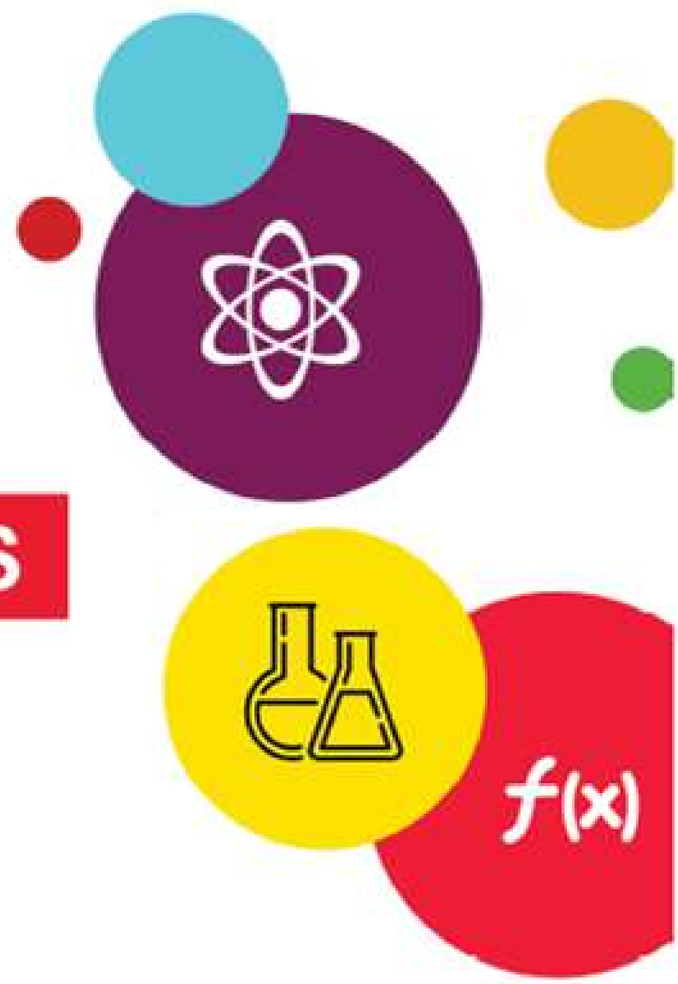
STUDY MATERIAL FOR

JEE Main

PHYSICS

CHEMISTRY

MATHEMATICS



CP PUBLICATION

Study Material for JEE Main preparation

Prepared by Career Point Kota Experts

CONTENTS OF THE PACKAGE AT A GLANCE

PHYSICS

Class 11

Module-1

- Unit, Dimension & Error
- Vector
- Motion in one dimension
- Projectile motion
- Newton's laws of motion & friction

Module-2

- Circular Motion & Rotational Dynamics
- Work, Power, Energy & Conservation Law
- Gravitation
- Simple Harmonic Motion
- Properties Of Matter
- Fluid Mechanics

Module-3

- Wave Motion : Mechanical Waves In String
- Wave Motion : Sound Waves
- Calorimetry
- Kinetic Theory Of Gases
- Thermodynamics
- Heat Transfer : Radiation
- Heat Transfer : Conduction
- Thermal Expansion

Class 12

Module-4

- Electrostatics
- Capacitance
- Current Electricity
- Magnetic Effect Of Current
- Magnetism
- Electro Magnetic Induction
- Alternating Current
- Electromagnetic Wave

Module-5

- Reflection
- Refraction At Plane Surface & Prism
- Refraction At Curved Surface & Optical Instruments
- Wave Optics : Interference
- Wave Optics : Diffraction & Polarisation

Module-6

- Atomic Structure
- Matter Waves
- Photoelectric Effect
- Nuclear Physics
- Semiconductor Devices
- X-Rays
- Practical Physics

CHEMISTRY

Class 11

Module-1

- Atomic Structure
- Mole Concept
- Oxidation-Reduction
- Equivalent Concept & Volumetric Analysis
- Periodic Table
- Chemical Bonding

Module-2

- Chemical Energetics
- Chemical Equilibrium
- Ionic Equilibrium

Module-3

- Classification & Nomenclature
- Isomerism
- General Organic Chemistry
- Hydrocarbon
- Aromatic Hydrocarbon

Class 12

Module-4

- Electro Chemistry
- Solution & Colligative Properties
- Chemical Kinetics

Module-5

- Halo Alkane
- Alcohol, Ether & Phenol
- Carbonyl Compound
- Carboxylic Acid & Its Derivative)
- Nitrogen Containing Substance
- Purification & Characterisation Of Organic Compounds
- Biomolecules

Module-6

- P-Block Elements
- D & F-Block Elements
- Coordination Compound
- Practical Chemistry

MATHEMATICS

Class 11

Module-1

- Trigonometric Ratios
- Properties Of Triangle
- Statistics
- Set & Relation

Module-2

- Quadratic Equation & Expression
- Progression & Series
- Binomial Theorem
- Permutation & Combination

Module-3

- Point
- Straight Line
- Circle
- Parabola
- Ellipse
- Hyperbola

Class 12

Module-4

- Function
- Inverse Trigonometric Function
- Limit
- Continuity & Differentiability
- Differentiation
- Tangent, Normal & Rate Measure
- Monotonicity
- Maxima & Minima

Module-5

- Indefinite Integration
- Definite Integration
- Area Under The Curve
- Differential Equation

Module-6

- Vector
- 3-D
- Probability
- Determinants
- Matrices
- Complex Number

Mole Concept

This chapter covers the following syllabus

- Significant Figures.
- Types of Mixture.
- Laws of Chemical Combination.
- Avogadro's Hypothesis.
- Atom, Molecules and Molecular Formula.
- Brief discussion about some of the terms used in Mole Concept.
- Units of Pressure, Volume & Temperature; Conversion of Volume of Gases into Mass.
- Mole Concept.
- Chemical Formula.
- Limiting Reactants or Limiting Reagent.
- Eudiometry.
- Concentration Terms.
- Basic of Ideal Gas Equation.
- Gas Laws.
- Dalton's Law of Partial Pressure
- Avagadro's Law

Revision Plan

Prepare Your Revision plan today!

After attempting Exercise Sheet, please fill below table as per the instruction given.

- Write Question Number (QN) which you are unable to solve at your own in column A.
- After discussing the Questions written in column A with faculty, strike off them in the manner so that you can see at the time question number during Revision, to solve such questions again.
- Write down the Question Number you feel are important or good in the column B.

EXERCISE	COLUMN A	COLUMN B
	Questions unable to solve in first attempt	Good or Important questions
Exercise-1		
Exercise-2		
Exercise-3		
Exercise-4		
Exercise-5		

Revision Strategy:

Whenever you wish to revision this chapter, follow the following steps -

- ❑ Step-1: Review your theory notes.
- ❑ Step-2: Solve Questions of column A
- ❑ Step-3: Solve Questions of Column B
- ❑ Step-4: Solve questions from other Question Bank, Problem book etc.

Mole Concept

KEY CONCEPT

1. Significant Figures

(a) Every scientific observation involves some degree of uncertainty depending upon the limitation of instrument. To represent scientific data, role of significant figures has its own importance.

(b) Significant figures are equal to the number of digits in numbers with last digit uncertain and rest all are certain digits i.e. all the digits of datum including the uncertain one , are called significant figures.

(c) **Rules for determination significant figure:**

(i) All non zero digits are significant.

Example : 3.14 has three significant figures

(ii) The zeros to the right of the decimal point are significant.

Example : 3.0 has two significant figures.

(iii) The zeros to the left of the first non zero digit in a number are not significant.

Example : 0.02 has one significant figure.

(iv) The zeros between two non zero digits are also significant.

Example : 6.01 has three significant figures.

(v) **Exponential form :** $N \times 10^n$. Where N show the significant figure.

Example : 1.86×10^4 has three significant figure.

(vi) **Rounding off the uncertain digit :**

(1) If the left most digit to be rounded off is more than 5 , the preceding number is increased by one.

Example : 2.16 is rounded to 2.2

(2) If the left most digit to be rounded off is less than 5 , the preceding number is retained.

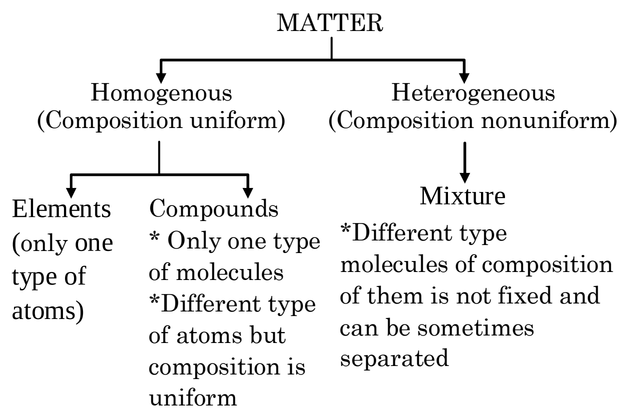
Example : 2.14 is rounded off to 2.1

(3) If the left most digit to be rounded off is equal to 5, the preceding number is not changed if it is even and increased by one if it is odd.

Example : 3.25 is rounded off to 3.2

2.35 is round off to 2.4

2. Types of Mixture



2.1 Heterogenous mixture

A mixture in which the different constituents are not distributed uniformly is known as heterogenous mixture. **eg Water**

2.2 Homogenous mixture

A mixture in which the different constituents are uniformly distributed is known as homogenous mixture. eg. O_2, N_2 etc.

3. Laws of Chemical Combination

3.1 Law of conservation of mass-

[Lavoisier, 1744]

(i) According to this law , matter is neither created nor destroyed in the course of chemical reaction although it may change from one form to other

(ii) This law contradicts nuclear reactions where Einstein equation is applicable

(iii) According to this law , sum of the masses of product formed is always equal to the sum of the masses of the reactant undergone change

Example : $H_2 \quad + \quad Cl_2 \rightarrow \quad 2HCl$

$\underbrace{2gm \qquad 71\,gm} \qquad 2\,[\,1 + 35.5]$

$\Rightarrow \qquad 73\ gm \quad \equiv \quad 73\ gm$

3.2 Law of definite proportion [Proust, 1799]

(i) According to the law, the composition of a compound always remains a constant i.e. the ratio of weights of different elements in a compound ; no matter by whatever method , it is prepared or obtained from different sources, remains always a constant

Example : In H_2O ratio of weight = 1 : 8

In CO_2 ratio of weight = 3 : 8

3.3 Law of multiple proportion

[John Dalton, 1804]

According to this law, when two elements A and B combine to form more than one chemical compound then different weights of A , which combine with a fixed weight of B , are in a proportion of simple whole number

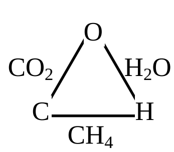
Example :	CO	&	CO_2
	12 : 16	&	12 : 32
ratio	=	16 : 32	
	=	1 : 2	

3.4 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

3.5 Gay-Lussac's [1808] law of combining volumes :

This law states that under similar conditions of pressure and temperature, volume ratio of gases is always in terms of simple integers.

Ex. $N_{2(g)} + 3H_{2(g)} \rightarrow 2NH_{3(g)}$

vol. ratio 1 : 3 : 2

4. Avogadro's Hypothesis

According to this under similar conditions of pressure and temperature , equal volumes of gases contain equal number of molecules.

4.1 Salient features of Avogadro's hypothesis

(i) It has removed the anomaly between Dalton's atomic theory and Gay Lussac's law of volume by making a clear distinction in between atoms and molecules

(ii) It reveals that common elementary gases like hydrogen , nitrogen , oxygen etc. are diatomic

(iii) It provides a method to determine the atomic weights of gaseous elements

(iv) It provides a relationship between vapour density and molecular weight of substances

Vapour density =

$$\frac{\text{Volume of definite amount of Gas}}{\text{Volume of same amount of Hydrogen}}$$

or Vapour density =

$$\frac{\text{Weight of n molecules of Gas}}{\text{Weight of n molecules of Hydrogen}}$$

or Vapour density =

$$\frac{\text{Weight of one molecule of Gas}}{\text{Weight of one atom of hydrogen} \times 2}$$

or Vapour density = $\frac{\text{Molecular weight}}{2}$

(v) It helps to determine molar volume

Molecular weight of the gas

= 2 × vapour density

$$= 2 \times \frac{\text{Weight of 1 litre of the Gas at S.T.P}}{\text{Weight of 1 litre of Hydrogen at S.T.P}}$$

$$= 2 \times \frac{\text{Weight of 1 litre of the Gas at S.T.P}}{0.089\text{ gm}}$$

$$= \frac{2}{0.089} \times \text{Weight of 1 litre of the gas at S.T.P.}$$

= 22.4 × Weight of 1 litre of gas at S.T.P.

= Weight of 22.4 litre of the gas at S.T.P

5. Atom, Molecules and Molecular Formula

Atom: It is the smallest particle of an element that takes part in a chemical reaction and not capable of independent existence.

Molecule : It is the smallest particle of matter which is capable of independent existence. A molecule is generally an assembly of two or more tightly bonded atoms.

Homoatomic molecules : Molecules of an element contain one type of atoms. eg. O_2, Cl_2 etc.

Heteroatomic molecules : Molecules of compounds contain more that one type of atom.

eg. H_2O, HCl etc

5.1 Atomic mass scale

5.1.1 Oxygen as standard : The standard reference for atomic weight may be oxygen with an assigned value of 16.

Atomic weight of an element =

$$\frac{\text{Weight of 1 atom of element}}{1/16 \times \text{Weight of 1 atom of oxygen}}$$

5.1.2 Carbon as standard : The modern reference standard for atomic weight is carbon isotope of mass number 12.

Atomic weight of an element =

$$\frac{\text{Weight of 1 atom of the element}}{1/12 \times \text{Weight of 1 atom of C}-12}$$

IMPORTANT POINTS

- Atomic weight is not a weight but a number.
- Atomic weight is not absolute but relative to the weight of the standard reference element C-12

5.2 Molecular weight

It is the number of times a molecule is heavier than 1/12th of an atom of C – 12.

$$\text{Molecular weight} = \frac{\text{Weight of 1 molecule}}{1/12 \times \text{Weight of one C}-12}$$

IMPORTANT POINTS

- Molecular weight is not a weight but a number
- Molecular weight is relative and not absolute
- Molecular weight expressed in grams is called gram molecular weight
- Molecular weight is calculated by adding all the atomic weights of all the atoms in a molecule

  Example : CO_2 = 12 + 2 × 16 = 44

6. Brief discussion about some of the terms used in Mole Concept

6.1 Atomic weight and atomic mass unit (amu) :

(a) The atomic weight (or atomic mass) of an element may be defined as the average relative weight (or mass) of an atom of the element with respect to the $\frac{1}{12}$th mass of an atom of carbon (mass number 12)

(b) Thus,

atomic weight

$$= \frac{\text{weight of an atom the element}}{\text{weight of an of C(mass no. 12)}} \times 12$$

(c) The multiplying factor 12 is used to avoid atomic weights less than unity.

(d) If we express atomic weight in grams, it becomes gram atomic weight (symbol gm-atom). For example, atomic weight of oxygen = 16, therefore, 1 gm-atom oxygen = 16 gm of oxygen, similarly, atomic weight of Ag = 108, therefore, 540 gm Ag = $\frac{540}{108}$ = 4 gm-atom of Ag.

(e) Thus the number of gm-atom of an element $= \frac{w}{A}$ where w is the given mass of the element of atomic weight A.

(f) 1 gm-atom of any element contain N_A number of atoms.

(g) The atomic weight of H = 1.008,

Therefore, the weight of single H-atom $= \frac{1.008}{N_A} gm = \frac{1.008}{6.023 \times 10^{23}} = 1.673 \times 10^{-24}$ gm.

Similarly, $\frac{1}{12}$ th of the mass of a carbon atom (mass number 12)

$$= \frac{1}{12} \times \frac{12}{6.023 \times 10^{23}}$$

$$= \frac{1}{6.023 \times 10^{23}}$$

$= 1.667 \times 10^{-24}$ gm.

The atomic mass unit (amu or u) is defined as the $\frac{1}{12}$ th of the mass of single carbon atom of mass number 12.

Thus, 1 amu or u = 1.667×10^{-24} gm

$= 1.667 \times 10^{-27}$ kg.

Example Based on

Atomic weight

Example.

Calculate the number of atoms present in 4.8 gm of oxygen gas.

Solution.

The weight of oxygen. i.e, w = 4.8 gm.

The atomic mass of oxygen. i.e, A = 16 gm.

$\therefore$ number of gm-atom of oxygen $= \frac{w}{A} = \frac{4.8}{16}$

$\therefore$ The number of oxygen atoms present in the given gas $= \frac{4.8}{16} \times N_A$

Example.

The radius of hydrogen atom is 0.53 Å. Assuming the hydrogen atom as spherical, calculate the atomic weight of Hydrogen. (Given the density of hydrogen atom = 2.675 gm/ml)

Solution.

The volume of each hydrogen atom $= \frac{4}{3} \pi r^3$

Now r = 0.53 Å = 0.53×10^{-8} cm.

