विध्न विचारत भीरु जन, नहीं आरम्भे काम, विपति देख छोड़े तुरंत मध्यम मन कर श्याम।
पुरुष सिंह संकल्प कर, सहते विपति अनेक, 'बना' न छोड़े ध्येय को, रघुबर राखे टेक।।

रचितः मानव धर्म प्रणेता
सद्गुरु श्री रणछोड़दासजी महाराज

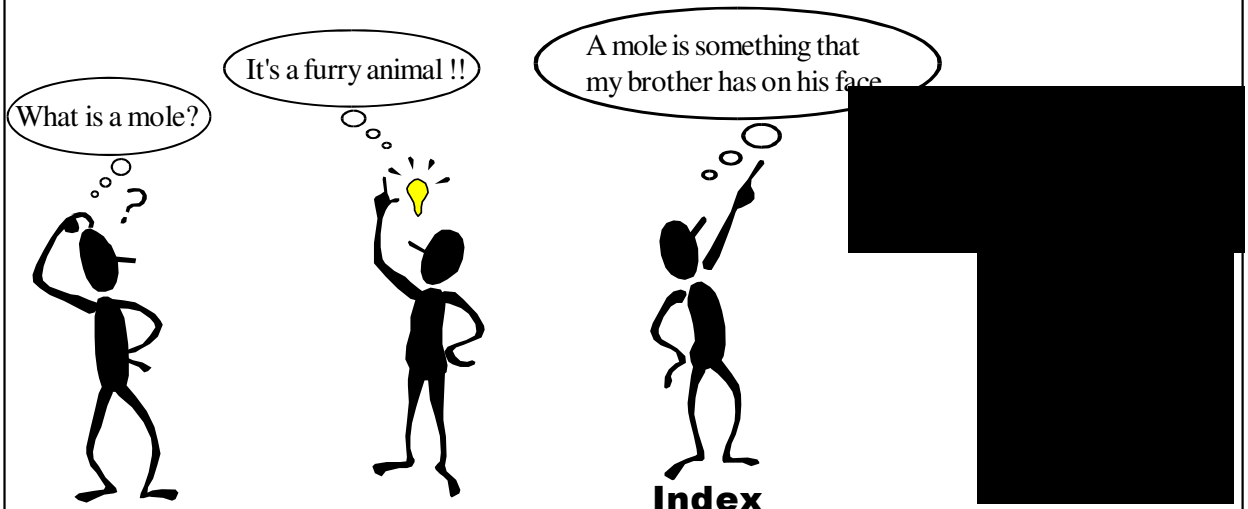
STUDY PACKAGE

This is TYPE 1 Package please wait for Type 2

Subject : CHEMISTRY

MOLE CONCEPT

(EK ANMOL CONCEPT)



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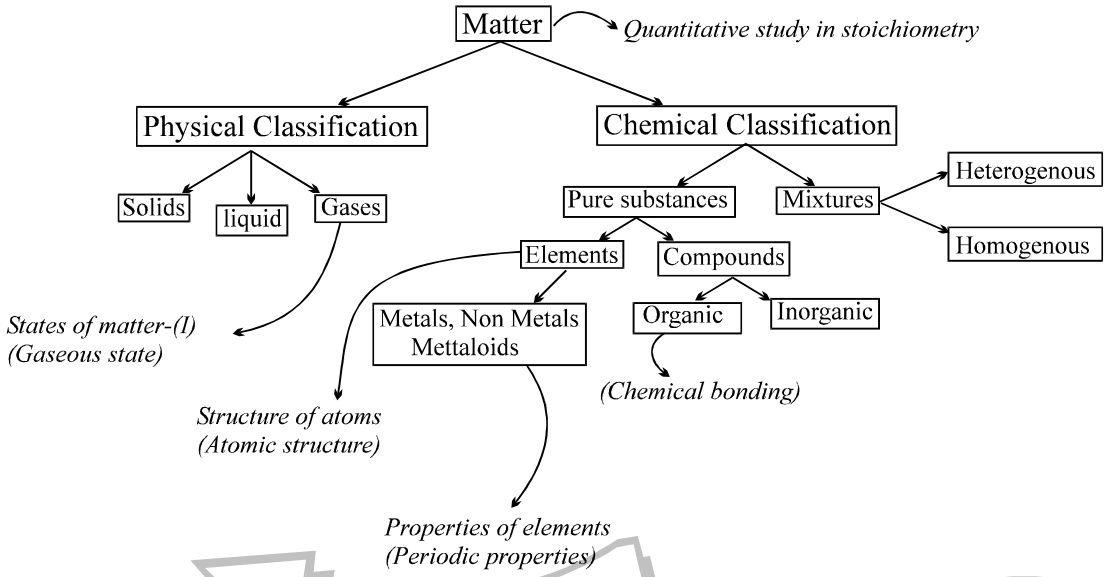
CHEMISTRY – STUDY OF MATTER

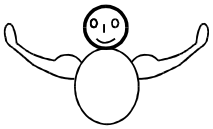
Overview of Chemistry



Friends for you used in the sheet.

1. Teacher's advice ⟶  : Tips which can enhance your performance.

2. Student's query ⟶  : Arbit doubts which are generally developed among students.

3. Boost your confidence ⟶  : Some additional information.

4. Dangers ⟶  Take care of the general mistakes and crucial points.

KEY CONCEPTS

1. LAWS OF CHEMICAL COMBINATION

1.1 Law of conservation of mass [Lavoisier]

1.2 Law of constant composition [Proust]

1.3 Law of multiple proportions [Dalton]

1.4 Law of reciprocal proportions [Richter]

1.5 Gay Lussac law of combining volumes [Guess Who??]

"*Wonder these laws are useful?*"

"*These are no longer useful in chemical calculations now but gives an idea of earlier methods of analysing and relating compounds by mass.*"

2. MOLE CONCEPT

2.1 Definition of mole : One mole is a collection of that many entities as there are number of atoms exactly in 12 gm of C-12 isotope.

or 1 mole = collection of 6.02×10^{23} species

$6.02 \times 10^{23} = N_A$ = Avogadro's No.

1 mole of atoms is also termed as 1 gm-atom, 1 mole of ions is termed as 1 gm-ion and 1 mole of molecule termed as 1 gm-molecule.

2.2 Methods of Calculations of mole :

(a) If no. of some species is given, then no. of moles = $\frac{\text{Given no.}}{N_A}$

(b) If weight of a given species is given, then no of moles = $\frac{\text{Given wt.}}{\text{Atomic wt.}}$ (for atoms),

or $= \frac{\text{Given wt.}}{\text{Molecular wt.}}$ (for molecules)

(c) If volume of a gas is given along with its temperature (T) and pressure (P)

use $n = \frac{PV}{RT}$

where R = 0.0821 lit-atm/mol-K (when P is in atmosphere and V is in litre.)

1 mole of any gas at STP occupies 22.4 litre.

Gases do not have volume. What is meant by "Volume of gas"?

Do not use this expression (PV = nRT) for solids/liquids.

How would I calculate moles if volume of a solid is given?

2.3 ***Atomic weight:*** It is the weight of an atom relative to *one twelvth of weight of 1 atom of C-12*

Be clear in the difference between 1 amu and 1 gm.

(a) Average atomic weight = $\sum$ % of isotope X molar mass of isotope.

The % obtained by above expression (used in above expression) is by number (i.e. its a mole%)

2.4 ***Molecular weight :*** It is the sum of the atomic weight of all the constituent atom.

(a) Average molecular weight = $\dfrac{\sum n_i M_i}{\sum n_i}$

where n_i = no. of moles of any compound and m_i = molecular mass of any compound.

Make yourselves clear in the difference between mole% and mass% in question related to above.

