, the value of x is -
(A) 1 (B) 2
(C) 3 (D) None of these

24. The density of air is 0.001293 gm/ml at S.T.P. It's vapour density is -
(A) 143 (B) 14.3
(C) 1.43 (D) 0.143

PERCENTAGE COMPOSITION, EMPIRICAL & MOLECULAR FORMULA

25. The percentage of nitrogen in urea is about-
(A) 38.4 (B) 46.6
(C) 59.1 (D) 61.3

26. The mass of carbon present in 0.5 mole of $K_4[Fe(CN)_6]$ is -
(A) 1.8 gm (B) 18 gm
(C) 3.6 gm (D) 36 gm

27. 1.2 gm of Mg (At. mass 24) will produce MgO equal to -
(A) 0.05 mol (B) 40 gm
(C) 40 mg (D) 4 gm

28. Insulin contains 3.4% sulphur by mass. What will be the minimum molecular weight of insulin -
(A) 94.117 (B) 1884
(C) 941 (D) 976

29. The percent of N in 66% pure $(NH_4)_2$ SO_4 sample is -
(A) 32 (B) 28
(C) 14 (D) None of these

30. The chloride of a metal contains 71% chlorine by weight and the vapour density of it is 50. The atomic weight of the metal will be -
(A) 29 (B) 58
(C) 35.5 (D) 71

31. The haemoglobin of most mammals contains approximately 0.33% of iron by mass. The molecular mass of haemoglobin is 67200. The number of iron atoms in each molecule of haemoglobin is-
(A) 3 (B) 4
(C) 2 (D) 6

32. A compound was found to contain 5.37% nitrogen by mass. What is the minimum molecular weight of compound-
(A) 26.07 (B) 2.607
(C) 260.7 (D) None

33. An element (A) (at wt = 75) and another element (B) (at. wt. = 25) combine to form a compound. The compound contains 75% (A) by weight. The formula of the compound will be -
(A) A_2B (B) A_3B
(C) AB_3 (D) AB

34. The empirical formula of a compound is CH. Its molecular weight is 78. The molecular formula of the compound will be -
(A) C_2H_2 (B) C_3H_3
(C) C_4H_4 (D) C_6H_6

35. An oxide of a metal (M) contains 40% by mass of oxygen. Metal (M) has atomic mass of 24. The empirical formula of the oxide is-
(A) M_2O (B) MO
(C) M_2O_3 (D) M_3O_4

36. Two oxides of Metal contain 27.6% and 30% oxygen respectively. If the formula of first oxide is M_3O_4 then formula of second oxide is -
(A) MO (B) M_2O
(C) M_2O_3 (D) MO_2

37. The formula which represents the simple ratio of atoms in a compound is called -
(A) molecular formula
(B) structural formula
(C) empirical formula (D) rational formula

38. On analysis, a certain compound was found to contain 254 gm of iodine (at. mass 127) and 80 gm oxygen (at. mass 16). What is the formula of the compound -
(A) IO (B) I_2O
(C) I_5O_3 (D) I_2O_5

39. 14g of element X combine with 16g of oxygen. On the basis of this information, which of the following is a correct statement

(A) The element X could have an atomic weight of 7 and its oxide formula XO

(B) The element X could have an atomic weight of 14 and its oxide the formula X_2O

(C) The element X could have an atomic weight of 7 and its oxide is X_2O

(D) The element X could have an atomic weight of 14 and its oxide is XO_2

LIMITING REAGENT AND STOICHIOMETRY

40. A mixture containing 100 gm H_2 and 100 gm O_2 is ignited so that water is formed according to the reaction, $2H_2 + O_2 \rightarrow 2H_2O$; How much water will be formed -

(A) 113 gm (B) 50 gm
(C) 25 gm (D) 200 gm

41. 0.5 mole of H_2SO_4 is mixed with 0.2 mole of Ca $(OH)_2$. The maximum number of moles of $CaSO_4$ formed is -

(A) 0.2 (B) 0.5
(C) 0.4 (D) 1.5

42. How many mol Fe^{2+} ions are formed, when excess of iron is treated with 50mL of 4.0M HCl under inert atmosphere ? Assume no change in volume -