$\therefore \quad \frac{4}{3}\pi r^3 = \frac{4}{3} \times \pi \times (0.53)^3 \times 10^{-24}$ cm^3

$\therefore$ mass of each hydrogen atom

$= \frac{4}{3} \times \pi \times (0.53)^3 \times 10^{-24} \times 2.675$ gm

$\therefore$ atomic weight of hydrogen

$= N_A \times$ mass of one hydrogen atom

$= 6.023 \times 10^{23} \times \frac{4}{3} \times \pi \times (0.53)^3 \times 10^{-24} \times 2.675$

$= 10.04 \times 10^{-1} = 1.004$ **Ans.**

6.2 Molecular Weight and Formula Weight :

(a) Molecular weight is defined as the weight of a molecule of a substance compared to the $\frac{1}{12}$ th of the mass of a carbon atom (mass number = 12). For compounds, molecular weight is the sum of the atomic weights of all atoms present in the molecule.

(b) In ionic compounds, as for example, NaCl, $CaCl_2$, H_2SO_4, etc. there are no existence of molecules. The individual units are stabilized by the electrostatic interactions of the ion pairs present in the ionic compounds. so, word, molecular weight is not applicable.

(c) Instead of "molecular weight" we use a new term known as "formula weight". "Formula weight" is defined as the total weights of atoms present in the formula of the compound.

(d) Thus, formula weight of $Fe_2(SO_4)_3$ = $56 \times 2 + 32 \times 3 + 16 \times 12 = 400$

(At. wts of Fe and S are 56 and 32 respectively).

6.3 The average atomic mass and average molecular mass :

(a) After the discovery of isotopes, it has been concluded that same element can be present in the nature with different atomic masses.

(b) Let us consider, an element x, is available in the earth as isotopes of

${}_nX^{a_1}, {}_nX^{a_2}, \ldots\ldots, {}_nX^{a_n}$ the percentage abundance of the given isotopes in earth are $x_1, x_2, \ldots\ldots, x_n$ respectively.

$\therefore$ the average atomic mass of X (A_x) = $\frac{a_1x_1 + a_2x_2 + ... + a_nx_n}{100}$

Calculation of average molar mass :

(c) Let us consider, in a container,

n_1 moles of substance x_1 (mol. wt M_1) present

n_2 moles of substance x_2 (mol. wt M_2) present

....

....

....

n_n moles of substance x_n (mol. wt M_n) present

Hence,

the total number of moles of substance present in the container = $n_1 + n_2 + ... + n_n$

Total mass of the substance present in the container = $n_1M_1 + n_2M_2 + ... + n_nM_n$

$\therefore$ the average molar mass of the substance present in the container = $\frac{n_1M_1 + n_2M_2 + ... + n_nM_n}{n_1 + n_2 + ...n_n}$

Example Based on

Molecular weight & formula weight

Example.

How many grams of nitrogen gas can be maximum obtained from 720 kg of urea ?

Solution.

The molecular formula of urea is $CO(NH_2)_2$.

Its molecular wt = 12 + 16 + 28 + 4 = 60

From 60 kg of urea 28 kg of nitrogen can be obtained

From 720 kg of urea $\frac{28}{60} \times 720 = 336$ kg

Example.

Naturally occurring chlorine is 75.53% Cl^{35} which has an atomic mass of 34.969 amu and 24.47% Cl^{37} which has a mass of 36.966 amu. Calculate the average atomic mass of chlorine

(A) 35.5 amu (B) 36.5 amu

(C) 71 amu (D) 72 amu

Solution.(A)

Average atomic mass = % of I isotope × Its atoms mass + % II isotope × its atomic mass/100

$= \frac{75.53 \times 34.969 + 24.47 \times 36.96}{100} = 35.5$ amu.

Example.

The molar composition of polluted air is as follows :

Gas	At. wt.	Mole Percentage Composition
Oxygen	16	16%
Nitrogen	14	80%
carbon dioxide	–	03%
sulphurdioxide	–	01%

What is the average molecular weight of the given polluted air ? (Given, atomic weights of C and S are 12 and 32 respectively).

Solution.

$$M_{avg} = \frac{\sum_{j=1}^{j=n} n_jM_j}{\sum_{j=1}^{j=n} n_j}, \quad \text{Here} \sum_{j=1}^{j=n} n_j = 100$$

$$\therefore M_{avg} = \frac{16 \times 32 + 80 \times 28 + 44 \times 3 + 64 \times 1}{100}$$

$$= \frac{512 + 2240 + 132 + 64}{100} = \frac{2948}{100} = 29.48$$ **Ans.**

7. Units of Pressure, Volume & Temperature; Conversion of Volume of Gases into Mass

(a) In the chemical calculation, sometimes the conversion of volume of gas into its weight is necessary.

(b) To do so, we are to apply the combined gas law. For example, at absolute temperature T (273 + t ºC) and pressure P, the volume of a given mass of gas (molecular weight M) is V, now as per the combined gas law we can write,

PV = nRT (where n indicates number of moles of gas and R is universal gas constant)

As we know, $n = \frac{w}{M}$, where w is the mass of gaseous substance).

$$\therefore PV = \frac{w}{M} RT \text{ or } w = \frac{PVM}{RT}$$

(c) Therefore if we know, pressure, volume, temperature and molecular weight of gas, we can calculate its mass.

(d) Be careful while putting the value of R. R = 0.082 lit atm/K/mole when units of P and V are atmosphere and Liter respectively. It means, if the pressure of the given gas in other unit, you have to convert into atmosphere (symbol atm). Similarly, if the volume of the gas is given in any other unit, you have to convert it into litre. Similarly, you have to convert the given temperature into absolute temperature.

(e) Density of gas may be calculated as

$$d = \frac{w}{V} = \frac{PM}{RT}$$

(f) Here we are discussing the relation between the various units of pressure, volume and temperature.

✦ **Pressure units :**

The units of pressure of gas are divided into two types

(i) Absolute units

(ii) Relative units

(i) Absolute units :

In MKS system : N/m^2 or Pascal (Pa)

N stands for Newton

In CGS system : gm/cm^2

In FPS system : lb/ft^2 or lb per square inch ($lb/inch^2$)

(ii) Relative units :

Bar, atmosphere (symbol atm), torr and cm of Hg.

✦ **Relation :**

1 atm = 1.01325×10^5 Pa = 1.01325 bar (1bar = 10^5 Pa)

= 14.7 lb/in^2

= 760 torr = 760 mm of Hg

(1 torr = 1 mm. of Hg)

= 76 cm of Hg.

✦ **Volume units :**

1 dm^3 = 1 litre (symbol lit) = 1000 ml = 1000 cm^3

1 m^3 = 10^3 litre = 10^6 ml

1 mm^3 = 10^{-3} cm^3 = 10^{-9} m^3

1 U.S. gallon = 8.34 lb of water at room temperature

1 lb of water = 453.6 gm

1 U.S. gallon = 8.34 × 453.6 ml = 3783 ml = 3.783 lit

✦ **Temperature units :**

Absolute temperature T (in k) = 273 + t°C where, t is the temperature in centigrade scale.

STP (Standard temp. and pressure) which considerd 273K and 1atm

NTP (Normal temp. and pressure) which considerd 273K and 1atm

Example Based on
Pressure, volume and temperature

Example.

What is the density of H_2S gas at 27°C and 2 atmosphere ?

(A) 2.77 gm/lit (B) 2.25 gm/lit

(C) 2 gm/lit (D) 3.4 gm/lit

Solution.(A)

Here P = 2 atm, M = 2 × 1 + 32 = 34,

T = 273 + 27 = 300 K

$$d = \frac{PM}{RT} = \frac{2 \times 34}{0.082 \times 300} = 2.764 \text{ gm/litre}$$

Example.

Density of dry air containing only N_2 and O_2 is 1.146 gm/lit at 740 mm and 300 K. what is % composition of N_2 by weight in the air.

(A) 78% (B) 82%

(C) 73.74% (D) 72.42%

Solution.(C)

First calculate the av. mol. wt. of the mixture as

$$d = \frac{PM}{RT}$$

$$\Rightarrow M = \frac{dRT}{P} = \frac{1.146 \times 0.082 \times 300}{\left(\frac{740}{760}\right)} = 28.95$$

Now, let 100 gm of dry air contains x gm N_2 and hence (100 – x) gm O_2. Applying mole conservation :

mole of air = mole of N_2 + mole of O_2

$$\text{or, } \frac{100}{28.95} = \frac{x}{28} + \frac{100 - x}{32} \Rightarrow x = 73.74$$

Example.

A 1.225g mass of a volatile liquid is vapourized, giving 400ml of vapour when measured over water at 30ºC and 770 mm. The vapour pressure of water at 30ºC is 32 mm. What is the molecular weight of the substance ?

Solution.

w = 1.225 gm, V = 400 ml = 0.4 litre ;

T = 273 + 30 = 303 K

P = (770 – 32) = 738 mm = 0.971 atm

(from Dalton's law of partial pressure, pressure of dry gas = total pressure – vapour pressure of water)

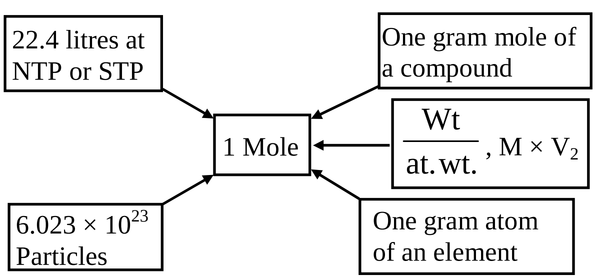
Now, PV = n R T or $PV = \frac{w}{M} RT$

$$\therefore \; M = \frac{wRT}{PV} = \frac{1.225 \times 0.082 \times 303}{0.4 \times 0.971} = 78.36$$

8. Mole Concept

One mole is the amount of a substance that contains as many particles or entities as there are atoms in exactly

12gm of the ^{12}C isotope



IMPORTANT :

⇒ 1 mole = 6.023×10^{23} particles

⇒ 1 mole atoms = 6.023×10^{23} atoms

⇒ One mole molecule = 6.023×10^{23} molecules

⇒ Mass of one mole of atoms = Gram atomic mass

⇒ Mass of one mole of molecules = Gram molecular mass

⇒ Moles of a compound = Mass of compound

⇒ Volume occupied by 1 mole of a gas at N.T.P = 22.4 litres.

9. Chemical Formula

It is of two types -

(a) **Molecular formulae :** Chemical formulae that indicate the actual numbers and type of atoms in a molecule are called molecular formulae

(b) **Empirical formulae :** The chemical formulae that give only the relative number of atoms of each type in a molecule are called empirical formulae

9.1 Determination of chemical formulae

9.1.1 Determination of empirical formulae :

Step - I : Determination of percentage

Step - II : Determination of mole ratio

Step - III : Making it whole number ratio

Step - IV : Removal of fractions from mole ratio

9.1.2 Determination of molecular formulae

(i) First of all find empirical formulae

(ii) Molecular formulae

= (Empirical formulae) n

$$\text{where } n = \frac{\textit{Molecular weight}}{\textit{Empirical formula weight}}$$

✦ **<u>Details about Gravimetric analysis</u> :**

Problems of Gravimetric analysis are of three types.

(i) Problems involving mass by mass relationship

(ii) Problems involving mass by volume relationship

(iii) Problems involving volume by volume relationship

(i) <u>Problems involving mass by mass relationship</u> :

To solve this types of problem you are to proceed as follows.

Step 1 : Find out the chemical reaction involved in the problem.

Step 2 : Write the chemical reaction as an equation and balance it by any suitable method.

Step 3 : Write the number of moles below the formula of the reactants and products. Also write the formula weights of reactants and products, below their respective formula.

Step 4 : Apply the unitary method to calculate the unknown factor (s). Let us start with a problem; it is, A mixture of NaCl and KCl weighed 5.4892 gm. The sample was dissolved in water and treated with an excess of silver nitrate solution. The resulting AgCl weighed 12.7052 gm. What is the percentage of NaCl in the mixture ? (Given atomic weight of Na, K, Ag, Cl are 23, 39, 108, 35.5respectively)

The reactions involved are,

$NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$

58.5 143.5

$KCl + AgNO_3 \rightarrow AgCl + KNO_3$

74.5 143.5

Let us consider in the mixture x gm of NaCl present

$\therefore$ KCl present = (5.4892 – x) gm.

By, unitary methods, from

58.5 gm of NaCl, AgCl produced = 143.5 gm

1 gm of NaCl, AgCl produced = $\frac{143.5}{58.5}$ gm

x gm of NaCl, AgCl produced = $\frac{143.5 \times x}{58.5}$ gm

similarly, from, 74.5 gm of KCl,

AgCl produced = (5.4892 – x) gm

$$\therefore \quad \frac{143.5x}{58.5} + \frac{173.5}{74.5}(5.4892 - x) = 12.7052$$

$$\text{or} \quad \frac{x}{58.5} + \frac{(5.4892 - x)}{74.5} = \frac{127052}{143.5} = 0.08854$$

$$\text{or} \quad \frac{x}{58.5} - \frac{x}{74.5} = 0.08854 - \frac{5.4892}{74.5}$$

$$= 0.08854 - 0.07368 = 0.01486$$

or 16 x = 0.01486 × 58.5 × 74.5

or x = 4.0477 $\therefore$ % NaCl in the mixture

$$= \frac{4.0477}{5.4892} \times 100 = 73.74 \ \textbf{Ans.}$$

✦ Let us discuss another problem to clear your doubt further – it is, 25.4 gm of I_2 and 14.2 gm of Cl_2 are made to react completely to yield a mixture of ICl and ICl_3. Calculate moles of ICl and ICl_3 formed.

Step 1 : We will write the reaction in terms of chemical equation as.

$$I_2 + Cl_2 \longrightarrow ICl + ICl_3.$$

Step 2 : We will balance the chemical equation by any conveniable method as.

$$x\, I_2 + y\, Cl_2 \longrightarrow a\, ICl + b\, ICl_3.$$

by I balance by Cl balance

2x = a + b 2y = a + 3b.

2y – 2x = 2b.

or y – x = b. | a = 3x – y

if y = 2, x = 1, the a = 3 × 1 – 2 = 1.

b = 1

$\therefore$ $I_2 + 2Cl_2 \rightarrow ICl + ICl_3$.

This is the balanced equation.

Step 3 : At wt of I = 127, At wt of Cl = 35.5

$$\therefore \quad 25.4 \text{ gm } I_2 = \frac{25.4}{127 \times 2}$$

$$= 0.1 \text{ mole of } I_2.$$

$$14.2 \text{ gm } Cl_2 = \frac{14.2}{35.5 \times 2} = 0.2 \text{ mole } Cl_2.$$

Step 4 : 1 mole I_2 reacts with 2 moles of Cl_2 as per equation

0.1 mole I_2 reacts with 0.2 moles of Cl_2

1 mole I_2 yields 1 mole of ICl & 1 mole of ICl_3

$\therefore$ 0.1 mole of I_2 yields 0.1 mole of ICl & 0.1 mole of ICl_3

$\therefore$ Moles of ICl formed = 0.1

$\therefore$ Moles of ICl_3 formed = 0.1 **Ans.**

(ii) Problems involving mass by volume relationship :

✦ To solve the problems involving mass by volume relationship we are to proceed according to the following instructions :

Step 1 : Find out the chemical reaction involved in the problem and also find out the physical state of the given reactants and products.

Step 2 : Write the chemical reaction as an equation and balance it by any suitable method.

Step 3 : Gases are usually expressed in terms of volumes. Depending on your need, (i) convert the volume of the gas at NTP by applying the gas equation. or (ii) convert the volume of the gas into its wt. by applying the equation PV = $\frac{W}{M}$RT

Step 4 : Calculate the unknown factor by unitary method.

◆ Let us solve one problem to clear your doubts. It is, a mixture of Na_2CO_3 and $NaHCO_3$ had a mass of 22 gm. Treatment with excess HCl liberates 6.00 lit CO_2 at 25ºC and 0.947 atm pressure. Determine the percent Na_2CO_3 in the mixture.

Step 1 : Among the reactants and products only CO_2 will be gaseous at the given condition. The Na_2CO_3 and $NaHCO_3$ both will react will HCl and yield CO_2 (g).

Step 2 : The balanced chemical reactions are

$$Na_2CO_3 + 2\,HCl \rightarrow 2\,NaCl + H_2O + CO_2$$
106 gm 44 gm

$$NaHCO_3 + HCl \rightarrow NaCl + H_2O + CO_2$$
84 gm 44 gm

$$\therefore\ PV = \frac{W}{M}RT$$

$$\text{or } W = \frac{PVM}{RT} = \frac{0.947 \times 6 \times 44}{0.082 \times 298} = 10.23$$

Let in the mixture x gm. of Na_2CO_3 present,

$\therefore$ from x gm. Na_2CO_3, CO_2 produced

$$= \frac{44x}{106}\ \text{gm.}$$

In the mixture the amount of $NaHCO_3$ present = (22 – x) gm.

From (22 – x) gm of $NaHCO_3$, CO_2

$$\text{produced} = \frac{44}{84}\ (22 - x)\ \text{gm}$$

$$\therefore\ \frac{44x}{106} + \frac{44}{84} + (22 - x) = 10.231$$

on, solving x = 11.9 gm.

$\therefore$ % Na_2CO_3 in the 22 gm of mixture

$$= \frac{119}{22} \times 100 = 54.09\ \textbf{Ans.}$$

(iii) Problems involving volume by volume relationship :

(a) The type relationship are used correlate the volume of gaseous reactants with other gaseous reactants or gaseous products.