Shortcut for % determination if average atomic weight is given for X having isotopes X^A & X^B.

$$\% \text{ of } X^A = \left| \frac{\text{Average atomic weight} - \text{wt of } X^B}{\text{difference in weight of } X^A \text{ \& } X^B} \right| \times 100$$

Try working out of such a shortcut for X^A, X^B, X^C

3. EMPIRICAL FORMULA, MOLECULAR FORMULA :

3.1 ***Empirical formula :*** Formula depicting constituent atom in their simplest ratio.
Molecular formula : Formula depicting actual number of atoms in one molecule of the compound

3.2 ***Relation between the two :*** Molecular formula = Empirical formula × n

$$n = \frac{Molecular\ mass}{Empirical\ \ Formula\ mass}$$

Check out the importance of each step involved in calculations of *empirical formula*.

3.3 ***Vapour density :***

Vapour density : Ratio of density of vapour to the density of hydrogen at similar pressure and temperature.

$$\text{Vapour density} = \frac{Molecular\ mass}{2}$$

Can you prove the above expression?

Is the above parameter temperature dependent?

4. STOICHIOMETRY : Stoichiometry pronounced ("stoy – key – om – e – tree") is the calculations of the quantities of reactants and products involved in a chemical reaction.

This can be divided into two category.

(A) Gravimetric analysis

(B) Volumetric analysis (to be discussed later)

4.1 Gravimetric Analysis :

4.1.1 Methods for solving :

(a) Mole Method
(b) Factor Label Method } Balance reaction required

(c) POAC method } Balancing not required but common sense ☺ *use it with slight care*.

(d) Equivalent concept } to be discussed later

5. CONCEPT OF LIMITING REAGENT.

5.1 Limiting Reagent : It is very important concept in chemical calculation. It refers to reactant which is present in minimum stoichiometry quantity for a chemical reaction. It is reactant consumed fully in a chemical reaction. So all calculations related to various products or in sequence of reactions are made on the basis of limiting reagent.

☠ It comes into picture when reaction involves two or more reactants. For solving any such reactions, first step is to calculate L.R.

5.2 Calculation of Limiting Reagent :

(a) By calculating the required amount by the equation and comparing it with given amount. [Useful when only two reactant are there]

(b) By calculating amount of any one product obtained taking each reactant one by one irrespective of other reactants. The one giving least product is *limiting reagent.*

(c) Divide given moles of each reactant by their stoichiometric coefficient, the one with least ratio is *limiting reagent*. [Useful when number of reactants are more than two.]

6. PERCENTAGE YIELD : The percentage yield of product $= \dfrac{\textit{actual yield}}{\textit{the theoretical maximum yield}} \times 100$

☺ The actual amount of any limiting reagent consumed in such incomplete reactions is given by [% yield × given moles of limiting reagent] [For reversible reactions]

☺ For irreversible reaction with % yield less than 100, the reactants is converted to product (desired) and waste.

7. CONCENTRATION TERMS :

7.1 General concentraction term :

(a) $\text{Density} = \dfrac{\text{Mass}}{\text{Volume}}$, Unit : gm/cc

(b) $\text{Relative density} = \dfrac{\textit{Density of any substance}}{\textit{Density of refrence substance}}$

(c) Specific gravity = $\frac{Density\ of\ any\ substance}{Density\ of\ water\ at\ 4°C}$

(d) Vapour density = $\frac{Density\ of\ vapour\ at\ some\ temperature\ and\ pressure}{Density\ of\ H_2\ gas\ at\ same\ temperature\ and\ pressure}$

(1) Which of these are temperature dependent.

(2) Classify them as w/w, w/v, v/v ratio.

7.2 For solutions (homogeneous mixture) :

What is solute and solvent in a solution.

If the mixture is not homogeneous, then none of them is applicable.

Classify each given ratio as w/w, w/v, v/v and comment on their temperature dependence.

(a) **% by mass** $\left(\frac{w}{W}\right)$ **: =** $\frac{\text{wt.of solute}}{\text{wt.of solution}} \times 100$

[X % by mass means 100 gm solution contains X gm solute ; ∴ (100 – X) gm solvent]

(b) **%** $\left(\frac{w}{V}\right)$ **: =** $\frac{\text{wt.of solute}}{\text{volumeof solution}} \times 100$ [for liq. solution]

[X % $\left(\frac{w}{V}\right)$ means 100 ml solution contains X gm solute]

for gases **% by volume** is same as **mole %**

(c) **%** $\left(\frac{v}{V}\right)$ **: =** $\frac{\text{volumeof solute}}{\text{volumeof solution}} \times 100$

(d) **Mole % : =** $\frac{\text{Moles of solute}}{\text{Total moles}} \times 100$

(e) **Mole fraction (X_a) : =** $\frac{\text{Moles of solute}}{\text{Total moles}}$

(f) **Molarity (M) : =** $\frac{\text{Mole of solute}}{\text{volume of solution in litre}}$

(g) **Molality (m) : =** $\frac{\text{Moles of solute}}{\text{Mass of solvent(in kg)}}$

(h) **Parts per million (ppm) : =** $\frac{\text{Mass of solute}}{\text{Mass of solvent}} \times 10^6 \cong \frac{Mass\ of\ solute}{Mass\ of\ solution} \times 10^6$

Get yourselves very much confortable in their interconversion. It is very handy.

7.3 Some typical concentration terms :

(a) **Oleum :** Labelled as '% oleum' (for e.g. 102% oleum), it means maximum amount of H_2SO_4 that can be obtained from 100 gm of such oleum (mix of H_2SO_4 and SO_3) by adding sufficient water.

Work out what are the maximum and minimum value of the %

(b) **H_2O_2 :** Labelled as 'volume H_2O_2 (for e.g. 20V H_2O_2), it means volume of O_2 (in litre) at STP that can be obtained from 1 litre of such a sample when it decomposes according to

$$H_2O_2 \rightarrow H_2O + \frac{1}{2}O_2$$

Work out a relationship between M and volume H_2O_2 and remember it

8. SOME EXPERIMENTAL METHODS :

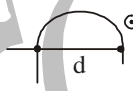
8.1 For determination of atomic mass :

(a) Dulong's and Petit's Law :

Atomic weight × specific heat (cal/gm°C) $\propto\cong 6.4$

Gives approximate atomic weight and is applicable for metals only. Take care of units of specific heat.

(b) Mass spectrometry : $\frac{mv^2}{r} = qvB$



B is the magnitude of magnetic field r = d/2

m is mass of ion, *v* is velocity of ion, *r* is the distance where the ions strikes, *q* is the charge on the ion.

8.2 For molecular mass determination :

(a) **Victor Maeyer's process :** (*for volatile substance*)

Procedure : Some known weight of a volatile substance (w) is taken, converted to vapour and collected over water. The volume of air displaced over water is given (V) and the following expressions are used.

$M = \frac{w}{PV}RT$ or $M = \frac{w}{(P-P')V}RT$

If aq. tension is not given — If aq. tension is P'

Aqueous tension : Pressure exerted due to water vapours at any given temperature.

This comes in picture when any gas is collected over water. Can you guess why?

(b) **Silver salt method :** (*for organic acids*)

Basicity of an acid : No. of replacable H^+ atoms in an acid (H contained to more electronegative atom is acidic)

Procedure : Some known amount of silver salt (w_1 gm) is heated to obtain w_2 gm of while shining residue of silver. Then if the basicity of acid is n, molecular weight of acid would be

$$\left(\frac{w_2}{108}\times\frac{1}{n}\right)\times M_{salt} = w_1 \text{ and molecular weight of acid} = M_{salt} - n(107)$$

This is one good practical application of POAC.

(c) **Chloroplatinate salt method :** (*for organic bases*)

Lewis acid : electron pair acceptor

Lewis base :electron pair donor

Procedure : Some amount of organic base is reacted with H_2PtCl_6 and forms salt known as chloroplatinate. If base is denoted by B then salt formed

(i) with monoacidic base = $B_2H_2PtCl_6$

(ii) with diacidic base = $B_2(H_2PtCl_6)_2$

(iii) with triacidic base = $B_2(H_2PtCl_6)_3$

The known amount (w_1 gm) of salt is heated and Pt residue is measured. (w_2 gm). If acidity of base is 'n'

then $\left(\frac{w_2}{195}\times\frac{1}{n}\right)\times M_{salt} = w_1$ and $M_{base} = \frac{M_{salt} - n(410)}{2}$

8.3 For % determination of elements in organic compounds :

☺ All these methods are applications of POAC

☺ Do not remember the formulas, derive them using the concept, its easy.