(A) 0.4 (B) 0.1
(C) 0.2 (D) 0.8

43. 12 litre of H_2 and 11.2 litre of Cl_2 are mixed and exploded. The composition by volume of mixture is -

(A) 24 litre of HCl
(B) 0.8 litre Cl_2 and 20.8 lit HCl.
(C) 0.8 litre H_2 & 22.4 litre HCl
(D) 22.4 litre HCl

44. For the reaction : $A + 2B \rightarrow C$
5 mole of A and 8 mole of B will produce -

(A) 5 mole of C
(B) 4 mole of C
(C) 8 mole of C
(D) 13 mole of C

LAWS OF CHEMICAL COMBINATION

45. Hydrogen and oxygen combine to form H_2O_2 and H_2O containing 5.93% and 11.2% Hydrogen respectively. The data illustrates-

(A) Law of conservation of mass
(B) Law of constant proportions
(C) Law of reciprocal proportions
(D) Law of multiple proportions

46. If water samples are taken from sea, rivers, clouds, lake or snow, they will be found to contain H_2 and O_2 in the fixed ratio of 1 : 8. This indicates the law of -

(A) Multiple proportion
(B) Definite proportion
(C) Reciprocal proportion
(D) None of these.

47. One of the following combinations illustrate law of reciprocal proportions-

(A) N_2O_3, N_2O_4, N_2O_5
(B) NaCl, NaBr, NaI
(C) CS_2, CO_2, SO_2
(D) PH_3, P_2O_3, P_2O_5

48. The law of multiple proportions is illustrated by -

(A) Carbon monoxide and carbon dioxide
(B) Potassium bromide and potassium chloride
(C) Water and heavy water
(D) Calcium hydroxide and barium hydroxide.

49. The law of conservation of mass holds good for all of the following except -

(A) All chemical reactions
(B) Nuclear reactions
(C) Endothermic reactions.
(D) Exothermic reactions.

50. If law of conservation of mass was to hold true, then 20.8 gm of $BaCl_2$ on reaction with 9.8 gm of H_2SO_4 will produce 7.3 gm of HCl and $BaSO_4$ equal to -

(A) 11.65 gm (B) 23.3 gm
(C) 25.5 gm (D) 30.6 gm

MISCELLANEOUS QUESTIONS

01. Which one of the following properties of an element is not variable ?
(A) Valency (B) Equivalent mass
(C) Atomic mass (D) All the three

02. An element A is tetravalent and another element B is divalent. The formula of the compound formed from these elements will be-
(A) A_2B (B) AB
(C) AB_2 (D) A_2B_3

03. The vapour density of gas A is four times that of B. If molecular mass of B is M, then molecular mass of A is -
(A) M (B) 4M
(C) $\frac{M}{4}$ (D) 2M

04. Percentage of copper and oxygen in sample of CuO obtained by different methods were found to be same. This proves the law of -
(A) Constant proportion
(B) Multiple proportion
(C) Reciprocal proportion
(D) None of these

05. 6 gm of carbon combines with 32 gm of sulphur to form CS_2. 12 gm of C also combine with 32 gm of oxygen to form carbondioxide. 10 gm of sulphur combines with 10 gm of oxygen to form sulphur dioxide. Which law is illustrated by them
(A) Law of multiple proportions
(B) Law of constant composition
(C) Law of Reciprocal proportions
(D) Gay Lussac's law.

06. Two elements X (at mass 16) and **Y** (at mass 14) combine to form compounds **A, B** and **C**. The ratio of different masses of **Y** which combine with a fixed mass of **X** in A, B and C is 1 : 3 : 5. If 32 parts by mass of **X** combines with 84 parts by mass of **Y** in **B**, then in **C**, 16 parts by mass of **X** will combine with-
(A) 14 parts by mass of **Y**
(B) 42 parts by mass of **Y**
(C) 70 parts by mass of **Y**
(D) 84 parts by mass of **Y**

07. If one mole of ethanol (C_2H_5OH) completely burns to form carbon dioxide and water, the weight of carbon dioxide formed is about -
(A) 22 gm (B) 45 gm
(C) 66 gm (D) 88 gm

08. If LPG cylinder contains mixture of butane and isobutane, then the amount of oxygen that would be required for combustion of 1kg of it will be-
(A) 1.8 kg (B) 2.7 kg
(C) 4.5 kg (D) 3.58 kg

09. 1 gm - atom of nitrogen represents -
(A) 6.02×10^{23} N_2 molecules
(B) 22.4 lit. of N_2 at N.T.P.
(C) 11.2 lit. of N_2 at N.T.P.
(D) 28 gm of nitrogen.