(b) Stoichiometric equation for the combustion of any hydrocarbon is,

$$C_xH_y + \frac{7}{2}(x + y/4)\ O_2 \rightarrow xCO_2 + y/2\ H_2O.$$

Consider at temperature (T) and pressure (P) we have taken v_H volume of C_xH_y. Therefore for complete combustion of v_H volume of C_xH_y,

O_2 required = v_H (x + y/4) vol. [At pressure P and temp. T]

CO_2 product = v_H x vol

[At pressure P and temp. T]

if H_2O is also gas at the given condition, then,

H_2O vapour produced = v_H y/2 [At pressure P and temp. T]

If the general formula of organic compound is $C_xH_yO_z$, the stoichiometric equation for its combustion is

$$C_xH_yO_z + (x + y/4 - z/2)\ O_2 \rightarrow xCO_2 + y/2\ H_2O.$$

(c) To solve the problems related to volume by volume we are to follow the given instruction.

Step 1 : Find out the chemical reaction involved in the problem and also find out the physical state of the reactants and products at the given condition.

Step 2 : Write the chemical reaction and balance it by any suitable method.

Step 3 : Write down the volume of reactants and products below the formula to each reactant and product with help of the fact that 1 gm molecule of every gaseous substance occupies 22.4 litres at NTP.

Step 4 : In case volume of the gas is measured under particular (or room) temperature. Convert it to volume at NTP by using ideal gas equation

At the same temperature, it is seen that molar ratio of reactants and products is equal to that of ratio of volumes of reactants and products, therefore, we can conclude that mole % = volume %. Let us apply the concept to solve a problem.

✦ A mixture of ethane (C_2H_6) and ethene (C_2H_4) occupies 40 lit at 1 atm and 400 K. The mixture reacts completely with 130 gm of O_2 to produce CO_2 and H_2O. Assuming ideal gas behaviour, calculate the mole fraction of C_2H_6 and C_2H_4 in the mixture.

Solution.

Let at the given condition volume of C_2H_6 = x lit

$\therefore$ at the given condition volume of C_2H_4 = (40 – x) lit

Step 1 : C_2H_6 and C_2H_4 will be completely oxidized into CO_2 and H_2O

Step 2 : Therefore equation for their combustion are :

$$C_2H_6 + \frac{7}{2}O_2 \rightarrow 2CO_2 + 3H_2O \quad ...(1)$$

$$C_2H_4 + 3O_2 \rightarrow 2CO_2 + 2H_2O \quad ...(2)$$

Step 3 : For x lit of C_2H_6 at the given conditions O_2 required for combustion

$$= \frac{7}{2}\ x\ \text{lit}$$

For (40 – x) lit of C_2H_4 at the given conditions O_2 required for combustion = 3 (40 – x) lit.

Now, total volume of O_2 required for the combustion of the 40 lit of given mixture

= 3.5 x + 3 (40 – x) lit

= (120 + 0.5 x) lit

Now P = 1 atm, V = (120 + 0.5 x) lit

T = 400 K, R = 0.082 lit atm/K/mole

$$PV = \frac{W}{M} RT \quad \text{or} \quad W = \frac{PVM}{RT}$$

$$= \frac{1(120+0.5x)\times 32}{0.082\times 400} = \frac{(120+0.5x)}{1025}$$

Now, wt of O_2 required = 130 gm.

$$\therefore \frac{(120+0.5x)}{1025} = 130 \text{ or } x = 26.5$$

$\therefore$ volume fraction of

$$C_2H_6 = \frac{26.5}{40} = 0.6625$$

volume fraction of C_2H_4 = 0.3375

$\therefore$ mole fraction of C_2H_6 = 0.6625

$\therefore$ mole fraction of

C_2H_4 = 0.3375 **Ans.**

✦ **Some Important Reactions :**

(A) Decomposition Reaction :

$CaCO_3(s) \xrightarrow{\Delta} CaO(s) + CO_2(g)$

$MgCO_3(s) \xrightarrow{\Delta} MgO(s) + CO_2(g)$

$SrCO_3(s) \xrightarrow{\Delta} SrO(s) + CO_2(g)$

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

$2KHCO_3 \xrightarrow{\Delta} K_2CO_3 + H_2O + CO_2$

$2HI \xrightarrow{\Delta} H_2 + I_2$

$2NH_3 \xrightarrow{\Delta} N_2 + 3H_2$

NOTE Arbonates of I[st] group elements i.e. Na, K, Rb, Cs, Fr do not decompose on heating

(B) Displacement Reactions :

$Zn(s) + CuSO_4 \rightarrow ZnSO_4 + Cu$

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

$Pb + CuCl_2 \rightarrow PbCl_2 + Cu$

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

NOTE Precipitation reactions discussed above are also example of displacement reactions.

(C) Double Displacement Reactions :

$NaCl + AgNO_3 \rightarrow AgCl\downarrow + NaNO_3$
White ppt.

$NaBr + AgNO_3 \rightarrow AgBr\downarrow + NaNO_3$
Yellow ppt.

$NaI + AgNO_3 \rightarrow AgI\downarrow + NaNO_3$
Yellow ppt.

$Na_2SO_4 + BaCl_2 \rightarrow BaSO_4\downarrow + 2NaCl$
White ppt.

NOTE

(i) Similarly sulphides as HgS (Black), PbS (Black), Bi_2S_3 (Black), CuS (Black), CdS (Yellow), As_2S_3 (Yellow), Sb_2S_3 (orange), SnS (Brown), SnS_2(Yellow) give precipitate.

(ii) Carbonates of 2[nd] group elements also give precipitate.

(D) Neutralisation Reactions :

Reaction between acids (contain replaceable H^+ ion) and bases (containing replaceable OH^- ion) is known as neutralisation reaction.

Examples :

$NaOH + HCl \rightarrow NaCl + H_2O$

$2\,KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$

Example Based on

Gravimetric analysis

Example.

Assuming that petrol is octane (C_8H_{18}) and has density 0.8 gm/ml, 1.425 litre of petrol on complete combustion will consume -

(A) 50 mole of O_2 (B) 100 mole of O_2

(C) 125 mole of O_2 (D) 200 mole of O_2

Solution.(C)

wt of 1.425 litre of petrol

$= 1.425 \times 10^3 \times 0.8$ gm

In 1.425 litre of petrol moles of C_8H_{18} present

$$= \frac{1.425\times 10^3 \times 0.8}{114} = 10$$

$$C_8H_{18} + \left(8+\frac{18}{4}\right) O_2 \longrightarrow 8\,CO_2 + \frac{18}{2}\,H_2O.$$

or $C_8H_{18} + 12.5\,O_2 \longrightarrow 8\,CO_2 + 9\,H_2O.$

$\therefore$ per 10 mole of C_8H_8, moles of O_2 required $= 12.5 \times 10 = 125$

Example.

1gm dry green algae absorbs 0.10528 lit of CO_2 at STP per hour by photosynthesis. If the fixed carbon atoms were all stored after the photosynthesis as starch $(C_6H_{10}O_5)_n$, how long would it take for algae to double its own weight assuming photosynthesis taking place at a constant rate.

Solution.

Let, time required to double the weight of algae = t hr.

So in t hr the amount of starch produced = 1 gm.

In 1 hr CO_2 uptake = 0.10528 lit at STP.

$$= \frac{0.10528}{22.4} \text{ mole}$$

In 1 mole of CO_2, moles of carbon present = 1.

$\therefore$ in 1 hr the amount of carbon assimilated $= \frac{0.10528}{22.4}$ mole.

$\therefore$ in t hr the amount of carbon assimilated = $\frac{0.10528}{22.4} \times$ t moles.

The entire amount of the carbon assimilated will be converted into starch.

The molecular wt. of starch = 162 n

From, 6n moles of carbon starch produced = 162 n gm

From, 1 mole of carbon starch produced

$= \frac{162n}{6n}$ gm

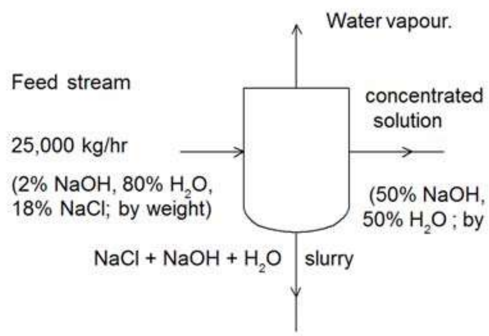
$$\therefore \quad \frac{162}{6} \times \frac{1.10528t}{22.4} = 1$$

$$\text{or} \quad t = \frac{22.4 \times 6}{162 \times 0.10528} = 7.88$$

so, given green algae need 7.88 hr to double its weight **Ans.**

Example.

Figure shows a scheme, for concentrating a dilute solution of NaOH



Calculate :

1. How much water evaporate per hour
2. How much concentrated solution obtained per hour

Solution.

Let per hour, slurry, concentrated solution and water vapour obtained x kg, y kg and z kg respectively.

By mass balance, we can write,

25, 000 = x + y + z ...(1)

By mass balance of NaOH, we can write,

25, 000 × 0.02 = 0.05 x + 0.5 y ...(2)

By mass balance of H_2O, we can write,

25, 000 × 0.8 = 0.05 x + 0.5 y + z ...(3)

By mass balance of NaCl, we can write,

25, 000 × 0.18 = x × 0.9 ...(4)

$\therefore$ x = 5000 kg/hr.

$$y = \frac{25000 \times 0.02 - 0.05 \times 5000}{0.5} = 500 \text{ kg/hr}$$

z = 25,000 × 0.8– 0.05 × 5000 – 0.5 × 500

= 19, 500 kg/hr

$\therefore$ Per hour water evaporate = 19,500 kg & per hour concentrated solution obtained = 500 kg **Ans.**

10. Limiting Reactants or Limiting Reagent

(a) In the single-reactant reactions, the calculations are carried out with only that amount of the reactant which has converted to the product.

(b) In the reactions where more than one reactants are involved, our first task prior to calculation is to determine the limiting reactant. Limiting reactant is such type of reactant which is completely consumed. All calculations has to be carried out with the amount of the limiting reactant only.

(c) How to find the limiting reactant !

$4\,A + 9\,B \longrightarrow 5$ moles of product

Now we have taken, 14 moles of A and 15 moles of B initially in the reaction mixture. Limiting reactant is the such type of reactant which is producing least number of moles of product. In the given example,

from, 4 moles of A, product produced = 5 moles

from 14 moles of A, product produced

$= \frac{5}{4} \times 14$ moles = 17.5 moles

from, 9 moles of B, product produced

$= \frac{5}{9} \times 15 = = \frac{75}{9}$ moles

Since reactant B is producing least number of moles of product, therefore, here B is the limiting reactant and it will be completely consumed and product will be produced on the basis of B.

Example Based on limiting reactants

Example.

A solution contains 11 gram Na_2CO_3, In this solution 11.1 gram $CaCl_2$ is added. Find out the mass of $CaCO_3$ formed.

Solution.

$CaCl_2 + Na_2CO_3 \rightarrow CaCO_3 + 2NaCl$

from equation molar ratio of reactant which will react is 1:1

Now moles of Na_2CO_3 in solution $= \frac{11}{106} > 0.1$

Moles of $CaCl_2$ in solution = $\frac{11.1}{111} = 0.1$

It means $CaCl_2$ is less in amount (In terms of moles) hence $CaCl_2$ is limiting reagent.

Now because $CaCl_2$ is limiting reagent hence it will convert completely to products because it has enough Na_2CO_3 to react.

Now 1 mole of $CaCl_2$ produces = 1 mole of $CaCO_3$

So 0.1 mole ————— = 0.1 mole of $CaCO_3$

So mass of $CaCO_3$ produced = 0.1 × 100 = 10 grams

11. Eudiometry

(a) To evaluate the composition of gases, they are allowed to react in a special type of tube known as Eudiometer tube. The tube is graduated in mm for volume measurement.

(b) The reacting gases taken in Eudiometer tube are exploded by sparks produced by passing electricity through the platinum terminals provided in the tube. The volumes of gaseous explosion products are determined by absorbing then in suitable reagents.

(c) For example,

(i) CO_2, SO_2 and Cl_2 are absorbed in the KOH solution,

(ii) O_2 is absorbed in alkaline pyrogallol, CO is absorbed in the solution of ammonical Cu_2Cl_2

(iii) O_3 is absorbed in turpentine oil.

(iv) NH_3 & HCl is absorbed in water.

(v) water vapour is absorbed in silicagel or anhydrous $CaCl_2$.

(d) The principle of eudioumetry is based on the principle of volume by volume relationship which is based on the Arogadro's law.

(e) We have already discussed the principle of volume by volume relationship, again we are reminding it. As per this principle, at the same temperature and pressure the volume of reacting gases and gaseous products maintain the same moles ratio as it was in the balanced chemical equation.

(f) Eudiometry is applied mainly to determine the composition of gas mixture and the molecular formula of gaseous reactants.

Example Based on Eudiometry

Example.

10 ml of gaseous hydrocarbon on combustion gives 40 ml. of CO_2 (g) and 50 ml of H_2O (vap). The hydrocarbon is -

(A) C_4H_5 (B) C_8H_{10} (C) C_4H_8 (D) C_4H_{10}

Solution.(D)

$$C_x H_y + \left(x + \frac{y}{4}\right) O_2 \longrightarrow x\, CO_2 + \frac{y}{2} H_2O$$

$$1010 \quad \left(x + \frac{y}{4}\right) \qquad 10\,x \quad 5y\, H_2O$$

$\therefore$ 10 x = 40 or x = 4

5 y = 50 or y = 10

$\therefore$ molecular formula of hydrocarbon is C_4H_{10}

Example.

In gaseous reaction of the type aA + bB $\longrightarrow$ cC + dD, which of the following is wrong ?

(A) a litre of A combines with b litre of B to give C and D

(B) a mole of A combines with b mole of B to give C and D

(C) a gm of A combines with b gm of B to give C and D

(D) a molecule of A combines with b molecules of B to give C and D

Solution.(C)

Atomic weights of A and B are unknown so, we cannot say, a gm of A combines with b gm of B to give C and D as per option (C).

Example.

50 ml of dry ammonia gas was sparked for a long time in an eudiometer tube over mercury. After sparkling, the volume becomes 97 ml. After washing the gas with water and drying, the volume becomes 94 ml. This was mixed with 60.5 ml of oxygen and the mixture was burnt. After the completion of the combustion of H_2, the volume of residual gas was 48.75 ml. Derive the molecular formula of ammonia. (Given, N and H are only present in ammonia molecule).

Solution.

Let molecular formula of ammonia is N_xH_y.

$N_x\ H_y \longrightarrow \frac{x}{2}N_2 + \frac{y}{2}H_2$ (reaction due to sparking)

1 vol. $\quad \frac{x}{2}$ vol $\quad \frac{y}{2}$ vol

(50 – a) ml $\quad \frac{ax}{2}$ ml $\quad \frac{ay}{2}$ ml (After the sparking)

Here we have considered a ml of $N_x\ H_y$ has been decomposed due to sparkling.

∴ final volume of gas mixture

$$= (50 - a) + \frac{ax}{2} + \frac{ay}{2} = 97$$

Again due to washing with water ammonia will removed, therefore volume reduction due to washing of the gas mixture with water = volume of unreacted ammonia.

∴ 50 – a = 3 or a = 47

$$\therefore \frac{ax}{2} + \frac{ay}{2} = 97 - (50 - a) = 97 - 3 = 94$$

$$\text{or} \quad \frac{x}{2} + \frac{y}{2} = \frac{94}{a} = \frac{94}{47} = 2 \text{ or } x + y = 4 \quad ...(1)$$

Among the gas remaining after washing H_2 will completely react with O_2.

$$H_2(g) + \frac{1}{2}\ O_2\ (g) \rightarrow H_2O\ (\ell)$$

$\frac{ay}{2}$ ml $\qquad \frac{ay}{4}$ ml

$$\therefore \text{ residual } O_2 = \left(60.5 - \frac{ay}{4}\right) \text{ \& unreacted } N_2 = \frac{ax}{2}$$

$$\therefore \quad \frac{ay}{2} + 60.5 - \frac{ay}{4} = 48.75$$

$$\text{or} \quad a\left(\frac{x}{2} - \frac{y}{4}\right) = 48.75 - 60.5 = -11.75$$

$$\text{or} \quad a\left(\frac{y}{4} - \frac{x}{2}\right) = 11.75$$

$$\text{or} \quad \frac{y}{4} - \frac{x}{2} = \frac{11.75}{47} = 0.25$$

or $\quad y - 2x = 1 \qquad ...(2)$

$2x + 2y = 4 \times 2 = 8$

$y - 2x = 1$

$3y = 9$

∴ $x = 4 - y = 4 - 3 = 1$ or $y = 3$

∴ molecular formula of ammonia is NH_3

Ans.

12. Concentration Terms

12.1 Weight by weight (w/w), weight by volume (w/v), volume by volume (v/v) percentage and mole percentage :

(a) Density (ρ) = $\frac{\text{Mass of the substance}}{\text{Volume of the surface}}$

In C.G.S. and MKS units, density is expressed in gm/cm^3 or gm/ml and kg/m^3 respectively.

(b) specific gravity (d) =

$$\frac{\text{Mass of V volume of substance at } t°C}{\text{Mass of V volume of water at } t°C}$$

(c) For simplification, we can conclude that the density and specific gravity of any substance is numerically same, but density has a definite unit, but specific gravity has no unit.