(a) **Liebig's method :** (*Carbon and hydrogen*)

$$(w)\text{ Organic Compound}\xrightarrow[CuO]{\Delta}(w_1)CO_2 + H_2O\,(w_2)$$

$$\%\text{ of C} = \frac{w_1}{44}\times\frac{12}{w}\times 100$$

$$\%\text{ of H} = \frac{w_2}{18}\times\frac{1}{w}\times 100$$

where w_1 = wt. of CO_2 produced, w_2 = wt. of H_2O produced,
w = wt. of organic compound taken

(b) **Duma's method :** (*for nitrogen*)

$$(w)\text{ Organic Compound}\xrightarrow[CuO]{\Delta} N_2 \rightarrow (P, V, T \text{ given})$$

use PV = nRT to calculate moles of N_2, n.

$$\therefore \quad \%\text{ of N} = \frac{n\times 28}{w}\times 100$$

w = wt of organic compound taken

(c) **Kjeldahl's method :** (*for nitrogen*)

$$(w)\text{O.C.} + H_2SO_4 \rightarrow (NH_4)_2SO_4 \xrightarrow{NaOH} NH_3 + H_2SO_4 \rightarrow (\text{molarity and volume } (V_1) \text{ consumed given})$$

$$\Rightarrow \quad \%\text{ of N} = \frac{MV_1\times 2\times 14}{w}\times 100$$

where M = molarity of H_2SO_4.

Some N containing compounds do not give the above set of reaction as in Kjeldahl's method.

(d) **Sulphur :**

(w) O.C. + $HNO_3 \rightarrow H_2SO_4 + BaCl_2 \rightarrow (w_1)\ BaSO_4$

$\Rightarrow \quad \%\ \text{of S} = \frac{w_1}{233} \times 1 \times 32 \times 100\%$.

where w_1 = wt. of $BaSO_4$, w = wt. of organic compound

(e) **Phosphorus :**

O.C + $HNO_3 \rightarrow H_3PO_4$ + [NH_3 + magnesia mixture ammonium molybdate] $\rightarrow MgNH_4PO_4$

$\xrightarrow{\Delta} Mg_2P_2O_7$

$$\%\ \text{of P} = \frac{w_1}{222} \times \frac{2 \times 31}{w} \times 100$$

(f) **Carius method :** (*Halogens*)

O.C. + HNO_3 + $AgNO_3 \rightarrow AgX$

If X is Cl then colour = white

If X is Br then colour = dull yellow

If X is I then colour = bright yellow

Flourine can't be estimated by this

$$\%\ \text{of X} = \frac{w_1}{(\text{M. weight of AgX})} \times \frac{1 \times (\text{At. wt. of X})}{w} \times 100$$

9. EUDIOMETRY : [For reactions involving gaseous reactants and products]

The stoichiometric coefficient of a balanced chemical reactions also gives the ratio of volumes in which gasesous reactants are reacting and products are formed at same temperature and pressure. The volume of gases produced is often given by mentioning certain solvent which absorb contain gases.

Solvent	**gas (es) absorb**
KOH	CO_2, SO_2, Cl_2
Ammon Cu_2Cl_2	CO
Turpentine oil	O_3
Alkaline pyrogallol	O_2
water	NH_3, HCl
$CuSO_4$	H_2O

Check out for certain assumption which are to be used for solving problem related to this.

EXERCISE # I

LAWS OF CHEMICAL COMBINATION

Q.10 What mass of sodium chloride would be decomposed by 9.8 gm of sulphuric acid, if 12 gm of sodium bisulphate and 2.75 gm of hydrogen chloride were produced in a reaction assuming that the law of conservation of mass is true?[Assume none of the reactants are remaining] [Ans. 4.95 gm]

Q.12 Zinc sulphate crystals contain 22.6% of zinc and 43.9% of water. Assuming the law of constant proportions to be true, how much zinc should be used to produce 13.7 gm of zinc sulphate crystal and how much water will they contain?

Q.13 Carbon combines with hydrogen to form three compounds A, B and C. The percentage of hydrogen in A, B and C are 25, 14.3 and 7.7 respectively. Which law of chemical combination is illustrated?
[Ans. law of multiple proportions]

Q.14 Illustrate the law of reciprocal proportions from the following data : KCl contains 52.0% potassium, KI contains 23.6% potassium and ICl contains 78.2% iodine.

ATOMIC MASS & MOLECULAR MASS

Q.1 The average mass of one gold atom in a sample of naturally occuring gold is 3.2707×10^{-22}g. Use this to calculate the molar mass of gold.

Q.2 A plant virus is found to consist of uniform symmetrical particles of 150 Å in diameter and 5000 Å long. The specific volume of the virus is 0.75 cm^3/g. If the virus is considered to be a single particle, find its molecular weight.

Q.3 Density of a gas relative to air is 1.17. Find the mol. mass of the gas. [M_{air} = 29g/mol]

MOLE

Q.4 If all 1 billion (10^9) people in India were put to work counting the atoms in a mole of gold and if each person could count one atom per second day and night for 365 days a year, how many years would it take to finish the count ?

Q.5 Vitamin C, ascorbic acid, has the formula $C_6H_8O_6$.

(a) The recommended daily dose of vitamin C is 60 milligrams. How many moles are you consuming if you ingest 60 mg of the vitamin ?

(b) A typical tablet contains 1.00 g of vitamin C. How many moles of vitamin C does this represent ?

(c) When you consume 1.00 gram of vitamin C, how many oxygen atoms are you eating ?

Q.6 Precious metals such as gold and platinum are sold in units of "troy ounces",where 1 troy ounce is 31.1 grams. If you have a block of platinum with a mass of 15.0 troy ounces, how many mole of the metal do you have ? What is the size of the block in cubic centimeters ? (The density of platinum is 21.45 g/cm^3at 20°C) (Atomic wt.of Pt. = 195)

Q.7 One type of artifical diamond (commonly called YAG for yttrium aluminium garnet) can be represented by the formula $Y_3Al_5O_{12}$.

(a) Calculate the weight percentage composition of this compound.

(b) What is the weight of yttrium present in a 200 – carat YAG if 1 carat - 200 mg ? (Y = 89, Al = 27)

Q.8 A chemical commonly called "dioxin" has been very much in the news in the past few years. (It is the by – product of herbicide manufacture and is thought to be quite toxic.) Its formula is $C_{12}H_4Cl_4O_2$. If you have a sample of dirt (28.3 g) that contains 1.0×10^{-4} % dioxin, how many moles of dioxin are in the dirt

sample ?

LIMITING REACTANT

Q.9 Titanium, which is used to make air plane engines and frames, can be obtained from titanium tetrachloride, which in turn is obtained from titanium oxide by the following process :

$$3\,TiO_2(s) + 4C\,(s) + 6Cl_2\,(g) \longrightarrow 3TiCl_4(g) + 2CO_2(g) + 2CO\,(g)$$

A vessel contains 4.15 g TiO_2, 5.67 g C and; 6.78 g Cl_2, suppose the reaction goes to completion as written, how many gram of $TiCl_4$ can be produced ? (Ti = 48)

Q.10 A chemist wants to prepare diborane by the reaction

$6\,LiH + 8BF_3 \longrightarrow 6Li\,BF_4 + B_2H_6$

If he starts with 2.0 moles each of LiH & BF_3. How many moles of B_2H_6 can be prepared.