10. The moles of O_2 required for reacting with 6.8 gm of ammonia.
(..... NH_3 +..... O_2 $\rightarrow$ ..... NO + ... H_2O) is
(A) 5 (B) 2.5
(C) 1 (D) 0.5

11. If isotopic distribution of C–12 and C–14 is 98% and 2% respectively, then the number of C–14 atoms in 12 gm of carbon is -
(A) 1.032×10^{22} (B) 3.01×10^{22}
(C) 5.88×10^{23} (D) 6.02×10^{23}

12. If 3.01×10^{20} molecules are removed from 98 mg of H_2SO_4, then the number of moles of H_2SO_4 left are-
(A) 0.1×10^{-3}
(B) 0.5×10^{-3}
(C) 1.66×10^{-3}
(D) 9.95×10^{-2}

13. Total number of atoms of all elements present in 1 mole of ammonium dichromate $[(NH_4)_2Cr_2O_7]$ is
(A) 14
(B) 19
(C) 6×10^{23}
(D) 114×10^{23}

14. X gm of Ag was dissolved in HNO_3 and the solution was treated with excess of NaCl. When 2.87 gm of AgCl was precipitated the value of x is -
(A) 1.08 gm (B) 2.16 gm
(C) 2.70 gm (D) 1.62 gm

15. What mass of calcium chloride in grams would be enough to produce 14.35 gm of AgCl. (At. mass Ca = 40, Ag = 108) -
(A) 5.55 gm (B) 8.295 gm
(C) 16.59 gm (D) 11.19 gm

16. Total no. of atoms in 44 gm of CO_2 is -
(A) 6.02×10^{23} (B) 6.02×10^{24}
(C) 1.806×10^{24} (D) 18.06×10^{22}

17. If the density of water is 1 gm/cm^3, then the volume occupied by one molecule of water is approximately-
(A) 18 cm^3 (B) 22400 cm^3
(C) 6.02×10^{-23} cm^3 (D) 3.0×10^{-23} cm^3

18. How many grams are contained in 1gm-atom of Na -
(A) 13 gm (B) 23 gm
(C) 1 gm (D) 1/23 gm

19. 1.35 gm of pure Ca metal was quantitatively converted into 1.88 gm of pure CaO. What is atomic weight of Ca -
(A) 40.75 (B) 50 (C) 60 (D) 70

20. The % loss in weight after heating a pure sample of potassium chlorate (M. wt. 122.5) will be -
(A) 12.25 (B) 24.50
(C) 39.17 (D) 49.00

21. The minimum quantity in gram of H_2S needed to precipitate 63.5 gm of Cu^{+2} will be nearly
(A) 63.5 gm (B) 31.75 gm
(C) 34 gm (D) 20 gm

22. Mass of H_2O in 1000 kg $CuSO_4.5H_2O$ is - (Cu = 63.5)
(A) 360.5 kg (B) 36.05 kg
(C) 3605 kg (D) 3.605 kg

23. Phosphine (PH_3) decomposes to produce vapours of phosphorus and H_2 gas. What will be the change in volume when 100 mL of phosphine is decomposed ?
(A) + 50 mL (B) 500 mL
(C) + 75 mL (D) – 500 mL

24. In the reaction $4A + 2B + 3C \rightarrow A_4B_2C_3$, what will be the number of moles of product formed, starting from one mole of A, 0.6 mole of B and 0.72 mole of C ?
(A) 0.25 (B) 0.3
(C) 0.24 (D) 2.32

25. 8 gm of O_2 has the same number of molecules as-
(A) 7 gm of CO (B) 14 gm of CO
(C) 14 gm of CO_2 (D) 12 gm of CO_2