(d) Weight by weight percentage (%w/w)

or percentage by weight

$$= \frac{\text{weight of solute}}{\text{weight of solution}} \times 100$$

(e) Weight by volume percentage (%w/v)

or percentage by volume

$$= \frac{\text{weight of solute}}{\text{volume of solution}} \times 100$$

(f) Volume by volume percentage (%v/v)

or percentage by strength

$$= \frac{\text{volume of solute}}{\text{volume of solution}} \times 100$$

(g) mole percentage (%mol/mol)

or percentage by moles

$$= \frac{(\text{Moles of solute})}{(\text{Moles of solute} + \text{moles of solvent})} \times 100$$

(h) Do remember, for the calculation of strength (%w/w, %w/v etc) the solute must be completely dissolved into the solution, otherwise, the given terminologies will be invalid.

For example, the specific gravity of gold = 19.3 gm/cm^3, if we add 193 gm gold powder in 1 litre of water, its % w/w = $\frac{193}{1000+193}$ × 100 = 16.17 is appears to be correct, but gold is not dissolvable in water, its % w/w in water cannot be calculated.

(i) A 65% solution has the following meanings 65% by weight i.e. 100 gm solution contain 65 gm solute. 65% by volume i.e. 100 ml of solution contain 65 ml solute. 65% by strength i.e. 100 ml of solution contain 65 gm solute. If, anything is not specified, 65% generally mean 65% by mass.

(j) For concentrated acids, like 98% H_2SO_4, 65% HNO_3 etc, if anything is not specified than percentage by mass/volume is usually considered.

Example Based on

W/W, W/V, V/V, and mole percentage

Example.

What is the mole fraction of ethanol in 20% by weight solution in water ?

(A) 0.095 (B) 0.089

(C) 0.9 (D) 1.2

Solution.(B)

100 gm of solution contain 20 gm C_2H_5OH and 80 gm of water

∴ moles of ethanol present = $\frac{20}{46}$ = 0.435 (mol. wt of ethanol = 46)

∴ moles of water present = $\frac{80}{18}$ = 4.444

Total no. of moles = 0.435 + 4.444 = 4.879

∴ mole fraction of C_2H_5OH = $\frac{0.435}{4.879}$ = 0.089

Example.

When 10 ml of ethanol of density 0.7893 gm/ml is mixed with 20 ml of water of density 0.9971 gm/ml at 25°C, the final solution has a density of 0.9571 gm/ml. Calculate the percentage change in total volume on mixing.

Solution.

Mass of 10 ml of ethanol = 10 × 0.7893 = 7.893 gm.

Mass of 20 ml of water = 20 × 0.9971 = 19.94 gm.

Total mass of solution = 19.94 + 7.893 = 27.83 gm.

∴ The actual volume of solution = $\frac{27.83}{0.9571}$

= 29.08 ml.

Added volume of the two solution = 10 + 20 = 30 ml

∴ change in volume due to mixing = 30 – 29.08 = 0.92 ml.

∴ percentage change in volume due to mixing

= $\frac{0.92}{30}$ × 100 = 3.067% (contraction) **Ans.**

Example.

The specific gravity of a solution is 1.8, having 62% by weight of acid. It is to be diluted to specific gravity of 1.2. What volume of water should be added to 100 ml of this solution ?

Solution.

Let, to 100 ml of given acid solution (Specific Gravity. 1.8) x ml. of water is added.

∴ the total volume of resulting solution = (100 + x) ml

∴ the total weight of resulting solution

= (100 + x) 1.2 gm.

weight of acid present in the given acid solution (per 100 ml) = 100 × 1.8 × 0.62

∴ the amount of water present in 100 ml of given acid solution = 1.8 × 100 × 0.38

∴ total wt of acid present in the diluted solution = (100 + x) 1.2 – x – 180 × 0.38

= 1.8 × 100 × 0.62

∴ 120 + 0. 2x = 180 or x = 300

∴ to lower sp. gravity of the given acid solution to 1.2, we are to add 300 ml of water per 100 ml of acid solution (sp gr. 1.2). **Ans.**

Example.

Fool's gold is so called because it bears a visual similarity to real gold. A block of fool's gold which measures 1.50 cm × 2.50 cm × 3.00 cm has a mass of 56.25 gm. The density of real gold is 19.3 gm/ml. What is the ratio of densities of Fool's gold to real gold ?

Solution.

The volume of Fool's gold = 1.50 × 2.50 × 3.00

= 11.25 cm^3 the density of Fool's gold

= $\frac{56.25}{11.25}$ gm/cm^3

∴ the ratio of densities Fool's gold to real gold is = $\frac{56.25}{11.25}/19.3$ = 0.259 **Ans.**

12.2 **<u>Parts per million (ppm), gm/litre, molarity, formality and molality</u> :**

(a) **Parts per million (ppm)** : It means the number of parts of solute per million parts of the weight of solution. It can be easily corelated with the % w/w or % w/v of the solution.

Let us consider m_1 gm. of solute 'x' is dissolved in m_2 gm of solvent.

∴ m_1 gm of 'X' present in (m_1 + m_2) gm of solution

$\therefore$ $(m_1 + m_2)$ gm of solution contain m_1 gm solute

$\therefore$ 10^6 gm of solution contain

$\frac{m_1}{m_1 + m_2} \times 10^6$ gm of solute

$\therefore$ ppm concentration of 'X' in the given solution = $\frac{m_1}{m_1 + m_2} \times 10^6$.

(b) Gram per litre (gm/lit) : It is the amount of solute in gm dissolved in 1 litre (1000 ml) of solution. It is one of higher unit of % mass by volume.

(c) Formality : It is the number of formula units of solute dissolved in 1 litre (1000 ml) of solution. It is similar to that of molarity.

$$\text{Formality} = \frac{\text{Number of formula units of solute}}{\text{volume of solution (in litres)}}$$

For ionic substances, since there is no actual existence of molecule or mole, so instead of molecular weight we are using the formula weight.

For example, in 20 ml of solution 7.45 gm. of KCl is present, what is the formality of the given solution ?

The formula weight of

KCl = 39 + 35.5 = 74.5

$\therefore$ 7.45 gm KCl = $\frac{7.45}{74.5}$

= 0.1 formula unit of KCl

In 20 ml of solution the number of formula units of KCl present = 0.1

In 10^3 ml of solution the number of formula units of KCl present

$= \frac{0.1}{20} \times 10^3 = 0.1 \times 50 = 5$

Hence, the strength of the solution = 5(F) where, F stands for formality.

(d) Molality : It is the number of moles of solute present per 1000 gm (1 kg) of solvent in a given solution.

$$\text{molality} = \frac{\text{Number of moles of solute}}{\text{weight of solvent (in kg.)}}$$

Let us consider, m_1 gm. of solute (mol. wt M_1) is dissolved in m_2 gm of solvent.

$\therefore$ per m_2 gm of solvent moles of solute present = $\frac{m_1}{M_1}$

$\therefore$ per 10^3 gm of solvent moles of solute present = $\frac{m_1}{M_1} \times \frac{1}{m_2} \times 10^3$

Hence the molality of solution (symbol m) $= \frac{m_1}{M_1} \times \frac{1}{m_2} \times 10^3$

If $m_1 = 10$, $M_1 = 250$ and $m_2 = 100$, the strength = $\frac{10}{250} \times \frac{1}{100} \times 10^3 = 0.4$ (m).

Where, m stands for molality.

(e) Molarity : It is the number of moles of solute present per litre of solution.

$$\text{molarity} = \frac{\text{Number of moles of solute}}{\text{volume of solution (in litres)}}$$

If m_1 gm. of solute (mol. wt M_1) is dissolved in m_2 gm of solvent and if the density of resulting solution is ρ_s gm/ml then, molarity

(M) = $\frac{m_1 \times \rho_s}{M_1(m_1 + m_2)}$

1.80 gm. of glucose ($C_6H_{12}O_6$) is dissolved in 50 ml of solution, what will be the molarity of the resulting solution ?

The molecular weight of glucose

= 6 × 12 + 12 × 1 + 16 × 6 = 180

$\therefore$ 1.80 gm glucose = $\frac{1.80}{180}$ = 0.01 mole of glucose

In 50 ml of solution the number of moles of $C_6H_{12}O_6$ present = 0.01 mole

$\therefore$ In 10^3 ml of solution the number of moles of $C_6H_{12}O_6$ present

$= \frac{0.01}{50} \times 10^3 = 0.2$ mole

Hence, the strength of the solution = 0.2 (M). Here, symbol (M) stands for molarity.

Now to calculate the number of moles of urea present in 150 ml of 0.05 (M) solution.

The word 0.05 (M) solution implies that in 1000 ml of the given solution 0.05 moles of urea present

In 150 ml of the given solution = $\frac{0.05}{1000} \times$ 150 moles of urea present

= 0.75×10^{-3} moles of urea present

(Now, 1 mole = 10^3 milli moles) = 0.75 milli moles of urea present

(f) Let us consider, the molarity, molality and density (gm/ml) of a solution are M, m and ρ_s respectively. We are to find out a relation among M, m and ρ_s. Given that the molecular weight of solute is M.

From the given data we can write,

10^3 ml of solution contain M moles of solute

$\Rightarrow$ 10^3 ml of solution contain MM^1 gm of solute

$\Rightarrow$ $10^3 \times \rho_s$ gm of solution contain MM^1 gm of solute

$\therefore$ the weight of solvent present in 10^3 ml of solution = $(10^3 \times \rho_s - MM')$ gm

$\therefore$ 6 molality of solution (m)

$$= \frac{M \times 10^3}{(10^3 \times \rho_s - MM')}$$

or $\frac{1}{m} = \frac{10^3 \rho_s - MM'}{M \times 10^3}$ or $\frac{1}{m} = \frac{\rho_s}{M} - \frac{M'}{10^3}$

or $\frac{\rho_s}{M} = \frac{1}{m} + \frac{M'}{10^3}$

or

$$\frac{1}{M} = \frac{1}{\rho_s}\left(\frac{1}{m} + \frac{M'}{10^3}\right) = \frac{1}{\rho_s}\left(\frac{1}{m} + 10^{-3} \times M'\right)$$

Example Based on

Formality, molarity, molality and ppm

Example.

In a solution the concentration of $MgCl_2$ is 5 (m), the sp gravity of the solution is 1.05 the concentration of Cl^- in the solution is -

(A) 10 (M) (B) 20 (M)

(C) 18.5 (M) (D) 7.12 (M)

Solution. (D)

$$\frac{1}{M} = \frac{1}{\rho_s}\left(\frac{1}{m} + 10^{-3} \times M'\right)$$

$M' = 24 + 71 = 95$ $\rho_s = 1.05$

$$\therefore \quad \frac{1}{M} = \frac{1}{1.05}\left(\frac{1}{5} + 0.095\right)$$

or $M = 3.56$ or $\frac{1}{M} = 0.28095$

$\therefore$ molarity of $MgCl_2 = 3.56$

$\therefore$ concentration of $Cl^- = 3.56 \times 2 = 7.12$ (M)

13. Basic of Ideal Gas Equation

When the molecular forces of attraction between the particles of a matter are minimum, the particles exist in a state known as gaseous state or a state of matter in which molecules are far away from each other and free to move in available space is called gaseous state.

13.1 Properties of Gases

(i) They do not have definite shape and volume.
(ii) They can occupy whole space open to then.
(iii) Gases have unlimited dispensability and high compressibility.
(iv) They have very low densities because of negligible intermolecular forces.
(v) Gases exerts pressure on the wall of the container with perfectly elastic collisions.
(vi) They diffuse rapidly through each other to form homogeneous mixture against the electric, magnetic and gravitational field.

13.2 Parameters of Gases

The characteristics of gases are described in terms of four measurable parameters and it is also called as measurable properties of gases which are

(i) Mass (ii) Volume
(iii) Pressure and (iv) Temperature

13.2.1 Mass (m) - The mass of a gas is denoted by 'm' which is related to the no of moles 'n'.

Therefore,

$$n \text{ (no of moles)} = \frac{m(\text{mass in grams})}{M(\text{Molar mass})}$$

so, $m = n \times M$

13.2.2 Volume V-

(i) Gases occupy whole space available to then. The volume occupy by a gas is simply the volume of container in which it is filled.
(ii) The volume of a gas is denoted by 'V' and it is measured in units of litre or cubic metre (m^3) or cm^3 or dm^3.
(iii) 1 litre = 1 dm^3 = 1000 cm^3 = 1000 ml

13.2.3 Pressure (P)-

(i) It is force acting per unit area. A confined gas exerts uniform pressure on the walls of its container in all the direction.

(ii) It is denoted by 'P' and specified in pascal (P_a).

(iii) Other units of pressure are atm, cm hg, mmHg, N/m^2, bar, torr.

(iv) 1 atm = 76 cm Hg = 760 mm Hg

$= 1.013 \times 10^5\ N/m^2 = 1.013 \times 10^5\ P_a$

$= 1.013$ bar = 760 torr.

(v) $P\ (\text{Pressure}) = \dfrac{F(\text{Force})}{A(\text{Area})}$

$= \dfrac{\text{Mass} \times \text{Acceleration}}{\text{Area}}$

(vi) Pressure exerted by a gas is due to kinetic energy (K.E. = ½ mv^2) of the gases molecules.

(vii) K.E. of the gas molecules increases, as the temperature is increased so, pressure of a gas is directly proportional to temperature. $P \propto T$

13.2.4 Temperaturoe (T)-

(i) The temperature of a gas is denoted by 'T' and it is measured in the unit of kelvin (K).

(ii) Other units of temperature are,°C, °F, °R.

(iii) K = °C + 273.15

(iv) $\dfrac{x^\circ C}{5} = \dfrac{(y^\circ f - 32)}{9}$

14. Gas Laws

The certain laws which relate the four parameters are called gas laws.

14.1 Boyle's Law

(i) It states that at constant temperature, the volume of a given mass of a gas is inversely proportional to the pressure.

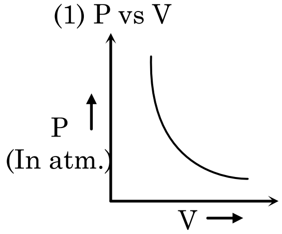
(ii) Mathematically -

$P \propto \dfrac{1}{V}$ (at constant temperature)

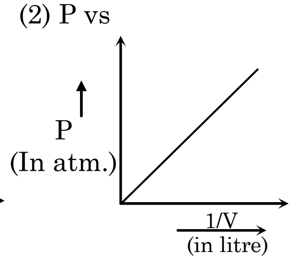
or PV = K or $P_1V_1 = P_2V_2$

(iii) Graphical representations

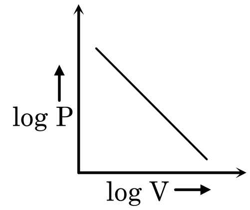
(1) P vs V



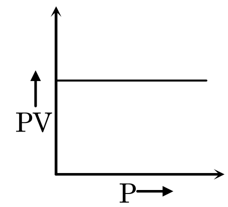
(2) P vs



(3) log P vs, log V



(4) PV vs P



14.2 Charle's law

(i) This law states that at constant pressure, the volume of a given mass of a gas is directly proportional to its absolute temperature.

(Absolute temperature = °C + 273.15)

(ii) Mathematically -$V \propto T$ (at constant pressure)

V = volume of gas

T = Absolute temperature

V = KT or

$\dfrac{V}{T} = K$

Hence, if the volume of a gas of mass is V_1 at temperature T_1 changes to V_2 at T_2, pressure remaining constant,

then $\dfrac{V_1}{T_1} = \dfrac{V_2}{T_2}$ = constant

or log V – log T = constant

(iii) For each degree change of temperature the volume of sample of a gas changes by the fraction of $1/273.15$ of its volume at 0 °C

so $V_t = V_0 \left[\dfrac{273.15 + t}{273.15}\right]$

This equation is called Charles-gay-lussac equation.

where

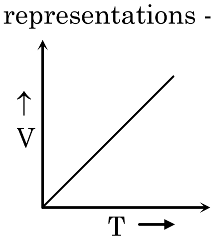
V_t = volume of gas at temperature t °C

V_0 = volume of gas at 0 °C temperature

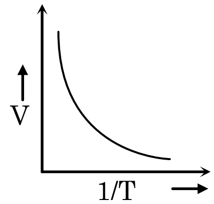
t = temperature in °C.

(iv) Graphical representations -

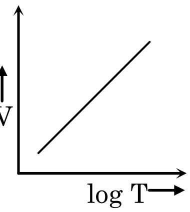
(1) V vs T



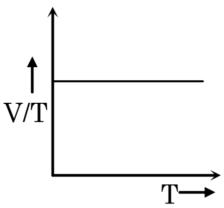
(2) V vs $\frac{1}{T}$ or T vs $\frac{1}{V}$



(3) log V vs log T, logV



(4) $\frac{V}{T}$ vs T V/T



14.3 Gay-Lussac's Law or Amonton's Law

(i) It states that at constant volume, the pressure of a given mass of a gas is directly proportional to its absolute temperature.

(ii) Mathematically - P $\propto$ T (at constant volume)

where P = pressure of gas

T = Absolute temperature

P = KT

or $\frac{P}{T}$ = K

Hence , if the pressure of a gas is P_1 at temperature T_1 changes to P_2 at T_2, volume remaining constant.

then $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ = constant

log P – log T = constant.