Q.11 When you see the tip of a match fire, the chemical reaction is likely to be

$P_4S_3 + 8O_2 \longrightarrow P_4O_{10} + 3SO_2$

What is the minimum amount of P_4S_3 that would have to be burned to produce at least 1.0 g of P_4O_{10} and at least 1.0 g of SO_2

GRAVIMETRIC ANALYSIS

Q.12 1 gm sample of $KClO_3$ was heated under such conditions that a part of it decomposed according to the equation (1) $2KClO_3 \longrightarrow 2\,KCl + 3O_2$

and remaining underwent change according to the equation.

(2) $4KClO_3 \longrightarrow 3\,KClO_4 + KCl$

If the amount of O_2 evolved was 146.8 ml at S.T.P., calculate the % by weight of $KClO_4$ in the residue.

Q.13 A sample of calcium carbonate contains impurities which do not react with a mineral acid. When 2 grams of the sample were reacted with the mineral acid, 375 ml of carbon dioxide were obtained at 27°C and 760 mm pressure. Calculate the % purity of the sample of $CaCO_3$?

Q.14 One gram of an alloy of aluminium and magnesium when heated with excess of dil. HCl forms magnesium chloride, aluminium chloride and hydrogen. The evolved hydrogen collected over mercury at 0°C has a volume of 1.2 litres at 0.92 atm pressure. Calculate the composition of the alloy.

Q.15 A sample containing only $CaCO_3$ and $MgCO_3$ is ignited to CaO and MgO. The mixture of oxides produced weight exactly half as much as the original sample. Calculate the percentages of $CaCO_3$ and $MgCO_3$ in the sample.

Q.16 Determine the percentage composition of a mixture of anhydrous sodium carbonate and sodium bicarbonate from the following data:

wt. of the mixture taken = 2g

Loss in weight on heating = 0.124 g.

Q.17 A 10 g sample of a mixture of calcium chloride and sodium chloride is treated with Na_2CO_3 to precipitate calcium as calcium carbonate. This $CaCO_3$ is heated to convert all the calcium to CaO and the final mass of CaO is 1.62g. Calculate % by mass of NaCl in the original mixture.

Q.18 In a gravimetric determination of P an aqueous solution of NaH_2PO_4 is treated with a mixture of ammonium and magnesium ions to precipitate magnesium ammonium phosphate $Mg(NH_4)PO_4.\ 6H_2O$. This is heated and decomposed to magnesium pyrophosphate, $Mg_2P_2O_7$ which is weighed. A solution of NaH_2PO_4 yielded 1.054 g of $Mg_2P_2O_7$. What weight of NaH_2PO_4 was present originally ?

Q.19 By the reaction of carbon and oxygen, a mixture of CO and CO_2 is obtained. What is the composition of the mixture obtained when 20 grams of O_2 reacts with 12 grams of carbon ?

Q.20 A mixture of nitrogen and hydrogen. In the ratio of one mole of nitrogen to three moles of hydrogen, was partially converted into NH_3 so that the final product was a mixture of all these three gases. The mixture was to have a density of 0.497 g per litre at 25°C and 1.00 atm. What would be the mass of gas in 22.4 litres at S.T.P? Calculate the % composition of this gaseous mixture by volume.

Q.21 Direct reaction of iodine (I_2) and chlorine (Cl_2) produces an iodine chloride, I_xCl_y, a bright yellow solid. If you completely used up 0.508 g of iodine and produced 0.934 g of I_xCl_y, what is the empirical formula of the compound? Later experiment showed the molar mass, of I_xCl_y was 467 g/mol. What is the molecular formnula of the compound ? (I = 127)

Q.22 Equal weights of mercury and I_2 are allowed to react completely to form a mixture of mercurous and mercuric iodide leaving none of the reactants. Calculate the ratio of the wts of Hg_2I_2 and HgI_2 formed.

EMPIRICAL & MOLECULAR FORMULA

Q.23 Tha action of bacteria on meat and fish produces a poisonous compound called cadaverine. As its name and origin imply, it stinks! It is 58.77% C, 13.81% H, and 27.42% N. Its molar mass is 102 g/mol. Determine the molecular formula of cadaverine.

Q.24 Polychlorinated biphenyls, PCBs, known to be dangerous environmental pollutants, are a group of compounds with the general empirical formula $C_{12}H_mCl_{10-m}$, where m is an integer. What is the value of m, and hence the empirical formula of the PCB that contains 58.9% chlorine by mass ?

Q.25 Given the following empirical formulae and molecular weights, compute the true molecular formulae :

	Empirical Formula	Molecular weight		Empirical Formula	Molecular weight
(a)	CH_2	84	(b)	CH_2O	150
(c)	HO	34	(d)	HgCl	472
(e)	HF	80			

Q.26 Hexachlorophene, $C_{13}H_6Cl_6O_2$, is a germicide in soaps. Calculate weight percent of each element in the compound.

Q.27 What is the empirical formula of a compound 0.2801 gm of which gave on complete combustion 0.9482 gm of carbon dioxide and 0.1939 gm of water ?

Q.28 What is the percentage of nitrogen in an organic compound 0.14 gm of which gave by Dumas method 82.1 c.c. of nitrogen collected over water at 27°C and at a barometric pressure of 774.5 mm? (aqueous tension of water at 27°C is 14.5 mm)

Q.29 0.2000 gm of an organic compound was treated by Kjeldahl's method and the resulting ammonia was passed into 50 cc of M/4 H_2SO_4. The residual acid was then found to require 36.6 cc of M/2 NaOH for neutralisation. What is the percentage of nitrogen in the compound?

Q.30 0.275 gm of an organic compound gave on complete combustion 0.22 gm of carbon dioxide and 0.135 gm of water. 0.275 gm of the same compound gave by Carius method 0.7175 gm of silver chloride. What is the empirical formula of the compound ?

Q.31 0.6872 gm of an organic compound gave on complete combustion 1.466 gm of carbon dioxide and 0.4283 gm of water. A given weight of the compound when heated with nitric acid and silver nitrate gave an equal weight of silver chloride. 0.3178 gm of the compound gave 26.0cc of nitrogen at 15°C and 765 mm pressure. Deduce the empirical formula of the compound?

Q.32 0.80g of the chloroplatinate of a mono acid base on ignition gave 0.262g of Pt. Calculate the mol wt of the base.

Q.33 A compound which contains one atom of X and two atoms of Y for each three atoms of Z is made by mixing 5.00 g of X, 1.15×10^{23} atoms of Y, 0.03 mole of Z atoms. Given that only 4.40 g of compound results. Calculate the atomic weight of Y if the atomic weight of X and Z are 60 and 80 a.m.u. respectively.

CONCENTRATION TERMS

Q.34 Calculate the molarity of the following solutions :

(a) 4g of caustic soda is dissolved in 200 mL of the solution.

(b) 5.3 g of anhydrous sodium carbonate is dissolved in 100 mL of solution.

(c) 0.365 g of pure HCl gas is dissolved in 50 mL of solution.

Q.35 The density of a solution containing 13% by mass of sulphuric acid is 1.09 g/mL. Calculate the molarity of the solution.

Q.36 The mole fraction of CH_3OH in an aqueous solution is 0.02 and its density is 0.994 g cm^{-3}. Determine its molarity and molality.

Q.37 The density of a solution containing 40% by mass of HCl is 1.2 g/mL. Calculate the molarity of the solution.

Q.38 A mixture of ethanol and water contains 54% water by mass. Calculate the mole fraction of alcohol in this solution.

Q.39 15 g of methyl alcohol is present in 100 mL of solution. If density of solution is 0.90 g mL^{-1}. Calculate the mass percentage of methyl alcohol in solution.

Q.40 Units of parts per million (ppm) or per billion (ppb) are often used to describe the concentrations of solutes in very dilute solutions. The units are defined as the number of grams of solute per million or per billion grams of solvent. Bay of Bengal has 1.9 ppm of lithium ions. What is the molality of Li^+ in this water ?

Q.41 A 6.90 M solution of KOH in water contains 30% by mass of KOH. Calculate the density of the solution.