26. 4.4 gm of CO_2 and 2.24 litre of H_2 at STP are mixed in a container. The total number of molecules present in the container will be
(A) 6.022×10^{23} (B) 1.2044×10^{23}
(C) 2 moles (D) 6.023×10^{24}

27. Find the volume of CO_2 obtained at S.T.P. on heating 200 gm of 50% pure $CaCO_3$ -
(A) 11.2 litre (B) 22.4 litre
(C) 44.8 litre (D) None of these

28. 2.76 gm of silver carbonate on being strongly heated yields a residue weighing -
(A) 2.16 gm (B) 2.48 gm
(C) 2.32 gm (D) 2.64 gm

29. A sample of AlF_3 contains 3.0×10^{24} F^- ions. The number of formula units in this sample are -
(A) 9.0×10^{24} (B) 3.0×10^{24}
(C) 0.75×10^{24} (D) 1.0×10^{24}

30. Calculate the gm quantity of Na_2CO_3 which has same No. of atoms as the No. of protons present in 10 gm $CaCO_3$ -
(A) 20 gm (B) 88.33 gm
(C) 44 gm (D) 60 gm

31. The mass of $CaCO_3$ produced when carbon dioxide is passed in excess through 500 ml of 0.5 M $Ca(OH)_2$ will be-
(A) 10 gm (B) 20 gm
(C) 50 gm (D) 25 gm.

32. The mass of 70% pure H_2SO_4 required for neutralisation of 1 mol of NaOH -
(A) 49 gm (B) 98 gm
(C) 70 gm (D) 34.3 gm

33. A sample of hard water is found to contain 40 mg of Ca^{+2} ion per litre. The amount of washing soda (Na_2CO_3) required to soften five litres of the sample would be -
(A) 1.06 gm (B) 5.3 gm
(C) 53 mg (D) 530 mg

34. The mass of oxygen that would be required to produce enough CO, which completely reduces 1.6 kg Fe_2O_3 (at. mass Fe = 56) is-
(A) 240 gm (B) 480 gm
(C) 720 gm (D) 960 gm

35. 1.5 gm of divalent metal displaced 4 gm of copper (at. wt. = 64) from a solution of copper sulphate. The atomic weight of the metal is-
(A) 12 (B) 24
(C) 48 (D) 6

36. Avogadro's number of Rupees can be spent in ....years if 10 lac rupees per second are spent
(A) 1.91×10^{10} year (B) 2.91×10^{10} year
(C) 3.91×10^{10} year (D) 4.91×10^{10} year

37. The amount of sulphur required to produce 100 moles of H_2SO_4 is -
(A) 3.2×10^3 gm (B) 32.65 gm
(C) 32 gm (D) 3.2 gm

38. The vapour density of a mixture containing NO_2 and N_2O_4 is 38.3 at 27° C. The moles of NO_2 in 100 mole mixture is -
(A) 33.48 (B) 53.52
(C) 28.3 (D) 76.6

39. Assuming that petrol is iso-octane (C_8H_{18}) and has density 0.8 gm/ml, 1.425 litre of petrol on complete combustion will consume oxygen -
(A) 50 L (B) 125 L
(C) 125 mol (D) 50 mol

40. The conversion of oxygen to ozone occurs to the extent of 15% only. The mass of ozone that can be prepared from 67.2 L of oxygen at S.T.P. will be -
(A) 14.4 gm (B) 96 gm
(C) 640 gm (D) 64 gm

41. The weight of 2.01×10^{23} molecules of CO is -
(A) 9.3 gm (B) 7.2 gm
(C) 1.2 gm (D) 3 gm

42. In an organic compound of molar mass 108 gm mol^{-1} C, H and N atoms are present in 9 : 1 : 3.5 by weight. Molecular formula can be –
(A) $C_6H_8N_2$ (B) $C_7H_{10}N$
(C) $C_5H_6N_3$ (D) $C_4H_{18}N_3$

43. Number of atoms in 560 gm of Fe (atomic mass 56 g mol^{-1}) is –
(A) is twice that of 70 gm N
(B) is half that of 20 gm H
(C) both are correct
(D) None is correct