(iii) $P_t = P_o\left(1+\frac{t}{273.15}\right)$

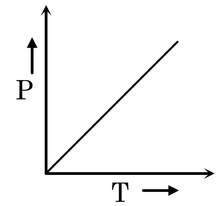
where P_t = Pressure of gas at t °C

P_o = Pressure of gas at 0 °C

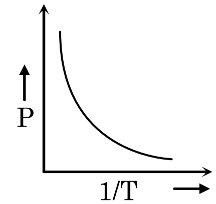
t = Temperature in °C.

(iv) Graphical representation –

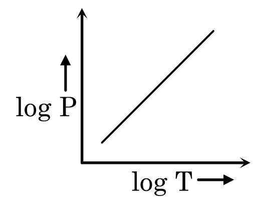
(1) P vs T



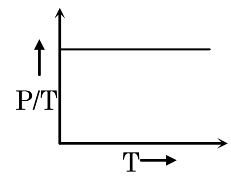
(2) P vs 1/T or T vs 1/P



(3) log P vs log T



(4) $\frac{P}{T}$ V_s T



14.4 Ideal gas equation

(i) It correlate all the four parameters of a gas.

(ii) It is the combination of Boyle's and charle's law.

(iii) PV = nRT

$PV = \frac{m}{M}RT$

The equation is called as ideal gas equation.

Where n = no of moles of the gas

m = mass of the gas

M = Mol. wt. of the gas

R = Molar gas constant.

(iv) For 1 mole of the gas n = 1

PV = RT

So $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} = R$ or $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

Where P_1, V_1, T_1 are the initial pressure, volume and temperature and P_2, V_2 T_2 are final.

The above equation is called as ideal gas equation.

(v) The unit of R is the unit of work or energy per degree per mole as -

$$R = \frac{PV}{nT} = \frac{\text{Pressure} \times \text{Volume}}{\text{mole} \times \text{Temperature}}$$

$$R = \frac{\frac{\text{force}}{\text{Area}} \times \text{volume}}{\text{mole} \times \text{Temperature}}$$

$$= \frac{\text{force} \times \text{length}}{\text{mole} \times \text{Temperature}}$$

$$R = \frac{\text{work(energy)}}{\text{mole} \times \text{Temperature}}$$

(vi) Numerical values of R in different units -

- $R = 0.0821$ litre atm. deg.$^{-1}$ mole^{-1}
- $R = 62.4$ litres mm. deg.$^{-1}$ mole^{-1}
- $R = 8.314 \times 10^7$ ergs deg.$^{-1}$ mole^{-1}
- $R = 82.05$ C.C.atm. deg.$^{-1}$ mole^{-1}
- $R = 2$ cals. deg.$^{-1}$ mole^{-1}
- $R = 8.314$ J K^{-1} mole^{-1}

15. Dalton's Law of Partial Pressure

(a) According to this law, when two or more than two chemically inert gases are kept in a closed container, the total pressure exerted by the gaseous mixture is equal to the sum of the partial pressures of individual gases - i.e.-

$$P = P_1 + P_2 + P_3 + ... + P_n$$

(b) Let n_1 & n_2 be the no. of moles of two inert gases A and B which is filled in a container of volume 'V' at temperature T. So the total pressure of container 'P' may be calculated as-

$$PV = (n_1 + n_2) RT \quad ....(i)$$

Partial pressure of individual gas calculates at-

$$P_AV = n_1 RT \quad ....(ii)$$

$$P_BV = n_2 RT \quad ....(iii)$$

On the addition of eq. (ii) & (iii) we get -

$$(P_A + P_B) V = (n_1 + n_2) RT \quad ....(iv)$$

On the comparison of eq. (i) & (iv)

$$P = P_A + P_B$$

Dividing by equation (ii) by (i), we get

$$\frac{P_A}{P} = \frac{n_1}{n_1 + n_2} = x_A$$

$$P_A = x_A \times P$$

where x_A = mole fraction of 'A'

Similarly dividing (iii) by (i), we get

$$P_B = x_B \times P$$

so partial pressure of a component

= mole fraction × total pressure

15.1 Applications of Dalton's Law of Partial pressure

(i) mole fraction of a gas in a mixture of gas

$$= \frac{\text{partial pressure of gas}}{\text{Total pressure of the mixture of gas}}$$

(ii) % of a gas in a mixture

$$= \frac{\text{partial pressure of gas}}{\text{Total pressure}} \times 100$$

(iii) Pressure of dry gas which is collected over the water is-

$$P_{Total} = P_{moist\ air} = P_{dry\ gas} + P_{water\ vapour}$$

(**Note :** $P_{water\ vapour}$ is called aqueous tension)

so $P_{dry\ gas} = P_{Total} - P_{Water\ vapour}$

(**Note:** Aqueous tension is directly proportional to absolute temperature)

15.2 Limitations of Dalton's law of partial pressure

(i) It is applicable only inert gases like N_2 and O_2, N_2 and Cl_2 etc.

(ii) It is not applicable for chemically reactive gases like H_2 and Cl_2, CO and Cl_2 etc.

16. Avagadro's Law

(a) According to this law under the same condition of temperature and pressure, equal volumes of all gas contains equal no. of molecules.

$V \propto n$ (At constant temperature & pressure)

Where V = volume

n = no of molecules

(b) Molar Volume or gram molecular volume - 22.4 litres or 22400 ml of every gas at NTP is the volume occupied by its one gram mole and it is called molar volume or gram molecular volume.

(c) The mole Concept - Mole is defined as the total amount of substance that contains as many basic units as there are atoms in 12 g of the isotopes of carbon -12. Thus a mole will be defined as the Avogadro no of particles which is equal to 6.023×10^{23}.

(d) Loschmidt number - It the no of molecules present in the volume of a gas at S.T.P. Its value is 2.617×10^{19} per c.c.

SOLVED EXAMPLES

Ex.1 8 litre of H_2 and 6 litre of Cl_2 are allowed to react to maximum possible extent. Find out the final volume of reaction mixture. Suppose P and T remains constant throughout the course of reaction -

(A) 7 litre (B) 14 litre

(C) 2 litre (D) None of these.

Sol.(B)

	H_2 +	Cl_2 →	2HCl
Vol. before reac.	8 lit	6 lit	0
Vol. after reac.	2	0	12

∴ Volume after reaction

= Volume of H_2 left + Volume of HCl formed

= 2 + 12 = 14 lit

Ex.2 Naturally occurring chlorine is 75 % Cl^{35} and 25 % Cl^{37}. Calculate the average atomic mass of chlorine-

(A) 35.5 amu

(B) 36.5 amu

(C) 71 amu

(D) 72 amu

Sol.(A) Average atomic mass

$$= \frac{\%\text{ of I isotope} \times \text{its at. mass} + \%\text{ of II isotope} \times \text{Its at. mass}}{100}$$

$$= \frac{(75 \times 35) + (25 \times 37)}{100} = 35.5 \text{ amu.}$$

Ex.3 Calculate the mass in gm of 2g atom of Mg-

(A) 12 gm (B) 24 gm

(C) 6 gm (D) None of these.

Sol.(D) ∵ 1 gm atom of Mg has mass = 24 gm

∴ 2 gm atom of Mg has mass

= 24 x 2 = 48 gm.

Ex.4 Calculate the weight of one atom of Ag – (At. wt. of Ag = 108)

(A) 17.93×10^{-23}gm (B) 16.93×10^{-23} gm

(C) 17.93×10^{23} gm (D) 36×10^{-23} gm

Sol.(A) ∵ N atoms of Ag weigh 108 gm

∴ 1 atom of Ag weigh = $\frac{108}{N}$

$$= \frac{108}{6.023 \times 10^{23}} = 17.93 \times 10^{-23} \text{ gm.}$$

Ex.5 In 5g atom of Ag (at. wt. = 108), calculate the no. of atoms of Ag -

(A) 1 N (B) 3N

(C) 5 N (D) 7 N

Sol.(C) ∵ 1 gm atom of Ag has atoms = N

∴ 5 gm atom of Ag has atoms = 5N.

Ex.6 Calculate the mass in gm of 2N molecules of CO_2 -

(A) 22 gm

(B) 44 gm

(C) 88 gm

(D) None of these.

Sol.(C) ∵ N molecules of CO_2 has molecular mass = 44.

∴ 2N molecules of CO_2 has molecular mass = 44 × 2 = 88 gm.

Ex.7 How many carbon atoms are present in 0.35 mol of $C_6H_{12}O_6$ -

(A) 6.023×10^{23} carbon atoms

(B) 1.26×10^{23} carbon atoms

(C) 1.26×10^{24} carbon atoms

(D) 6.023×10^{24} carbon atoms

Sol.(C) ∴ 1 mol of $C_6H_{12}O_6$ has = 6 N atoms of C

∴ 0.35 mol of $C_6H_{12}O_6$ has

= 6 × 0.35 N atoms of C = 2.1 N atoms

= $2.1 \times 6.023 \times 10^{23}$

= 1.26×10^{24} carbon atoms

Ex.8 How many molecules are in 5.23 gm of glucose ($C_6H_{12}O_6$) -

(A) 1.65×10^{22} (B) 1.75×10^{22}

(C) 1.75×10^{21} (D) None of these

Sol.(B) ∵ 180 gm glucose has = N molecules

∴ 5.23 gm glucose has = $\frac{5.23 \times 6.023 \times 10^{23}}{180}$

= 1.75×10^{22} molecules

Ex.9 What is the weight of 3.01×10^{23} molecules of ammonia -

(A) 17 gm

(B) 8.5 gm

(C) 34 gm

(D) None of these

Sol. (B) $\because$ 6.023×10^{23} molecules of NH_3 has weight = 17 gm

$\therefore$ 3.01×10^{23} molecules of NH_3 has

weight = $\frac{17 \times 3.01 \times 10^{23}}{6.023 \times 10^{23}}$ = 8.50 gm

Ex.10 How many molecules are present in one mℓ of water vapours at STP -

(A) 1.69×10^{19} (B) 2.69×10^{-19}

(C) 1.69×10^{-19} (D) 2.69×10^{19}

Sol.(D) $\because$ 22.4 litre water vapour at STP has = 6.023×10^{23} molecules

$\therefore$ 1×10^{-3} litre water vapours at STP has

= $\frac{6.023 \times 10^{23}}{22.4} \times 10^{-3} = 2.69 \times 10^{+19}$

Ex.11 How many years it would take to spend Avogadro's number of rupees at the rate of 1 million rupees in one second -

(A) 19.098×10^{19} years

(B) 19.098 years

(C) 19.098×10^{9} years

(D) None of these

Sol.(C) $\because$ 10^6 rupees are spent in 1sec.

$\therefore$ 6.023×10^{23} rupees are spent in

= $\frac{1 \times 6.023 \times 10^{23}}{10^6}$ sec

= $\frac{1 \times 6.023 \times 10^{23}}{10^6 \times 60 \times 60 \times 24 \times 365}$ years

= 19.098×10^9 year

Ex.12 An atom of an element weighs 6.644×10^{-23} g. Calculate g atoms of element in 40 kg-

(A) 10 gm atom

(B) 100 gm atom

(C) 1000 gm atom

(D) 10^4 gm atom

Sol.(C) $\because$ weight of 1 atom of element

= 6.644×10^{-23} gm

$\therefore$ weight of 'N' atoms of element

= $6.644 \times 10^{-23} \times 6.023 \times 10^{23}$

= 40 gm

$\because$ 40 gm of element has 1 gm atom.

$\therefore$ 40×10^3 gm of element has $\frac{40 \times 10^3}{40}$

= 10^3 gm atom.

Ex.13 Calculate the number of Cl^- and Ca^{+2} ions in 222 g anhydrous $CaCl_2$ -

(A) 2N ions of Ca^{+2} 4 N ions of Cl^-

(B) 2N ions of Cl^- & 4N ions of Ca^{+2}

(C) 1N ions of Ca^{+2} & 1N ions of Cl^-

(D) None of these.

Sol.(A) $\because$ mol. wt. of $CaCl_2$ = 111 g

$\because$ 111 g $CaCl_2$ has = N ions of Ca^{+2}

$\therefore$ 222g of $CaCl_2$ has $\frac{N \times 222}{111}$

= 2N ions of Ca^{+2}

Also $\because$ 111 g $CaCl_2$ has = 2N ions of Cl^-

$\therefore$ 222 g $CaCl_2$ has $\frac{2N \times 222}{111}$ = ions of Cl^-

= 4N ions of Cl^- .

Ex.14 The density of O_2 at NTP is 1.429g / litre. Calculate the standard molar volume of gas-

(A) 22.4 lit.

(B) 11.2 lit

(C) 33.6 lit

(D) 5.6 lit.

Sol.(A) $\because$ 1.429 gm of O_2 gas occupies vol.= 1 litre.

$\therefore$ 32 gm of O_2 gas occupies = $\frac{32}{1.429}$

= 22.4 litre/mol.

Ex.15 Which of the following will weight maximum amount-

(A) 40 g iron

(B) 1.2 g atom of N

(C) 1×10^{23} atoms of carbon

(D) 1.12 litre of O_2 at STP

Sol.(A) (A) Mass of iron = 40 g

(B) Mass of 1.2 g atom of N

= $14 \times 1.2 = 16.8$ gm

(D) Mass of 1×10^{23} atoms of C

= $\frac{12 \times 1 \times 10^{23}}{6.023 \times 10^{23}}$ = 1.99 gm.

(D) Mass of 1.12 litre of O_2 at STP

= $\frac{32 \times 1.2}{22.4}$ = 1.6 g

Ex.16 How many moles of potassium chlorate to be heated to produce 11.2 litre oxygen -

(A) $\frac{1}{2}$ mol (B) $\frac{1}{3}$ mol

(C) $\frac{1}{4}$ mol (D) $\frac{2}{3}$ mol.

Sol.(B) $2\ KClO_3 \rightarrow 2KCl + 3O_2$

Mole for reaction 2 2 3

$\because$ 3 × 22.4 litre O_2 is formed by 2 mol $KClO_3$

$\therefore$ 11.2 litre O_2 is formed by $\frac{2 \times 11.2}{3 \times 22.4}$

$= \frac{1}{3}$ mol $KClO_3$

Ex.17 Calculate the weight of lime (CaO) obtained by heating 200 kg of 95% pure lime stone ($CaCO_3$).

(A) 104.4 kg (B) 105.4 kg

(C) 212.8 kg (D) 106.4 kg

Sol.(D) $\because$ 100 kg impure sample has pure $CaCO_3$ = 95 kg

$\therefore$ 200 kg impure sample has pure $CaCO_3$

$= \frac{95 \times 200}{100} = 190$ kg.

$CaCO_3 \rightarrow CaO + CO_2$

$\because$ 100 kg $CaCO_3$ gives CaO = 56 kg.

$\therefore$ 190 kg $CaCO_3$ gives CaO = $\frac{56 \times 190}{100}$

= 106.4 kg.

Ex.18 The chloride of a metal has the formula MCl_3. The formula of its phosphate will be-

(A) M_2PO_4 (B) MPO_4

(C) M_3PO_4 (D) $M(PO_4)_2$

Sol.(B) MCl_3 indicates that metal is trivalent.

Ex.19 A silver coin weighing 11.34 g was dissolved in nitric acid. When sodium chloride was added to the solution all the silver (present as $AgNO_3$) was precipitated as silver chloride.

The weight of the precipitated silver chloride was 14.35 g. Calculate the percentage of silver in the coin -

(A) 4.8 % (B) 95.2%

(C) 90 % (D) 80%

Sol.(B) $Ag + 2HNO_3 \rightarrow AgNO_3 + NO_2 + H_2O$

108

$AgNO_3 + NaCl \rightarrow AgCl + NaNO_3$

143.5

$\therefore$ 143.5 gm of silver chloride would be precipitated by 108 g of silver.

or 14.35 g of silver chloride would be precipitated 10.8 g of silver.

$\because$ 11.34 g of silver coin contain 10.8 g of pure silver.

$\therefore$ 100 g of silver coin contain $\frac{10.8}{11.34} \times 100$

= 95.2%.

Ex.20 If the Faraday were to be 60230 coulombs instead of 96500 coulombs, what will be the charge on an electron ?

Sol. One mole electron carries 1 Faraday charge.

As 6.023×10^{23} electrons carry = 60230 C

So 1 electron carries

$= \frac{60230}{6.023 \times 10^{23}}$ C = $\mathbf{1 \times 10^{-19}}$ **C**.

Ex.21 On heating 0.199 g of a metallic oxide in a current of hydrogen 0.045 g of water is formed. Find the equivalent weight of the metal.

Sol. Weight of Metallic oxide = 0.199 g

As 16 g oxygen is present in = 18 g H_2O

So O_2 present in 0.045 g H_2O

$= \frac{16 \times 0.045}{18} = 0.04$ g

Weight of metal

= 0.199 – 0.04 = 0.159

Equivalent weight of metal

$= \frac{0.159 \times 8}{0.04}$

= 31.8

Ex.22 10 ml of 0.02 M $KMnO_4$ is required to oxidize 20 ml of oxalic acid of certain strength. 25 ml of the same oxalic acid is required to neutralize 20 ml of NaOH of unknown strength. Find the amount of NaOH in a litre of the solution.