Q.42 Fill in the blanks in the following table.

Compound	Grams Compd	Grams Water	Molality of Compd	Mole Fraction of Compd
Na_2CO_3	_____	250	0.0125	_____
CH_3OH	13.5	150	_____	_____
KNO_3	_____	555	_____	0.0934

Q.43 A solution of specific gravity 1.6 is 67% by weight. What will be the % by weight of the solution of same acid if it is diluted to specific gravity 1.2 ?

Q.44 Find out the volume of 98% w/w H_2SO_4 (density = 1.8 gm/ ml) must be diluted to prepare 12.5 litres of 2.5 M sulphuric acid solution.

Q.45 Determine the volume of diluted nitric acid (d = 1.11 g mL^{-1}, 19% w/v HNO_3) That can be prepared by diluting with water 50 mL of conc. HNO_3 (d =1.42 g mL^{-1}, 69.8% w /v).

Q.46 A mixture of Xe and F_2 was heated. A sample of white solid thus formed reacted with H_2, to give 112 ml of Xe at STP and HF formed required 30 ml of 1 M NaOH for complete neutralization. Determine empirical formula.

Q.47 A certain oxide of iron contains 2.5 grams of oxygen for every 7.0 grams of iron. If it is regarded as a mixture of FeO and Fe_2O_3 in the weight ratio x : y, what is x : y, (atomic weight of iron = 56).

Q.48 In what ratio shoudl you mix 0.2M $NaNO_3$ and 0.1M $Ca(NO_3)_2$ solution so that in resulting solution, the concentration of negative ion is 50% greater than conc. of positive ion.

Q.49 Sulfur dioxide is an atmospheric pollutant that is converted to sulfuric acid when it reacts with water vapour. This is one source of acid rain, one of our most pressing environmental problems. The sulfur dioxide content of an air sample can be determined as follows. A sample of air is bubbled through an aqueous solution of hydrogen peroxide to convert all of the SO_2 to H_2SO_4

$$H_2O_2 + SO_2 \longrightarrow H_2SO_4$$

Titration of the resulting solution completes the analysis. In one such case, analysis of 1550 L of Los Angeles air gave a solution that required 5.70 ml of 5.96 x 10^{-3}M NaOH to complete the titration. Determine the number of grams of SO_2 present in the air sample.

SOME TYPICAL CONCENTRATION TERMS

Q.50 Calculate the St. of "20V " of H_2O_2 in terms of

(i) gm/L (ii) M (iii) % by volume

Q.51 Calculate composition of the final solution if 100 gm oleum labelled as 109% is added with
(a) 9 gm water (b) 18 gm water (c) 120 gm water

EUDIOMETRY

Q.52 10 ml of a mixture of CO, CH_4 and N_2 exploded with excess of oxygen gave a contraction of 6.5 ml. There was a further contraction of 7 ml, when the residual gas treated with KOH. What is the composition of the original mixture?

Q.53 When 100 ml of a $O_2 - O_3$ mixture was passed through turpentine, there was reduction of volume by 20 ml. If 100 ml of such a mixture is heated, what will be the increase in volume?

Q.54 9 volumes of a gaseous mixture consisting of a gaseous organic compound A and just sufficient amount of oxygen required for complete combustion yielded on burning 4 volumes of CO_2, 6 volumes of water vapour and 2 volumes of N_2, all volumes measured at the same temperature and pressure. If the compound A contained only C, H and N (i) how many volumes of oxygen are required for complete combustion and (ii) what is the molecular formula of the compound A?

Q.55 60 ml of a mixture of nitrous oxide and nitric oxide was exploded with excess of hydrogen. If 38 ml of N_2 was formed, calculate the volume of each gas in the mixture.

Q.56 When a certain quantity of oxygen was ozonised in a suitable apparatus, the volume decreased by 4 ml. On addition of turpentine the volume further decreased by 8 ml. All volumes were measured at the same temperature and pressure. From these data, establish the formula of ozone.

Q.57 10 ml of ammonia were enclosed in an eudiometer and subjected to electric sparks. The sparks were continued till there was no further increase in volume. The volume after sparking measured 20 ml. Now 30 ml of O_2 were added and sparking was continued again. The new volume then measured 27.5 ml. All volumes were measured under identical conditions of temperature and pressure. V.D. of ammonia is 8.5. Calculate the molecular formula of ammonia. Nitrogen and Hydrogen are diatomic.

EXERCISE # II

Q.1 Nitrogen (N), phosporus (P), and potassium (K) are the main nutrients in plant fertilizers. According to an industry convention, the numbers on the label refer to the mass % of N, P_2O_5, and K_2O, in that order. Calculate the N : P : K ratio of a 30 : 10 : 10 fertilizer in terms of moles of each elements, and express it as x : y : 1.0.

Q.2 One mole of a mixture of N_2, NO_2 and N_2O_4 has a mean molar mass of 55.4. On heating to a temperature at which N_2O_4 may be dissociated : $N_2O_4 \longrightarrow 2NO_2$, the mean molar mass tends to the lower value of 39.6. What is the mole ratio of N_2 : NO_2 : N_2O_4 in the original mixture?

Q.3 10 mL of gaseous organic compound contain C, H and O only was mixed with 100 mL of O_2 and exploded under identical conditions and then cooled. The volume left after cooling was 90 mL. On treatment with KOH a contraction of 20 mL was observed. if vapour density of compound is 23 derive molecular formula of the compound.

Q.4 Fluorocarbon polymers can be made by fluorinating polyethylene according to the reaction $(CH_2)n + 4nCoF_3 \longrightarrow (CF_2)_n + 2nHF + 4nCoF_2$, where n is a large integer. The CoF_3 can be regenerated by the reaction $2\,CoF_2 + F_2 \longrightarrow 2CoF_3$. If the HF formed in the first reaction cannot be reused, how many kg of fluorine are consumed per kg of fluorocarbon produced, $(CF_2)_n$? If HF can be recovered and electrolyzed to hydrogen and fluorine, and if this fluorine is used for regenerating CoF_3,

what is the net consumption of fluorine per kg of fluorocarbon ?

Q.5 $A_2 + 2B_2 \longrightarrow A_2B_4$

$\frac{3}{2}A_2 + 2B_2 \longrightarrow A_3B_4$

Two substance A_2 & B_2 react in the above manner when A_2 is limited it gives A_2B_4 in excess gives A_3B_4. A_2B_4 can be converted to A_3B_4 when reacted with A_2. Using this information calculate the composition of the final mixture when the mentioned amount of A & B are taken

(a) 4 moles A_2 & 4 moles B_2 (b) $\frac{1}{2}$ moles A_2 & 2 moles B_2

(c) 1.25 moles A_2 & 2 moles B_2

Q.6 Exchange of ions in a solution by two compounds is known as metathesis reaction. How much minimum volume of 0.1 M aluminium sulphate solution should be added to excess calcium nitrate to obtain atleast 1 gm of each salt in the metathesis reaction.

$$Al_2(SO_4)_3 + 3Ca(NO_3)_2 \longrightarrow 2Al(NO_3)_3 + 3CaSO_4$$

Q.7 In a water treatment plant, Cl_2 used for the treatment of water is produced from the following reaction $2KMnO_4 + 16\,HCl \longrightarrow 2KCl + 2MnCl_2 + 8H_2O + Cl_2$. If during each feed 1 *l* $KMnO_4$ having 79% (w/v) $KMnO_4$ & 9 *l* HCl with d = 1.825 gm/ ml & 10% (w/w) HCl are entered & if that percent yield is 80% then calculate

(a) amount of Cl_2 produced.

(b) amount of water that can be treated by Cl_2 if 1 litres consumes 28.4 g of Cl_2 for treatment.