44. 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is -
(A) 0.001 M (B) 0.01 M
(C) 0.02 M (D) 0.1 M
(Avogadro constant, $N_A = 6.02 \times 10^{23}\ mol^{-1}$)

45. How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms ?
(A) 3.125×10^{-2} (B) 1.25×10^{-2}
(C) 2.5×10^{-2} (D) 0.02

46. In the reaction,
$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^{-}_{(aq)} + 3H_2(g)$,
(A) 6L $HCl_{(aq)}$ is consumed for every 3L $H_2(g)$ produced
(B) 33.6 L $H_{2(g)}$ is produced regardless of temperature and pressure for every mole Al that reacts
(C) 67.2 L $H_{2(g)}$ at STP is produced for every mole Al that reacts
(D) 11.2 L $H_{2(g)}$ at STP is produced for every mole $HCl_{(aq)}$ consumed

47. The weight of 1×10^{22} molecules of $CuSO_4.5H_2O$ is -
(A) 41.59 g (B) 415.9 g
(C) 4.159 g (D) none of the three

48. Rearrange the following (I to IV) in the order of increasing masses and choose the correct Answer from (A), (B), (C) and (D)
(At. mass : N = 14, O = 16, Cu = 63)
(I) 1 molecule of O
(II) 1 atom of nitrogen
(III) 1×10^{-10} g molecular mass of oxygen
(IV) 1×10^{-7} g atomic mass of copper
(A) II < I < III < IV (B) IV < III < II < I
(C) II < III < I < IV (D) III < IV < I < II

49. One mole of calcium phosphide on reaction with excess of water gives
(A) One mole of phosphine
(B) Two mole of Phosphoric acid
(C) Two moles of phosphine
(D) One mole of phosphorus pentoxide

50. At 100ºC and 1 atm, if the density of liquid water is 1.0 g cm^{-3} and that of water vapour is 0.0006 g cm^{-3}, then the volume occupied by water molecules in 1 litre of steam at that temperature is
(A) 6 cm^3 (B) 60 cm^3
(C) 0.6 cm^3 (D) 0.06 cm^3

♦ ♦ ♦ ♦ ♦ ♦

ANSWER KEY

TOPIC WISE MCQS

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	A	B	D	B	B	C	A	D	B	D	A	C	D	A	B	C	A	D	B	D
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	A	B	B	B	B	D	A	C	C	A	B	C	D	D	B	C	C	D	C	A
Ques.	41	42	43	44	45	46	47	48	49	50										
Ans.	A	B	C	B	D	B	C	A	B	B										

MISCELLANEOUS QUESTIONS

Ques.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	C	C	B	A	C	C	D	D	C	D	A	B	D	B	A	C	D	B	A	C
Ques.	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Ans.	C	A	C	C	A	B	B	A	D	B	D	C	D	B	B	B	A	A	C	A
Ques.	41	42	43	44	45	46	47	48	49	50										
Ans.	A	A	C	B	A	D	C	A	C	C										

Our **INFRASTRUCTURE**

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with Ranjan Singh Sir

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In Our Premises

LIBRARY

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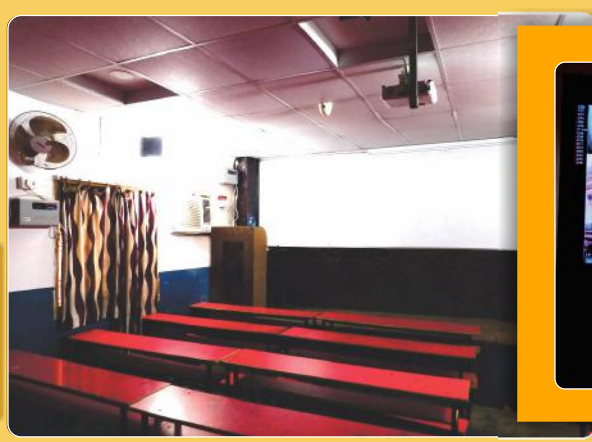
with complete care

RECEPTION

PROJECTOR



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