(Molecular weight of NaOH = 40) :

Sol. In acidic medium

1 M $KMnO_4$ = 5 N $KMnO_4$

0.02 M $KMnO_4$ = 0.1 N $KMnO_4$

According to normality equation,

N_1V_1 ($KMnO_4$) = N_2V_2 (Oxalic acid)

$0.1 \times 10 = N_2 \times 20$

$N_2 = \frac{10 \times 0.1}{20} = 0.05$ N

Again

N_1V_1 (Oxalic acid) = N_2V_2 (NaOH)

$0.05 \times 25 = N_2 \times 20$

$N_2 = \frac{0.05 \times 25}{20} = 0.0625$ N

As S = N × E

So S = 0.0625 × 40

= **2.5 g L^{-1}**.

Ex.23 What volume of a solution of hydrochloric acid containing 73 g of acid litre would suffice for the exact neutralization of sodium hydroxide obtained by allowing 0.46 g of metallic sodium to act upon water ?

Sol. $Na + H_2O \rightarrow NaOH + \frac{1}{2} H_2$

$NaOH + HCl \rightarrow NaCl + H_2O$

Thus, meq. of Na = Meq. of NaOH formed

= Meq. of HCl used

$\frac{0.46}{23} \times 1000 = \frac{73}{36.5} \times V$

(eq. of HCl = N × V) = **10 ml**

Ex.24 Find weight of iron which will be converted into its oxide by the action of 18 g of steam on it.

Sol. $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$

3 × 56 4 × 18

As by 72 g steam the weight of Fe oxidized = 168 g

So by 18 g " " " "

$= \frac{168 \times 18}{72} = 42$ g

Ex.25 2.68×10^{-3} moles of a solution containing an ion A^{n+} required 1.61×10^{-3} moles of MnO_4^- for the oxidation of A^{n+} to AO_3^- in an acidic medium. What is the value of n?

Sol. As 1.61×10^{-3} M $KMnO_4$

$\equiv 2.68 \times 10^{-3}$ M solution of A^{n+}

So M/5 $KMnO_4 = \frac{2.68 \times 10^{-3} M}{1.61 \times 10^{-3}} \times \frac{M}{5}$

= 0.33 M solution of A^{n+}

$0.33 M = \frac{M}{5-n}$.

$5 - n = \frac{1}{0.33} = 3$

n = 2

Ex.26 The label on a H_2O_2 bottle reads as 10 Vol. Find the concentration of the H_2O_2%.

Sol. $2H_2O_2 \rightarrow 2H_2O + O_2$

10 vol. means 1 vol H_2O_2 = 10 ml O_2

1 g $H_2O_2 = \frac{22400}{68} = 329$ ml

1 litre of 10 vol. means = 10000 ml of O_2

Weight of H_2O_2 to give 10000 ml

$= \frac{1}{329} \times 10000 = 30.4$ g

Conc. = 30.4 g/lit

Conc. % = $30.4 \times \frac{100}{1000}$ = **3.04%**

Ex.27 Calculate the volume of 20 g of hydrogen gas at NTP.

Sol. Moles of hydrogen gas $= \frac{20}{2} = 10$.

Volume of the gas at NTP

= no. of moles × 22.4

= 10 × 22.4

= **224 litres**.

Ex.28 Calculate the number of atoms of each element present in 122.5 g of $KClO_3$.

Sol. No. of moles of $KClO_3 = \frac{122.5}{122.5} = 1$.

(mol. wt. of $KClO_3$ = 122.5)

From the formula $KClO_3$, we know that 1 mole of $KClO_3$ contains 1 mole of K atoms, 1 mole of Cl atoms and 3 moles of O atoms.

$$\left.\begin{aligned} \therefore \text{no. of atoms of } K &= 1 \times 6.022 \times 10^{23} \\ \text{no. of atoms of } Cl &= 1 \times 6.022 \times 10^{23} \\ \text{no. of atoms of } O &= 3 \times 6.022 \times 10^{23} \end{aligned}\right\}$$

Ex.29 If the components of air are N_2, 78%; O_2, 21% Ar, 0.9% and CO_2, 0.1% by volume what would be the molecular weight of air ?

Sol. The volume ratio of the gases will be the same as their mole ratio (Avogadro's principle)

$\therefore$ mol. wt. of air (wt. in g per mole)

$$= \frac{78\times 28 + 21\times 32 + 0.9\times 40 + 0.1\times 44}{78 + 21 + 0.9 + 0.1}$$

$= 28.964$

(N_2 = 28, O_2 = 32, Ar = 40 and CO_2 = 44)

Ex.30 The vapour density (hydrogen = 1) of a mixture consisting of NO_2 and N_2O_4 is 38.3 at 26.7°C. Calculate the number of moles of NO_2 in 100 g of the mixture.

Sol. Wt. of NO_2 = x g.

$\therefore$ obs. mol. wt. (wt./mole) $= \frac{\text{wt. in g}}{\text{total moles}}$

$$= \frac{100}{\left(\frac{x}{46} + \frac{100 - x}{92}\right)} = 2\times 38.3.$$ (0.437 mole)

EXERCISE-1

Questions based on: Determination of Number of Different Type of Particle

Q.1 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

Q.2 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

Q.3 How many atoms are contained in a mole of $Ca(OH)_2$:
(A) $30 \times 6.02 \times 10^{23}$ atoms/mol
(B) $6 \times 6.02 \times 10^{23}$ atoms/mol
(C) 6.02×10^{23} atoms/mol
(D) $5 \times 6.02 \times 10^{23}$ atoms/mol

Q.4 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

Q.5 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}

Q.6 Number of oxygen atoms in 8 gms of ozone is -
(A) 6.02×10^{23} (B) $\frac{6.02\times10^{23}}{2}$
(C) $\frac{6.02\times10^{23}}{3}$ (D) $\frac{6.02\times10^{23}}{6}$

Q.7 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}

Q.8 Total number of atoms present in 64 gm of SO_2 is -
(A) $2 \times 6.02 \times 10^{23}$ (B) 6.02×10^{23}
(C) $4 \times 6.02 \times 10^{23}$ (D) $3 \times 6.02 \times 10^{23}$

Q.9 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) $0.5\ N_A$

Q.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

Q.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

Q.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) $4 \times 6.02 \times 10^{23}$

Q.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

Q.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

Questions based on: Vapour Density, Number of Moles and NTP & STP

Q.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

Q.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

Q.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

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

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

Q.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

Q.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

Q.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

Q.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

Q.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

Questions based on
Percentage and Weight Based Calculation

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

Q.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

Q.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

Q.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

Q.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

Q.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

Q.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

Q.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

Questions based on
Empirical Formula & Molecular Formula

Q.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

Q.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

Q.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

Q.36 A compound contains 69.5% oxygen and 30.5% nitrogen and its molecule weight is 92. The molecular formula of the compound will be -

(A) N_2O (B) NO_2

(C) N_2O_4 (D) N_2O_5

Q.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

Q.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

Q.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 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

Questions based on Limiting Reagent & Stochiometry

Q.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) 112.5 gm (B) 50 gm

(C) 25 gm (D) 200 gm

Q.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

Q.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

Q.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

Q.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

Questions based on Laws of Chemical Combination

Q.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

Q.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

Q.47 One of the following combinations illustrates the 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

Q.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

Q.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

Q.50 If the 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

Questions based on Boyle's Law, Charle's Law, Avogadro's Law and Gay- Lussac's Law

Q.51 At constant temperature, in a given mass of an ideal gas -
(A) The ratio of pressure and volume always remains constant
(B) Volume always remains constant
(C) Pressure always remains constant
(D) The product of pressure and volume always remains constant

Q.52 Three flasks of equal volumes contain CH_4, CO_2 and Cl_2 gases respectively. They will contain equal number of molecules if -
(A) the mass of all the gases is same
(B) the moles of all the gas is same but temperature is different
(C) temperature and pressure of all the flasks are same
(D) temperature, pressure and masses same in the flasks

Q.53 A certain mass of a gas occupies a volume of 2 litres at STP. Keeping the pressure constant at what temperature would the gas occupy a volume of 4 litres -
(A) 546ºC (B) 273ºC
(C) 100ºC (D) 50ºC

Q.54 At 100ºC a gas has 1 atm. pressure and 10 L volume. Its volume at NTP would be -
(A) 10 litres
(B) Less than 10 litres
(C) More than 10 litres
(D) None

Q.55 Two flasks A and B of 500 ml each are respectively filled with O_2 and SO_2 at 300 K and 1 atm. pressure. The flasks will contain -
(A) The same number of atoms
(B) The same number of molecules
(C) More number of moles in flask A as compared to flask B
(D) The same amount of gases

Questions based on The ideal gas equation

Q.56 In the gas equation PV = nRT, the value of universal gas constant would depend only on -
(A) The nature of the gas
(B) The pressure of the gas
(C) The temperature of the gas
(D) The units of measurement

Q.57 8.2 L of an ideal gas weight 9.0 gm at 300 K and 1 atm pressure. The molecular mass of gas is -

(A) 9 (B) 27
(C) 54 (D) 81

Q.58 If the density of a gas A is 1.5 times that of B then the molecular mass of A is M. The molecular mass of B will be-

(A) 1.5 M (B) M/1.5
(C) 3M (D) M/3

Q.59 The value of gas constant R is 8.314 X. Here X is represent -

(A) Litre atm K^{-1} mol^{-1}
(B) Cal mol^{-1} K^{-1}
(C) J K^{-1} mol^{-1}
(D) None of the above.

Q.60 The value of gas constant per mole is approximately-

(A) 1 cal (B) 2 cal (C) 3 cal (D) 4 cal

Q.61 A gas is found to have a formula $[CO]_x$. If its vapour density is 70 the value of x is -

(A) 2.5 (B) 3.0 (C) 5.0 (D) 6.0

Questions based on

Dalton's law of partial pressure

Q.62 A cylinder is filled with a gaseous mixture containing equal masses of CO and N_2. The ratio of their partial pressure is-

(A) $P_{N_2} = P_{CO}$
(B) $P_{CO} = 0.875\ P_{N_2}$
(C) $P_{CO} = 2\ P_{N_2}$
(D) $P_{CO} = \frac{1}{2}\ P_{N_2}$

Q.63 At room temperature Dalton's law of partial pressure is not applicable to -

(A) H_2 and N_2 mixture
(B) H_2 and Cl_2 mixture
(C) H_2 and CO_2 mixture
(D) None

Q.64 The total pressure of a mixture of two gases is -

(A) The sum of partial pressures of each gas
(B) The difference in partial pressures
(C) The product of partial pressures
(D) The ratio of partial pressures.

Q.65 Equal masses of SO_2, CH_4 and O_2 are mixed in empty container at 298 K, when total pressure is 2.1 atm. The partial pressures of CH_4 in the mixture is -

(A) 0.5 atm (B) 0.75 atm
(C) 1.2 atm (D) 0.6 atm

Question based on

Eudiometry

Q.66 100 ml of CH_4 and C_2H_2 were exploded with excess of O_2. After explosion and cooling, the mixture was treated with KOH, where a reduction of 165 ml was observed. Therefore the composition of the mixture is -

(A) CH_4 = 35 ml ; C_2H_2 = 65 ml
(B) CH_4 = 65 ml ; C_2H_2 = 35 ml
(C) CH_4 = 75 ml ; C_2H_2 = 25 ml
(D) CH_4 = 25 ml ; C_2H_2 = 75 ml

Q.67 A mixture of CO and CO_2 having a volume of 20 ml is mixed with x ml of oxygen and electrically sparked. The volume after explosion is (16 + x) ml under the same conditions. What would be the residual volume if 30 ml of the original mixture is treated with aqueous NaOH ?

(A) 12 ml (B) 10 ml
(C) 9 ml (D) 8 ml

EXERCISE-2

Q.1 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

Q.2 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

Q.3 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

Q.4 6 gm of carbon combines with 32 gm of sulphur to form CS_2. 12 gm of C also combines 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

Q.5 If one mole of ethanol (C_2H_5OH) completely burns to form carbon dioxide and water, the weight of carbon dioxide formed is about –
$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$
(A) 22 gm (B) 45 gm
(C) 66 gm (D) 88 gm

Q.6 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-
$2C_4H_{10} + 13O_2 \longrightarrow 8CO_2 + 10H_2O$
(A) 1.8 kg (B) 2.7 kg
(C) 4.5 kg (D) 3.58 kg

Q.7 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.

Q.8 The moles of O_2 required for reacting with 6.8 gm of ammonia.
($4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$) is
(A) 5 (B) 2.5 (C) 1 (D) 0.5

Q.9 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}

Q.10 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}

Q.11 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}

Q.12 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
$Ag + 2HNO_3 \longrightarrow AgNO_3 + NO_2 + H_2O$
$AgNO_3 + NaCl \longrightarrow AgCl + NaNO_3$
(A) 1.08 gm (B) 2.16 gm
(C) 2.70 gm (D) 1.62 gm

Q.13 What mass of calcium chloride in grams would be enough to produce 14.35 gm of AgCl. (At. mass Ca = 40, Ag = 108) –
$CaCl_2 + 2\,AgNO_3 \rightarrow Ca(NO_3)_2 + 2AgCl$
(A) 5.55 gm (B) 8.295 gm
(C) 16.59 gm (D) 11.19 gm

Q.14 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}

Q.15 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

Q.16 How many grams are contained in 1gm-atom of Na-
(A) 13 gm (B) 23 gm
(C) 1 gm (D) 1/23 gm

Q.17 1.35 gm of pure Ca metal was converted into 1.88 gm of pure CaO. What is atomic weight of Ca -
(A) 40.75 (B) 50
(C) 60 (D) 70

Q.18 The % loss in weight after heating a pure sample of potassium chlorate (M. wt. 122.5) will be –
$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$
(A) 12.25 (B) 24.50
(C) 39.17 (D) 49.00

Q.19 The minimum quantity in gram of H_2S needed to precipitate 63.5 gm of Cu^{+2} will be nearly
$Cu^{+2} + H_2S \longrightarrow CuS + 2H^+$
(A) 63.5 gm (B) 31.75 gm
(C) 34 gm (D) 20 gm

Q.20 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

Q.21 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 ?
$4PH_3(g) \longrightarrow P_4(g) + 6H_2(g)$
(A) + 50 mL (B) 500 mL
(C) + 75 mL (D) – 500 mL

Q.22 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

Q.23 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

Q.24 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}

Q.25 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

Q.26 A gas has a vapour density 11.2. The volume occupied by 1 g of the gas at NTP is :
(A) 1 L (B) 11.2 L
(C) 22.4 L (D) 4 L

Q.27 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}

Q.28 One mole of nitrogen gas is the volume of
(A) 1 litre of nitrogen at S.T.P.
(B) 32 litre of nitrogen at S.T.P.
(C) 22.4 litre of nitrogen at S.T.P.
(D) 11.2 litre of nitrogen at S.T.P.

Q.29 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.

Q.30 Atomic weight of Ne is 20.2 Ne is mixture of Ne^{20} and Ne^{22}, relative abundance of heavier isotope is :
(A) 90 (B) 20 (C) 40 (D) 10

Q.31 Which of the following contains maximum number of molecules -
(A) 400 cc of O_2 at S.T.P.
(B) 500 cc of NH_3 at S.T.P.
(C) 250 cc of SO_2 at S.T.P.
(D) 150 cc of CO_2 at S.T.P.

Q.32 1.6 g of sulphur was burnt in the air to form SO_2. The number of molecules of SO_2 introduced into the air will be -
(A) 6.02×10^{23} (B) 3.01×10^{23}
(C) 6.02×10^{22} (D) 3.01×10^{22}

Q.33 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

Q.34 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

Q.35 Containers X, Y and Z of equal volume contain oxygen, neon and methane respectively at the same temperature and pressure. The correct increasing order of their masses is -
(A) X < Y < Z (B) Y < Z < X
(C) Z < X < Y (D) Z < Y < X

Q.36 The partial pressure of hydrogen in a flask containing 2gm of H_2 & 32gm of SO_2 is -
(A) $\frac{1}{16}$ of total pressure
(B) $\frac{1}{2}$ of total pressure
(C) $\frac{2}{3}$ of total pressure
(D) $\frac{1}{8}$ of total pressure.

NUMERIC RESPONSE TYPE QUESTIONS

Q.37 An atom of element 'X' is 1.02 times heavier than that of an atom of 'Y'. An atom of 'Y' is 0.1809 times heavier than that of an atom of oxygen. What is the atomic weight of 'X' ?

Q.38 A gas container contain 35 gm nitrogen gas, 64 gm O_2 gas and 0.112 lit of CH_4 at STP, what is average molecular weight of the gas mixture?

Q.39 A mixture of HCOOH and $H_2C_2O_4$ is heated with conc. H_2SO_4. The gas produced is collected and on treating with KOH solution the volume of the gas decreases by $\frac{1}{6}$th. Calculate molar ratio of two acids in original mixture.

Q.40 How many grams of copper will be replaced in 2 L of a 1.50-M $CuSO_4$ solution if the latter is made to react with 27.0 g of aluminium ?
(Cu = 63.5, Al = 27.0)
($3CuSO_4 + 2Al \rightarrow Al_2(SO_4)_3 + 3Cu$)

Q.41 12 litre of H_2 and 11.2 litre of Cl_2 are mixed and exploded. The volume of H_2 in the mixture is -

Q.42 The ratio of the molar amounts of H_2S needed to precipitate the metal ions from 20 ml each of 1M $Cd(NO_3)_2$ and 0.5 M $CuSO_4$ is-
($Cd(NO_3)_2 + H_2S \rightarrow CdS\downarrow + 2HNO_3$)

Q.43 Calculate the weight of $BaCl_2$ needed to prepare 250 mL of a solution having the same concentration of Cl^- ions as in a solution of KCl of concentration 80 g/L. (Ba = 137.4, Cl = 35.5) –

Q.44 What volume of 0.4M $FeCl_3.6H_2O$ will contain 600 mg of Fe^{3+} ?