(c) Calculate efficiency η of the process if $\eta = \frac{\text{vol. of water treated}}{\text{vol of total feed}}$

Q.8 Hexane (C_6H_{14}) & aniline (C_6H_7N) are partially miscible. At 25°C, 0.5 mole of hexane & 0.5 mol of aniline are shaken together & allowed to settle. Two liquid layers are formed.On analysis, the layer A rich in aniline has 10 mol% of hexane while the layer B, rich in hexane has 70 mole% of hexane. What is the weight ratio of layers A & B?

Q.9 The molecular mass of an organic acid was determined by the study of its barium salt. 2.562 g of salt was quantitatively converted to free acid by the reaction 30 ml of 0.2 M H_2SO_4, the barium salt was found to have two moles of water of hydration per Ba^{+2} ion and the acid is mono basic. What is molecularweight of anhydyous acid ? (At. mass of Ba = 137)

Q.10 Three different brands of liquid chlorine are available in the market for the use in purifying water of swimming pools. All are sold at the same rate of Rs 10 per litre and all are water solutions. Brand A contains 10% hypochlorite (ClO), brand B contains 7% available chlorine (Cl) and brand C contains 14% sodium hypochlorite (NaClO). All percentage are (w/v) ratios. Which of the three would you buy?

Q.11 A complex compound cobalt has : Co = 22.58%, H = 5.79%, N = 32.2%, O = 12.26% and Cl=27.17%. When the compound is heated it lost NH_3 to the extent of 32.63% of its original weight. How many molecules of NH_3 are present in the complex compound ? Derive empirical formula of the compound. (Co = 59)

Q.12 A sea water sample has a density of 1.03 g/cm^3 and 2.8% NaCl by mass. A saturated solution of NaCl in water is 5.45 M NaCl. How much water would have to be evaporated from 1.00×10^6 L of the sea water before NaCl would precipitate ?

Q.13 A mixture of formic acid (HCOOH) and oxalic acid ($H_2C_2O_4$) is heated with conc. H_2SO_4. The gas

produced is collected and on its treatment with KOH solution the volume of the gas decreases by one sixth. Calculate the molar ratio of the two acid in the original mixture. The reactions are

$HCOOH\ (l) + H_2SO_4\ (l) \longrightarrow CO(g) + H_2SO_4.\ H_2O$ (liq.)

$H_2C_2O_4\ (l) + H_2SO_4\ (l) \longrightarrow CO(g) + CO_2(g) + H_2SO_4\ .\ H_2O$ (liq.)

Q.14 A sample of oleum is such that ratio of "free SO_3" by "combined SO_3" is equal to unity. Calculate its labelling in terms of percentage oleum.

Q.15 One litre of milk weighs 1.035 kg. The butter fat is 4% (v/v) of milk has density of 875 kg/m^3. Find the density of fat free skimed milk.

Q.16 A sample of fuming sulphuric acid containing H_2SO_4, SO_3 and SO_2 weighing 1.00 g is found to require 23.47 mL of 1.00 M alkali (NaOH) for neutralisation. A separate sample shows the presence of 1.50% SO_2. Find the percentage of "free" SO_3, H_2SO_4 and "combined" SO_3 in the sample.

Q.17 Chloride samples are prepared for analysis by using NaCl, KCl and NH_4Cl separately or as mixture. What minimum volume of 5 % by weight $AgNO_3$ solution(sp.gr, 1.04 g ml^{-1}) must be added to a sample of 0.3 g in order to ensure complete precipitation of chloride in every possible case?

Q.18 In one process for waterproofing, a fabric is exposed to $(CH_3)_2SiCl_2$ vapour. The vapour reacts with hydroxyl groups on the surface of the fabric or with traces of water to form the waterproofing film $[(CH_3)_2SiO]_n$, by the reaction

$$n(CH_3)_2SiCl_2 + 2nOH^- \longrightarrow 2nCl^- + nH_2O + [(CH_3)_2SiO]_n$$

where n stands for a large integer. The waterproofing film is deposited on the fabric layer upon layer. Each layer is 6.0 Å thick [the thickness of the $(CH_3)_2SiO$ group]. How much $(CH_3)_2\ SiCl_2$ is needed to waterproof one side of a piece of fabric, 1.00 m by 3.00 m, with a film 300 layers thick ? The density of the film is 1.0 g/cm^3.

Q.19 Diatoms, microscopic organism, produce carbohydrates from carbon dioxide and water by normal photosynthesis :

$6\ CO_2 + 6\ H_2O$ + solar energy $\longrightarrow C_6H_{12}O_6 + 6\ O_2$. During the first five years of life whales gain 75 kg of mass per day.

(a) Assuming that the mass gain in the first five years of a whale's life is due to the production of carbohydrates, calculated the volume of CO_2 per day at 0°C and 101 kPa that must be used by the diatoms to produce the carbohydrates.

(b) There is 0.23 mL of dissolved CO_2 per *l* sea water (at 24°C and 101 kPa). If diatoms can completely remove carbon dioxide from the water they process, what volume of water would they process to produced the carbohydrates required by a blue whale per day?

(c) 3% of the mass of a 9.1×10^4 kg adult whale is nitrogen. What is the maximum mass of NH_4^+ that can become available for other marine organisms if one adult whale dies ?

(d) 18% of a adult whale's mass is carbon which can be returned to the atmosphere as CO_2 being removed from there by weathering of rocks containing calcium silicate.

$$CaSiO_3(s) + 2CO_2 + 3H_2O(l) \longrightarrow Ca^{2+}(aq) + 2HCO_3^-(aq) + H_4SiO_4(aq)$$

What are the maximum grams of $CaSiO_3$ that can be weathered by the carbon dioxide produced from the decomposition of 1000 blue whales, the number estimated to die annually ?

Q.20 20 ml of a mixture of methane and a gaseous compound of Acetylene series were mixed with 100 ml of oxygen and exploded. The volume of the products after cooling to original room temperature and pressure, was 80 ml and on treatment with potash solution a further contracting of 40 ml was observed. Calculate (a) the molecular formula of the hydrocarbon, (b) the percentage composition of the mixture.

Q.21 In a solution the concentrations of $CaCl_2$ is 5M & that of $MgCl_2$ is 5m. The specific gravity of solution is 1.05, calculate the concentration of Cl^- in the solution in terms of Molarlity.

Q.22 3.6 g of Mg is burnt in limited supply of oxygen. The residue was treated with 100 mL of H_2SO_4 (35% by mass, 1.26 g mL^{-1} density). When 2.463 L of H_2 at 760 mm Hg at 27^0C was evolved. After the reaction, H_2SO_4 was found to have a density of 1.05 g mL^{-1}. Assuming no volume change in H_2SO_4 solution. Find
(i) % by mass of final H_2SO_4
(ii) % by mass of Mg converted to oxide
(iii) mass of oxygen used. (Mg = 24, S= 32)

Q.23 A mixture of H_2, N_2 & O_2 occupying 100 ml underwent reaction so as to form H_2O_2 (*l*) and N_2H_2 (g) as the only products, causing the volume to contract by 60 ml. The remaining mixture was passed through pyrogallol causing a contraction of 10 ml. To the remaining mixture excess H_2 was added and the above reaction was repeated, causing a reduction in volume of 10 ml. Identify the composition of the initial mixture in mol %. (No other products are formed)

Q.24 For a gas A_2B_6 dissociating like $A_2B_6(g) \longrightarrow A_2(g) + 3B_2(g)$, Vapour densities of the mixture at various time is observed. From the data & informations given.

Informations

(1) At t = 0, reaction starts with 1 mole of A_2B_6 only & observed V.D. = 50.
(2) Density of A_2B_6 relative to A_2 is 2.5.
(3) Reaction is complete at time t = 40 min.

Observations

(i) time t = 0 , V.D. = 50
(ii) time t = 10 min., V.D. = 25
(iii) time t = 20 min., V.D.=20

Calculate
(a) Molecular weight of A_2B_6, Atomic weight of A, Atomic weight of B.
(b) Mole percent of A_2B_6, A_2B_6, A_2 & B_2 at t =10 min.
(c) Mass percent of A_2B_6, A_2 & B_2 at t = 20 min.
(d) Rate of disappearance of A_2B_6 between t =10 to t = 20, if it is assumed that it disappears uniformly during this time interval. [Rate of disappearance = $\frac{Mole\ \ dissociated}{Time\ \ taken}$]
(e) Vap. density of mixture at t = 40 min.

Q.25 An **impure** sample of CH_3COONa, Na_2SO_4 & $NaHCO_3$ containing equal moles of each component was heated to cause liberation of CO_2 gas [Assume no dissociation of CH_3COONa to give CO_2 gas]. If 7.389 *l* of CO_2 gas at 1 atm pressure & 300 K is evolved & it is known that the sample contains 50% by mass inert impurities (which are not involved in any reactions) then calculate
(a) moles of each component
(b) wt. of total impure sample
(c) Volume of 0.2 M HCl required for complete neutralisation of that wt. of fresh impure sample as obtained in (b) part. [Assume no interference by weaker acid (if formed) in neutralization process in presence of strong acid]

Q.26 An **impure** sample of $CuSO_4.5H_2O$ (having 40% purity) undergoes following sequence of reactions in a reaction flask having large amount of KCN

$CuSO_4.5H_2O \longrightarrow CuSO_4 + 5H_2O$ ....(1)
$CuSO_4 + KCN \longrightarrow Cu(CN)_2 + K_2SO_4$ ....(2)
$Cu(CN)_2 \longrightarrow Cu_2(CN)_2 + (CN)_2\uparrow$ ....(3)
$Cu_2(CN)_2 + KCN \longrightarrow K_3[Cu(CN)_4]$ ....(4)

If % yield of react. (1) is 100% (2) is 80% (3) is 60% & (4) is 50%. Calculate
(i) wt. of impure sample of $CuSO_4.5H_2O$ required for producing 28.5 gm of complex compound $K_3[Cu(CN)_4]$
(ii) vol. of $(CN)_2$ gas produced at STP if wt. of impure sample of $CuSO_4.5H_2O$ as obtained in 'a' is reacted

EXERCISE # III

Q.1 Equal volumes of 10% (v/v) of HCl is mixed with 10% (v/v) NaOH solution. If density of pure NaOH is 1.5 times that of pure HCl then the resultant solution be.
(A) basic (B) neutral (C) acidic (D) can't be predicted.

Q.2 A definite amount of gaseous hydrocarbon having (carbon atoms less than 5) was burnt with sufficient amount of O_2. The volume of all reactants was 600 ml, after the explosion the volume of the products [CO_2(g) and H_2O(g)] was found to be 700 ml under the similar conditions. The molecular formula of the compound is
(A) C_3H_8 (B) C_3H_6 (C) C_3H_4 (D) C_4H_{10}

Q.3 A mixture (15 mL) of CO and CO_2 is mixed with V mL (excess) of oxygen and electrically sparked. The volume after explosion was (V + 12) mL. What would be the residual volume if 25 mL of the original mixture is exposed to KOH. All volume measurements were made at the same temperature and pressure
(A) 7 mL (B) 12 mL (C) 10 mL (D) 9 mL

Q.4 One gram of the silver salt of an organic dibasic acid yields, on strong heating, 0.5934 g of silver. If the weight percentage of carbon in it 8 times the weight percentage of hydrogen and one-half the weight percentage of oxygen, determine the molecular formula of the acid. [Atomic weight of Ag = 108]
(A) $C_4H_6O_4$ (B) $C_4H_6O_6$ (C) $C_2H_6O_2$ (D) $C_5H_{10}O_5$

Q.5 The density of vapours of a particular volatile specie was found to be 10 miligram / ml at STP. Its atomic weight in amu is
(A) 20 amu (B) 112 amu (C) 224 amu (D) data insufficient

Q.6 A mixture of C_3H_8 (g) & O_2 having total volume 100 ml in an Eudiometry tube is sparked & it is observed that a contraction of 45 ml is observed what can be the composition of reacting mixture.
(A) 15 ml C_3H_8 & 85 ml O_2 (B) 25 ml C_3H_8 & 75 ml O_2
(C) 45 ml C_3H_8 & 55 ml O_2 (D) 55 ml C_3H_8 & 45 ml O_2

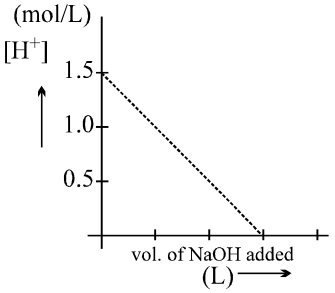
Q.7 Carbon can react with O_2 to form CO & CO_2 depending upon amount of substances taken. If each option is written in an order like (x, y, z, p) where x represents moles of C taken, y represents moles of O_2 taken z represents moles of CO formed & p represents moles of CO_2 formed, then which options are correct.
(A) (1, 0.75, 0.5, 0.5) (B) (1, 0.5, 0, 0.5)
(C) (1, 0.5, 0.5, 0) (D) (1, 2, 1, 1)

Q.8 One mole mixture of CH_4 & air (containing 80% N_2 20% O_2 by volume) of a composition such that when underwent combustion gave maximum heat (assume combustion of only CH_4). Then which of the statements are correct, regarding composition of initial mixture.(X presents mole fraction)

(A) $X_{CH_4} = \frac{1}{11}, X_{O_2} = \frac{2}{11}, X_{N_2} = \frac{8}{11}$ (B) $X_{CH_4} = \frac{3}{8}, X_{O_2} = \frac{1}{8}, X_{N_2} = \frac{1}{2}$

(C) $X_{CH_4} = \frac{1}{6}, X_{O_2} = \frac{1}{6}, X_{N_2} = \frac{2}{3}$ (D) Data insufficient

Q.9 To 500 ml of 2 M impure H_2SO_4 sample, NaOH soluton 1 M was slowly added & the followng plot was obtained. The percentage purity of H_2SO_4 sample and slope of the curve respectively are:



(A) 50%, $-\frac{1}{3}$ (B) 75%, $-\frac{1}{2}$
(C) 75% , –1 (D) none of these

Q.10 Two gaseous ions of unknown charge & mass initially at rest are subjected to same potential difference for accelerating the charges & then subjected to same magnetic field (placed perpendicular to the velocity) & following observations were made.

Obs 1. Before entering the magnetic field zone both ions had same kinetic energy.

Obs 2. The radius of curvature of ion A was greater than that of B.

Stat 1: The magnitude of charge on both the ions should be same

Stat 2: Particle A is more massive than particle B

Stat 3: The e/m ratio of A is higher than that of B

(A) Only Stat 1 & Stat 2 are correct (B) Only Stat 3 is correct

(C) Only Stat 2 is incorrect (D) Only Stat 1 is incorrect

Q.11 Two gases A and B which react according to the equation

$$aA_{(g)} + bB_{(g)} \longrightarrow cC_{(g)} + dD_{(g)}$$

to give two gases C and D are taken (amount not known) in an Eudiometer tube (operating at a constant Pressure and temperature) to cause the above.

If on causing the reaction there is no volume change observed then which of the following statement is/ are correct.

(A) (a + b) = (c + d)

(B) average molecular mass may increase or decrease if either of A or B is present in limited amount.

(C) Vapour Density of the mixture will remain same throughout the course of reaction.

(D) Total moles of all the component of taken mixture will change.

Question No. 12 to 13 (2 questions)

A mixture of H_2 and Acetylene (C_2H_2) was collected in a Eudiometer tube. Then, 60 ml of oxygen were also introduced. The resulting mixture of all the gases was exploded. **After** cooling **a resulting gaseous mixture passes through** Caustic potash solution a contraction of 32 ml occurred and 13 ml of oxygen alone were left behind.