Q.45 One litre of milk weighs 1.035 kg. The butter fat is 4% in volume of milk has density of 875 kg/m^3. Find the density of fat free skimed milk

Q.46 A particular 100-octane aviation gasoline used 1 cc of $(C_2H_5)_4Pb$, of density 1.66 gm/cc, per litre of gasoline. $(C_2H_5)_4Pb$ is made as follows :
$$4\,C_2H_5Cl + 4NaPb \longrightarrow (C_2H_5)_4Pb + 4NaCl$$
How many gram of C_2H_5Cl is needed to make enough $(C_2H_5)_4Pb$ for 10 litre of gasoline.
(atomic mass of Pb = 206)

EXERCISE-3

Q.1 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)

Q.2 0.01 mole of iodoform (CHI_3) reacts with Ag to produce a gas whose volume at NTP is -
(A) 224 ml
(B) 112 ml
(C) 336 ml
(D) None of these

Q.3 If 1.6 gms of SO_2 1.5×10^{22} molecules of H_2S are mixed and allowed to remain in contact in a closed vessel until the reaction
$2H_2S + SO_2 \longrightarrow 3S + 2H_2O$,
proceeds to completion. Which of the following statement is true ?
(A) Only 'S' and 'H_2O' remain in the reaction vessel
(B) 'H_2S' will remain in excess
(C) 'SO_2' will remain in excess
(D) None of these

Q.4 1.0 gm of a metal combines with 8.89 gms of Bromine. Equivalent weight of metal is nearly : (at. wt. of Br = 80)
(A) 8 (B) 9 (C) 10 (D) 7

Q.5 2.8 gm of iron displaces 3.2 gm of copper from a solution of copper sulphate solution. If the equivalent mass of iron is 28, then equivalent mass of copper will be -
(A) 16 (B) 32 (C) 48 (D) 64

Q.6 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

Q.7 A hydrocarbon contains 80% of carbon, then the hydrocarbon is -
(A) CH_4 (B) C_2H_4
(C) C_2H_6 (D) C_2H_2

Q.8 A giant molecule contains 0.25% of a metal whose atomic weight is 59. Its molecule contains one atom of that metal. Its minimum molecular weight is -
(A) 5900 (B) 23600
(C) 11800 (D) $\frac{100 \times 59}{0.4}$

Q.9 $CaCO_3$ is 90% pure. Volume of CO_2 collected STP when 10 gms of $CaCO_3$ is decomposed is -
(A) 2.016 litres (B) 1.008 litres
(C) 10.08 litres (D) 20.16 litres

Q.10 The formula of a metal oxide is Z_2O_3. If 6 mg. of hydrogen is required for complete reduction of 0.1596 gm metal oxide, then the atomic weight of metal is -
(A) 227.9 (B) 159.6
(C) 79.8 (D) 55.8

Q.11 The mass of carbon anode consumed (giving only carbondioxide) in the production of 270 Kg of aluminium metal from bauxite by the Hall process is -
(A) 180 Kg (B) 270 Kg
(C) 240 Kg (D) 90 Kg

Q.12 How many moles of lead (II) chloride will be formed from a reaction between 6.5 g of PbO and 3.2 g of HCl ?
(Atomic wt. of Pb = 207) -
(A) 0.011 (B) 0.029
(C) 0.044 (D) 0.333

Q.13 The emperical formula of an organic compound is CH_2. One mole of this compound has a mass 42 gm. Its molecular formula is -
(A) CH_2 (B) C_3H_6
(C) C_2H_2 (D) C_3H_8

Q.14 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

Q.15 The calculation on the given reaction is based on -
(A) Boyle's law
(B) Charle's law
(C) Gay-Lussac's law
(D) Avogadro's hypothesis

Q.16 Total number of moles of gaseous component will ...... after the reaction -
(A) increase
(B) decrease
(C) remain same
(D) may increase or decrease

Q.17 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

Q.18 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

Q.19 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

Q.20 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

Q.21 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

Q.22 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

Q.23 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

Q.24 The density of a liquid is 1.2 g/ml. There are 35 drops in 2 mL. The number of molecules in 1 drop is :
(molecular weight of liquid = 70)
(A) $\frac{12}{35} N_A$ (B) $\left(\frac{1}{35}\right)^2 N_A$
(C) $\frac{1.2}{(35)^2} N_A$ (D) 12 N_A

Q.25 Number of electrons present in 3.6 mg of NH_4^+ are -
(A) 1.2×10^{21} (B) 1.2×10^{20}
(C) 1.2×10^{22} (D) 2×10^{-3}

Q.26 If N_A is the Avogadro's number then number of valence electrons in 4.8 g of O^{2-} is -
(A) 2.4 N_A (B) 4.2 N_A
(C) 1.6 N_A (D) 3.2 N_A

Q.27 Which of the following has greatest number of atoms ?
(A) 1 g of butane (C_4H_{10})
(B) 1 g of nitrogen (N_2)
(C) 1 g of silver (Ag)
(D) 1 g of water (H_2O)

Q.28 The molar ratio of Fe^{2+} to Fe^{3+} in a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ having equal number of sulphate ions in both ferrous and ferric sulphates is -

(A) 1 : 2 (B) 3 : 2
(C) 2 : 3 (D) none of these

Q.29 Study the following table :

Compound	**Mass of the compound (in gram) taken**
I. CO_2	4.4
II. NO_2	2.3
III. H_2O_2	6.8
IV. SO_2	3.2

Which two compounds have least mass of oxygen ?

(A) II and IV (B) I and III
(C) I and II (D) III and IV

Q.30 How many electrons are present in 2×10^{-3} mol of ${}^{18}_{8}O^{-2}$?

(A) 1.2×10^{21} (B) 9.6×10^{21}
(C) 1.2×10^{22} (D) 1.9×10^{22}

Q.31 What is the empirical formula of vanadium oxide if 2.74 g of metal oxide contains 1.53 g of metal ? (V = 52)

(A) V_2O_3 (B) VO
(C) V_2O_5 (D) V_2O_7

Q.32 What is the formula of a substance with mass percentages of 35.79 % for S, 62.92 % for O and 1.13 % for H ?

(A) H_2SO_3 (B) H_2SO_4
(C) $H_2S_2O_7$ (D) $H_2S_2O_8$

Q.33 The chloride of a metal (M) contains 65.5 % of chlorine. 100 ml of the vapour of the chloride of the metal at STP weight 0.72 g. The molecular formula of the metal chloride is -

(A) MCl_3 (B) MCl (C) MCl_2 (D) MCl_4

Q.34 0.44 g of a colourless oxide of nitrogen occupies 224 ml at STP. The compound is -

(A) N_2O (B) NO
(C) N_2O_2 (D) NO_2

Q.35 How many grams of copper will be replaced in 2L of a 1.50 M $CuSO_4$ solution if the later is made to react with 27.0 gm of aluminium ?
[Cu = 63.5, Al = 27.0]

(A) 190.50 g (B) 95.25 g
(C) 31.75 g (D) 10.65 g

Q.36 22.4 litres of H_2S and 22.4 litres of SO_2 both at STP are mixed together. The amount of sulphur precipitated as a result of chemical calculation is :
($2H_2S + SO_2 \rightarrow 3S + 2H_2O$)

(A) 16 g (B) 23 g
(C) 48 g (D) 96 g

Q.37 Caffeine has a molecular weight of 194. If it contains 29 % by mass of nitrogen, number of atoms of nitrogen in one molecule of caffeine is-

(A) 4 (B) 6
(C) 2 (D) 3

Q.38 Sulphur trioxide is prepared by the following two reactions.
$S_8(s) + 8O_2(g) \rightarrow 8SO_2(g)$
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
How many grams of SO_3 are produced from 1 mol of S_8?

(A) 1280.0 (B) 640.0
(C) 960.0 (D) 320.0

Q.39 An organic compound contains 20 atoms of carbon per molecule, and contains 70% carbon by mass. The molecular mass of the organic compound is approximately.

(A) 465.0 (B) 342.85
(C) 415.0 (D) 667.0

Q.40 The volume of ammonia obtained by the combination of 10ml of N_2 and 30ml H_2 is -

(A) 20ml (B) 40 ml
(C) 30ml (D) 10ml

EXERCISE-4

Old Examination Questions [AIEEE/JEE Main]

Q.1 The no. of moles per litre in the equation PV = nRT is expressed by - **[AIEEE-2002]**

(A) $\frac{P}{RT}$ (B) $\frac{PV}{RT}$ (C) $\frac{RT}{PV}$ (D) None

Q.2 The weight of 2.01×10^{23} molecules of CO is- **[AIEEE-2002]**

(A) 9.3 gm (B) 7.2 gm
(C) 1.2 gm (D) 3 gm

Q.3 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 – **[AIEEE-2002]**

(A) $C_6H_8N_2$ (B) $C_7H_{10}N$
(C) $C_5H_6N_3$ (D) $C_4H_{18}N_3$

Q.4 Number of atoms in 560 gm of Fe (atomic mass 56 g mol^{-1}) is – **[AIEEE-2003]**

(A) is twice that of 70 gm N
(B) is half that of 20 gm H
(C) both are correct
(D) None is correct

Q.5 6.02×10^{20} molecules of urea are present in 100 ml of its solution. The concentration of urea solution is - **[AIEEE-2004]**

(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})

Q.6 How many moles of magnesium phosphate, $Mg_3(PO_4)_2$ will contain 0.25 mole of oxygen atoms ? **[AIEEE 2006]**

(A) 3.125×10^{-2} (B) 1.25×10^{-2}
(C) 2.5×10^{-2} (D) 0.02

Q.7 In the reaction, **[AIEEE 2007]**

$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2Al^{3+}_{(aq)} + 6Cl^{-}_{(aq)} + 3H_2(g)$,

(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

Q.8 The concentrated sulphuric acid that is labelled commercially is 95% H_2SO_4 by weight. If the density of this commercial acid is 1.834 g cm^{-3} , the molarity of this solution is : **[JEE Main Online– 2012]**

(A) 17.8 M (B) 15.7 M
(C) 10.5 M (D) 12.0 M

Q.9 The ratio of number of oxygen atoms (O) in 16.0 g ozone (O_3), 28.0 g carbon monoxide (CO) and 16.0 g oxygen (O_2) is (Atomic mass : C = 12, O = 16 and Avogadro's constant $N_A = 6.0 \times 10^{23}$ mol^{-1}) :

[JEE Main Online– 2012]

(A) 3 : 1 : 1 (B) 1 : 1 : 2
(C) 3 : 1 : 2 (D) 1 : 1 : 1

Q.10 When CO_2(g) is passed over red hot coke it partially gets reduced to CO(g). Upon passing 0.5 litre of CO_2(g) over red hot coke, the total volume of the gases increased to 700 mL . The composition of the gaseous mixture at STP is :

[JEE Main Online– 2012]

(A) CO_2 = 200 mL ; CO = 500 mL
(B) CO_2 = 350 mL ; CO = 350 mL
(C) CO_2 = 0.0 mL ; CO = 700 mL
(D) CO_2 = 300 mL ; CO = 400 mL

Q.11 The ppm level of F^- in a 500g sample of a tooth paste containing 0.2g F^- is :

[JEE Main Online– 2012]

(A) 250 (B) 200
(C) 400 (D) 1000

Q.12 A gaseous hydrocarbon gives upon combustion 0.72 g. of water and 3.08 g. of CO_2. The empirical formula of the hydrocarbon is –

[JEE Main 2013]

(A) C_6H_5 (B) C_7H_8 (C) C_2H_4 (D) C_3H_4

Q.13 Number of atoms in the following samples of substances is the largest in : **[JEE Main Online– 2013]**

(A) 4.0g of hydrogen (H_2)
(B) 71.0g of chlorine (Cl_2)
(C) 127.0g of iodine (I_2)
(D) 48.0g of magnesium (Mg)

Q.14 6 litres of an alkene require 27 litres of oxygen at constant temperature and pressure for complete combustion. The alkene is – **[JEE Main Online– 2013]**

(A) Ethene (B) Propene
(C) 1 – Butene (D) 2–Butene

Q.15 Dissolving 120 g of a compound of (mol. wt. 60) in 1000 g of water gave a solution of density 1.12 g/mL. The molarity of the solution is : **[JEE Main Online– 2014]**

(A) 1.00 M (B) 2.00 M
(C) 2.50 M (D) 4.00 M

Q.16 The amount of oxygen in 3.6 moles of water is **[JEE Main Online– 2014]**

(A) 115.2 g (B) 57.6 g
(C) 28. 8 g (D)18.4 g

Q.17 A gaseous compound of nitrogen and hydrogen contains 12.5% (by mass) of hydrogen. The density of the compound relative to hydrogen is 16. The molecular formula of the compound is: **[JEE Main Online– 2014]**

(A) NH_2 (B) N_3H
(C) NH_3 (D) N_2H_4

Q.18 The amount of $BaSO_4$ formed upon mixing 100 mL. of 20.8% $BaCl_2$ solution with 50 mL of 9.8% H_2SO_4 solution will be : (Ba = 137, Cl = 35.5, S = 32, H = 1 and O = 16) **[JEE Main Online– 2014]**

(A) 23.3 g (B) 11.65 g
(C) 30.6 g (D) 33.2 g

Q.19 The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecule is - **[JEE Main 2014]**

(A) 7 : 32 (B) 1 : 8
(C) 3 : 16 (D) 1 : 4

Q.20 The molecular formula of a commercial resin used for exchanging ions in water softening is $C_8H_7SO_3Na$ (Mol. Wt. 206). What would be the maximum uptake of Ca^{2+} ions by the resin when expressed in mole per gram resin ? **[JEE Main 2015]**

(A) $\frac{1}{103}$ (B) $\frac{1}{206}$ (C) $\frac{2}{309}$ (D) $\frac{1}{412}$

Q.21 At 300 K and 1 atm, 15 mL of a gaseous hydrocarbon requires 375 mL air containing 20% O_2 by volume for combustion. After combustion the gaseous occupy 345 mL. Assuming that the water formed is in liquid form and the volumes were measured at the same temperature and pressure, the formula of the hydrocarbon is : **[JEE Main 2016]**

(A) C_3H_6 (B) C_3H_8
(C) C_4H_8 (D) C_4H_{10}

Q.22 1 gram of a carbonate (M_2CO_3) on treatment with excess HCl produces 0.01186 mole of CO_2. The molar mass of M_2CO_3 in g mol^{-1} is – **[JEE Main 2017]**

(A) 118.6 (B) 11.86 (C) 1186 (D) 84.3

Q.23 The most abundant elements by mass in the body of a healthy human adult are : Oxygen (61.4%), Carbon (22.9 %), Hydrogen (10.0%) and Nitrogen (2.6%). The weight which a 75 kg person would gain if all ^1H atoms are replaced by ^2H atoms is **[JEE Main 2017]**

(A) 7.5 kg (B) 10 kg
(C) 15 kg (D) 37.5 kg

Q.24 Excess of NaOH (aq) was added to 100 mL of $FeCl_3$ (aq) resulting into 2.14 g of $Fe(OH)_3$. The molarity of $FeCl_3$ (aq) is (Given molar mass of Fe = 56 g mol^{-1} and molar mass of Cl = 35.5 g mol^{-1}) **[JEE Main Online– 2017]**

(A) 0.3 M (B) 0.2 M
(C) 0.6 M (D) 1.8 M

Q.25 The ratio of mass percent of C and H of an organic compound ($C_xH_yO_z$) is 6 : 1. If one molecule of the above compound ($C_xH_yO_z$) contains half as much oxygen as required to burn one molecule of compound C_xH_y completely to CO_2 and H_2O. The empirical formula of compound $C_xH_yO_z$ is- **[JEE Main - 2018]**

(A) $C_3H_6O_3$ (B) C_2H_4O
(C) $C_3H_4O_2$ (D) $C_2H_4O_3$

Q.26 The recommended concentration of fluoride ion in drinking water is up to 1 ppm as fluoride ion is required to make teeth enamel harder by converting $[3Ca_3(PO_4)_2.Ca(OH)_2]$ to :

[JEE Main - 2018]

(A) $[CaF_2]$ (B) $[3(CaF_2).Ca(OH)_2]$

(C) $[3Ca_3(PO_4)_2.CaF_2]$ (D) $[3\{Ca(OH)_2\}.CaF_2]$

Q.27 Biochemical oxygen demand (BOD) value can be a measure of water pollution caused by the organic matter. Which of the following statements is correct ?

[JEE-Main Online-2018]

(A) Polluted water has BOD value higher than 10 ppm

(B) Aerobic bacteria decreases the BOD value

(C) Anaerobic bacteria increases the BOD value

(D) Clean water has BOD value higher than 10 ppm

Q.28 What is the molar solubility of $A1(OH)_3$ in 0.2 M NaOH solution ? Given that, solubility product of $A1(OH)_3 = 2.4 \times 10^{-24}$:

[Main -2019]

(A) 3×10^{-22} (B) 3×10^{-19}

(C) 12×10^{-21} (D) 12×10^{-22}

Q.29 5 moles of AB_2 weigh 125×10^{-5} kg and 10 moles of A_2B_2 weigh 300×10^{-3} kg. The molar mass of A (M_A) and molar mass of B (M_B) in kg mol are : **[Main -2019]**

(A) $M_A = 10 \times 10^{-3}$ and $M_B = 5 \times 10^{-3}$

(B) $M_A = 25 \times 10^{-3}$ and $M_B = 50 \times 10^{-3}$

(C) $M_A = 5 \times 10^{-3}$ and $M_B = 10 \times 10^{-3}$

(D) $M_A = 50 \times 10^{-3}$ and $M_B = 25 \times 10^{-3}$

Q.30 An example of a disproportionation reaction is : **[Main -2019]**

(A) $2NaBr + Cl_2 \longrightarrow 2NaCl + Br_2$

(B) $2KMnO_4 \longrightarrow 2KMnO_4 + MnO_2 + O_2$

(C) $2CuBr \longrightarrow CuBr_2 + Cu$

(D) $2MnO_4^- + 10I^- + 16H^+ \longrightarrow 2Mn^{2+} + 5I_2 + 8H_2O$

Q.31 A mixture of one mole each of H_2, He and O_2 each are enclosed in a cylinder of volume V at temperature T. If the partial pressure of H_2 is 2 atm, the total pressure of the gases in the cylinder is –

[Main -2020]

(A) 14 atm (B) 22 atm

(C) 38 atm (D) 6 atm

Q.32 The average molar mass of chlorine is 35.5 g mol^{-1}. The ratio of ^{35}Cl to ^{37}Cl in naturally occurring chlorine is close to :

[Main -2020]

(A) 4 : 1 (B) 1 : 1

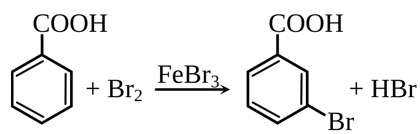
(C) 2 : 1 (D) 3 : 1

Q.33 Complete combustion of 3 g of ethane gives $x \times 10^{22}$ molecules of water. The value of x is —. (Round off to the Nearest Integer).

[Use : $N_A = 6.023 \times 10^{23}$; Atomic masses in u : C : 12.0 ; 0 : 16.0 ; H : 1.0]

[Main -2021]

Q.34



Consider the above reaction where 6.1 g of benzoic acid is used to get 7.8 g of m-bromo benzoic acid. The percentage yield of the product is_____.

(Round off to the Nearest integer)

[Given : Atomic masses : C = 12.0u, H : 1.0u, O : 16.0u, Br = 80.0 u]

[Main -2021]

Q.35 Complete combustion of 750 g of an organic compound provides 420 g of CO_2 and 210 g of H_2O. The percentage composition of carbon and hydrogen in organic compound is 15.3 and ________ respectively. (Round off to the Nearest Integer) **[Main -2021]**

Q.36 A 6.50 molal solution of KOH (aq.) has a density of 1.89 g cm^{-3}. The molarity of the solution is ________ mol dm^{-3}. (Round off to the Nearest Integer).

[Atomic masses: K :39.0 u; O :16.0 u; H :1.0 u] **[Main -2021]**

Q.37 Using the rules for significant figures, the correct answer for the expression $\frac{0.02858 \times 0.112}{0.5702}$ will be **[Main -2022]**

(A) 0.005613 (B) 0.00561
(C) 0.0056 (D) 0.006

Q.38 SO_2Cl_2 on reaction with excess of water results into acidic mixture

$SO_2Cl_2 + 2H_2O \rightarrow H_2SO_4 + 2HCl$

16 moles of NaOH is required for the complete neutralisation of the resultant acidic mixture. The number of moles of SO_2Cl_2 used is **[Main -2022]**

(A) 16 (B) 8 (C) 4 (D) 2

Q.39 Consider the reaction

$4HNO_3(\ell) + 3KCl(s) \rightarrow Cl_2(g) + NOCl(g) + 2H_2O(g) + 3KNO_3(s)$

The amount of HNO_3 required to produce 110.0 g of KNO_3 is :

(Given : Atomic masses of H, O, N and K are 1, 16, 14 and 39, respectively.) **[Main -2022]**

(A) 32.2 g (B) 69.4 g
(C) 91.5 g (D) 162.5 g

Q.40 The number of N atoms in 681 g of $C_7H_5N_3O_6$ is x × 10^{21}. The value of x is ________.

($N_A = 6.02 \times 10^{23}$ mol^{-1}) (Nearest Integer) **[Main -2022]**

Q.41 On complete combustion of 0.492 g of an organic compound containing C, H and O, 0.7938 g of CO_2 and 0.4428 g of H_2O was produced. The % composition of oxygen in the compound is _______. **[Main -2022]**

Q.42 A solution is prepared by adding 2 g of "X" to 1 mole of water. Mass percent of X" in the solution is **[Main -2023]**

(A) 5% (B) 20% (C) 2% (D) 10%

Q.43 The number of molecules and moles in 2.8375 litres of O_2 at STP are respectively **[Main -2023]**

(A) 7.527×10^{23} and 0.125 mol
(B) 7.527×10^{22} and 0.250 mol
(C) 1.505×10^{23} and 0.250 mol
(D) 7.527×10^{22} and 0.125 mol

Q.44 Which of the following have same number of significant figures ? **[Main -2023]**

(a) 0.00253 (b) 1.0003
(c) 15.0 (d) 163

Choose the correct answer from the options given below

(A) (a), (b) & (c) only (B) (c) & (d) only
(C) (b) and (c) only (D) (a), (c) & (d) only

Q.45 The molarity of a 10% (v/v) solution of di-bromine solution in CCl_4 (carbon tetrachloride) is 'x'.

x = _______ × 10^{-2} M. (Nearest integer)

[Given : molar mass of Br_2 = 160 g mol^{-1}
atomic mass of C = 12 g mol^{-1}
atomic mass of Cl = 35.5 mol^{-1}
density of dibromine = 3.2 g cm^{-3}
density of CCl_4 = 1.6 g cm^{-3}] **[Main -2023]**

Q.46 The density of 3 solution of NaCl is 1.0 g mL^{-1}. Molality of the solution is _________ × 10^{-2} m. (Nearest integer). Given : Molar mass of Na and Cl is 23 and 35.5 g mol^{-1} respectively. **[Main -2023]**

Q.47 Mass of methane required to produce 22 g of CO_2 after complete combustion is _______ g.

(Given Molar mass in g mol^{-1} C = 12.0
H = 1.0
O = 16.0) **[Main -2024]**

Q.48 The quantity which changes with temperature is: **[Main -2024]**

(A) Molarity (B) Molality
(C) Mass percentage (D) Mole fraction

Q.49 Volume of 3 M NaOH (formula weight 40 g mol^{-1}) which can be prepared from 84 g of NaOH is _____ × 10^{-1} dm^3. **[Main -2024]**

Q.50 1 mole of PbS is oxidised by "X" moles of O_3 to get "Y" moles of O_2. X + Y = _________. **[Main -2024]**

Q.51 A solution of H_2SO_4 is 31.4% H_2SO_4 by mass and has a density of 1.25g/mL.

The molarity of the H_2SO_4 solution is ______M (nearest integer)

[Given molar mass of H_2SO_4 = 98g mol^{-1}] **[Main -2024]**

Q.52 Density of 3 M NaCl solution is 1.25 g/mL. The molality of the solution is :

[Main -2025]

(A) 1.79 m (B) 2 m
(C) 3 m (D) 2.79 m

Q.53 2.8×10^{-3} mol of CO_2 is left after removing 10^{21} molecules from its 'x' mg sample. The mass of CO_2 taken initially is Given : $N_A = 6.02 \times 10^{23}$ mol^{-1}

[Main -2025]

(A) 196.2 mg (B) 98.3 mg
(C) 150.4 mg (D) 48.2 mg

Q.54 What amount of bromine will be required to convert 2 g of phenol into 2, 4, 6-tribromophenol ? (Given molar mass in g mol^{-1} of C, H, O, Br are 12, 1, 16, 80 respectively) **[Main -2025]**

(A) 10.22 g (B) 6.0 g
(C) 4.0 g (D) 20.44 g

Q.55 20 mL of 2 M NaOH solution is added to 400 mL of 0.5 M NaOH solution. The final concentration of the solution is _____ $\times 10^{-2}$ M. (Nearest integer).

[Main -2025]

Q.56 0.01 mole of an organic compound (X) containing 10% hydrogen, on complete combustion produced 0.9 g H_2O. Molar mass of (X) is ______ g mol^{-1}.

[Main -2025]

EXERCISE-5

Old Examination Questions [IIT JEE Advanced]

Q.1 The weight of 1×10^{22} molecules of $CuSO_4.5H_2O$ is - **[IIT-1991]**

(A) 41.59 g (B) 415.9 g
(C) 4.159 g (D) None of these

Q.2 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_2 **[IIT-1993]**
(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

Q.3 Equal masses of ethane and hydrogen are mixed in an empty container at 25ºC. The fraction of the total pressure exerted by the hydrogen is - **[IIT-1993]**

(A) 1 : 2 (B) 1 : 1
(C) 1 : 16 (D) 15 : 16

Q.4 One mole of calcium phosphide on reaction with excess of water gives **[IIT-1999]**

(A) One mole of phosphine
(B) Two moles of Phosphoric acid
(C) Two moles of phosphine
(D) One mole of phosphorus pentoxide

Q.5 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 **[IIT-2000]**

(A) 6 cm^3 (B) 60 cm^3
(C) 0.6 cm^3 (D) 0.06 cm^3

Q.6 How many moles of electron weigh one kilogram ? **[IIT- 2002]**

(A) 6.023×10^{23}
(B) $\frac{1}{9.108} \times 10^{31}$
(C) $\frac{6.023}{9.108} \times 10^{54}$
(D) $\frac{1}{9.108 \times 6.023} \times 10^{8}$

Q.7 In which of the following number of atoms are maximum ? **[IIT-2003]**

(A) 24 gms C
(B) 27 gms of Al
(C) 56 gms of Fe
(D) 108 gms of Ag

Q.8 Give that the abundances of isotopes ^{54}Fe, ^{56}Fe and ^{57}Fe are 5% 90% and 5% respectively, the atomic mass of Fe is - **[IIT-2009]**

(A) 55.85 (B) 55.95
(C) 55.75 (D) 56.05

Q.9 The simplest formula of a compound containing 50% of element X (At. mass = 10) and 50% of the element Y (At. mass = 20) is : **[IIT-2011]**

(A) XY (B) X_2Y (C) XY_2 (D) X_2Y_3

Q.10 The volume (in mL) of 0.1 M $AgNO_3$ required for complete precipitation of chloride ions present in 30 mL of 0.01 M solution of $[Cr(H_2O)_5Cl]Cl_2$, as silver chloride is close to - **[IIT-2011]**

Q.11 If the value of Avogadro number is 6.023×10^{23} mol^{-1} and the value of Boltzmann constant is 1.380×10^{-23} J K^{-1}, then the number of significant digits in the calculated value of the universal gas constant is **[JEE Advance – 2014]**

Q.12 The ammonia prepared by treating ammonium sulphate with calcium hydroxide is completely used by $NiCl_2.6H_2O$ to form a stable coordination compound. Assume that both the reactions are 100% complete. If 1584 g of ammonium sulphate and 952 g of $NiCl_2.6H_2O$ are used in the preparation, the combined weight (in grams) of gypsum and the nickel-ammonia coordination compound thus produced is(Atornic weights in g mol^{-1}: H = 1, N = 14, O = l6, S = 32, Cl=35.5, Ca = 40, Ni = 59) **[JEE Advance – 2018]**

Q.13 The amount of water produced (in g) in the oxidation of 1 mole of rhombic sulphur by conc. HNO_3 to a compound with the highest oxidation state of sulphur is _______

(Given data : Molar mass of water = 18 g mol^{-1}) **[JEE-Advanced 2019]**

Q.14 The mole fraction of urea in an aqueous urea solution containing 900 g of water is 0.05. If the density of the solution is 1.2 g cm^{-3}, the molarity of urea solution is ______

(Given data : Molar masses of urea and water are 60 g mol^{-1} and 18 g mol^{-1}, respectively) **[JEE-Advanced 2019]**

Q.15 The treatment of an aqueous solution of 3.74 g of $Cu(NO_3)_2$ with excess KI results in a brown solution along with the formation of a precipitate. Passing H_2S through this brown solution gives another precipitate X. The amount of X (in g) is ___________.

[Given: Atomic mass of H = 1, N = 14, O = 16, S = 32, K = 39, Cu = 63, I = 127]

[JEE-Advanced 2022]

Q.16 The stoichiometric reaction of 516 g of dimethyldichlorosilane with water results in a tetrameric cyclic product **X** in 75% yield. The weight (in g) of **X** obtained is _______.

[**Use**, molar mass (g mol^{-1}): H = 1, C = 12, O = 16, Si = 28, Cl = 35.5]

[JEE-Advanced-2023]

Q.17 H_2S (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is **x**, and the number of moles of electrons involved is **y**. The value of (**x** + **y**) is ____.

[JEE-Advanced-2023]

ANSWER KEYS

EXERCISE-1

1.(A)	**2.**(B)	**3.**(D)	**4.**(B)	**5.**(B)	**6.**(B)	**7.**(A)
8.(D)	**9.**(B)	**10.**(D)	**11.**(A)	**12.**(C)	**13.**(D)	**14.**(A)
15.(B)	**16.**(C)	**17.**(A)	**18.**(D)	**19.**(B)	**20.**(D)	**21.**(A)
22.(B)	**23.**(B)	**24.**(B)	**25.**(B)	**26.**(D)	**27.**(A)	**28.**(C)
29.(C)	**30.**(A)	**31.**(B)	**32.**(C)	**33.**(D)	**34.**(D)	**35.**(B)
36.(C)	**37.**(C)	**38.**(D)	**39.**(C)	**40.**(A)	**41.**(A)	**42.**(B)
43.(C)	**44.**(B)	**45.**(D)	**46.**(B)	**47.**(C)	**48.**(A)	**49.**(B)
50.(B)	**51.**(D)	**52.**(C)	**53.**(B)	**54.**(B)	**55.**(B)	**56.**(D)
57.(B)	**58.**(B)	**59.**(C)	**60.**(B)	**61.**(C)	**62.**(A)	**63.**(B)
64.(A)	**65.**(C)	**66.** (A)	**67.** (A)			

EXERCISE-2

1.(C)	**2.**(B)	**3.**(A)	**4.**(C)	**5.**(D)	**6.**(D)	**7.**(C)
8.(D)	**9.**(A)	**10.**(B)	**11.**(D)	**12.**(B)	**13.**(A)	**14.**(C)
15.(D)	**16.**(B)	**17.**(A)	**18.**(C)	**19.**(C)	**20.**(A)	**21.**(C)
22.(C)	**23.**(A)	**24.**(B)	**25.**(B)	**26.**(A)	**27.**(D)	**28.**(C)
29.(D)	**30.**(D)	**31.**(B)	**32.**(D)	**33.**(B)	**34.**(A)	**35.** (D)
36. (C)	**37.** 2.95	**38.** 30.44	**39.** 4.00	**40.** 95.25	**41.** 0.80	**42.** 2.00
43. 27.92	**44.** 26.78	**45.** 1041.00	**46.** 13.30			

EXERCISE-3

1.(C)	**2.**(B)	**3.**(C)	**4.**(B)	**5.**(B)	**6.**(A)	**7.**(C)
8.(B)	**9.**(A)	**10.**(D)	**11.**(D)	**12.**(B)	**13.**(B)	**14.**(C)
15.(C)	**16.**(B)	**17.**(B)	**18.**(D)	**19.**(B)	**20.**(A)	**21.**(A)
22.(C)	**23.**(A)	**24.**(C)	**25.**(A)	**26.**(A)	**27.**(A)	**28.**(B)
29.(A)	**30.**(C)	**31.**(C)	**32.**(C)	**33.**(A)	**34.**(A)	**35.**(B)
36.(C)	**37.**(A)	**38.**(B)	**39.**(B)	**40.** (A)		

EXERCISE-4

1. (A)	**2.**(A)	**3.**(A)	**4.**(C)	**5.**(B)	**6.**(A)	**7.**(D)
8.(A)	**9.**(D)	**10.**(D)	**11.**(C)	**12.**(B)	**13.**(A)	**14.**(B)
15.(B)	**16.**(B)	**17.**(D)	**18.**(B)	**19.** (A)	**20.**(D)	**21.**(B)
22.(D)	**23.**(A)	**24.**(B)	**25.** (D)	**26.** (C)	**27.** (A)	**28.** (A)
29. (C)	**30.** (C)	**31.** (D)	**32.** (D)	**33.** (18)	**34.** (78.00)	**35.** (3.00)
36. (9.00)	**37.** (B)	**38.** (C)	**39.** (C)	**40.** (5418.00)	**41.** (46.00)	**42.** (D)
43. (D)	**44.** (D)	**45.** (139)	**46.** (364)	**47.** (8)	**48.** (A)	**49.** (7)
50. (8)	**51.** (4)	**52.**(D)	**53.**(A)	**54.**(A)	**55.** (57.00)	**56.** (100.00)

EXERCISE-5

1.(C)	**2.**(A)	**3.** (D)	**4.**(C)	**5.**(C)	**6.**(D)	**7.**(A)
8.(B)	**9.**(B)	**10.** 6	**11.** 4	**12.** [2992.00]	**13.** [288.00]	**14.** [298.00]
15. [0.32]	**16.** [222]	**17.** [18]				

NOTES