Q.12 After explosion, on cooling of resulting mixture, contraction in volume will be

(A) 21 ml (B) 30 ml (C) 45 ml (D) none

Q.13 Percentage composition of the gaseous mixture of H_2 & acetylene are

(A) 53.3, 46.7 (B) 46.7, 53.3 (C) 15.7, 84.3 (D) 84.3, 15.7

Question No. 14 to 17 (4 questions)

A 4.925 g sample of a mixture of $CuCl_2$ and $CuBr_2$ was dissolved in water and mixed thoroughly with a 5.74 g portion of AgCl. After the reaction the solid, a mixture of AgCl and AgBr, was filtered, washed, and dried. Its mass was found to be 6.63 g.

Q.14 % By mass of $CuBr_2$ in original mixture is

(A) 2.24 (B) 74.5 (C) 45.3 (D) None

Q.15 % By mass of Cu in original mixture is

(A) 38.68 (B) 19.05 (C) 3.86 (D) None

Q.16 % by mole of AgBr in dried precipate is

(A) 25 (B) 50 (C) 75 (D) 60

Q.17 No. of moles of Cl^- ion present in the solution after precipitation are

(A) 0.06 (B) 0.02 (C) 0.04 (D) None

Question No. 18 to 20 (3 questions)

NaBr, used to produce AgBr for use in photography can be self prepared as follows :

$Fe + Br_2 \longrightarrow FeBr_2$ ....(1)

$FeBr_2 + Br_2 \longrightarrow Fe_3Br_8$ ....(2) (not balanced)

$Fe_3Br_8 + Na_2CO_3 \longrightarrow NaBr + CO_2 + Fe_3O_4$ ....(3) (not balanced)

How much Fe in kg is consumed to produce 2.06×10^3 kg NaBr. ....(4)

Q.18 Mass of iron required to produce 2.06×10^3 kg NaBr

(A) 420 gm (B) 420 kg (C) 4.2×10^5 kg (D) 4.2×10^8 gm

Q.19 If the yield of (ii) is 60% & (iii) reaction is 70% then mass of iron required to produce 2.06×10^3 kg NaBr

(A) 10^5 kg (B) 10^5 gm (C) 10^3 kg (D) None

Q.20 If yield of (iii) reaction is 90% then mole of CO_2 formed when 2.06×10^3 gm NaBr is formed

(A) 20 (B) 10 (C) 40 (D) None

Question No. 21 to 23 (3 questions)

In the gravimetric determination of sulfur the ignited precipitate of $BaSO_4$ sometimes partially reduces to BaS. This cause an error, of course, if the analyst does not realize this and convert the BaS back to $BaSO_4$. Suppose a sample which contains 32.3% SO_3 is analyzed and 20.0% of the final precipitate that is weighed is BaS. (80.0% is $BaSO_4$). What percentage of SO_3 in the sample would the analyst calculate if he assume the entire precipitate as $BaSO_4$? Repeat the question if BaS was 20% by mole.

Q.21 Calculate the mass of sample, assuming 100 gm precipitate is formed

(A) 106.3 gm (B) 114.35 gm (C) 110.5 gm (D) None

Q.22 Percentage of SO_3 in the sample, calculated by analyst is (if the assume the entire precipiate as $BaSO_4$)

(A) 30 (B) 30.5 (C) 32 (D) 32.3

Q.23 If BaS was 20% by mole in precipitate, then percentage of SO_3 in the sample calculated by analyst is (if he assume the entire precipitate as $BaSO_4$)

(A) 30 (B) 30.5 (C) 32 (D) 32.3

Question No. 24 to 25 are based on the following Passage. Read it carefully & answer the questions that follow

A monobasic acid of weight 15.5 gms is heated with excess of oxygen & evolved gases when passed through KOH solution increased its weight by 22 gms and when passed through anhydrous $CaCl_2$, increased its weight by 13.5 gms. When the same mass of this organic acid is reacted with excess of silver nitrate solution form 41.75 gm silver salt of the acid which on ignition gave the residue of weight 27 gm.

Q.24 The molecular formula of the organic acid is

(A) C_2H_6 (B) $C_2H_5O_2$ (C) $C_2H_6O_2$ (D) C_2H_4O

Q.25 The molar masses of the acid & its silver salt respectively are

(A) 60, 168 (B) 167, 60 (C) 60, 167 (D) 168, 60

Question No. 26 to 28 (3 questions)

N_2O_5 and H_2O can react to form HNO_3, according to given reaction

$$N_2O_5 + H_2O \longrightarrow 2HNO_3$$

the concentration of a mixture of HNO_3 and N_2O_5 (g) can be expressed similar to oleum. Then answer the following question.

Q.26 Find the percentage labelling of a mixture containing 23 gm HNO_3 and 27 gm N_2O_5.

(A) 104.5% (B) 109% (C) 113.5% (D) 118%

Q.27 Find the maxmum and minimum value of percentage labelling

(A) 133.3 % (B) 116.66%, 0% (C) 116.66%, 100% (D) None

Q.28 Find the new labelling if 100 gm of this mixture (original) is mixed with 4.5 gm water

(A) $100 + \frac{4.5}{1}$ (B) $100 + \frac{4.5}{1.045}$ (C) $100 + \frac{4.5}{104.5}$ (D) $100 + \frac{4.5}{1.09}$

Question No. 29 and 30 are based on the following piece of information. Mark the appropriate options on the basis of information.

342 gm of 20% by mass of $Ba(OH)_2$ solution (sp. gr. 0.57) is reacted with 200 ml of 2M HNO_3 according to given balanced reaction.

$$\mathbf{Ba(OH)_2 + 2HNO_3 \longrightarrow Ba(NO_3)_2 + 2H_2O}$$

Q.29 The nature of the final solution is

(A) acidic (B) neutral (C) basic (D) can't say

Q.30 If density of final solution is 1.01 gm/ml then find the molarity of the ion in resulting solution by which nature of the above solution is identified, is

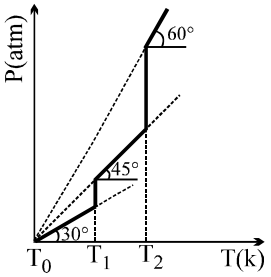
(A) 0.5 M (B) 0.8 M (C) 0.4 M (D) 1 M

Question No. 31 & 32 are based on the piece of information.

For a gaseous reaction,

$$2A(g) \longrightarrow 3B(g) + C(g)$$

Whose extent of dissociation depends on temperature is performed in a closed container, it is known that extent of dissociation of A is different in different temperature range. With in a temperature range it is constant. (Temperature range $T_0 - T_1, T_1 - T_2, T_2 - T_\infty$). A plot of P v/s T is drawn under the given condition.



Q.31 If $\alpha_{T_i - T_{i+1}}$ is the degree of dissociation of A then in the temperature range $T_i \to T_{i+1}$

(A) $\alpha_{T_0 - T_1}$ is lowest (B) $\alpha_{T_0 - T_1}$ is highest

(C) $\alpha_{T_2 - T_\infty} = 1$ (D) $\alpha_{T_2 - T_\infty} = 0$

Q.32 If initially 1 mole of A is taken in a 1 *l* container then [R = 0.0821 atm lit / k]

(A) $\alpha_{T_0 - T_1} = \frac{1}{2\sqrt{3R}} + \frac{1}{2}$ (B) $\alpha_{T_0 - T_1} = \frac{1}{2\sqrt{3R}} - \frac{1}{2}$

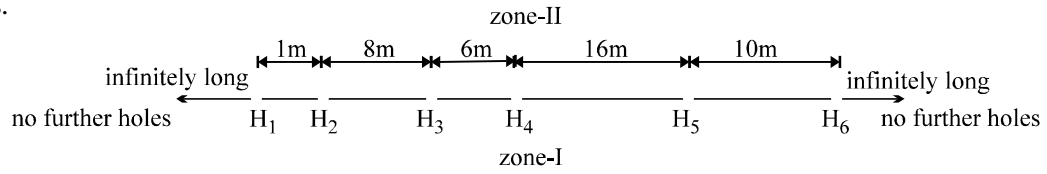
(C) $\alpha_{T_1 - T_2} = \frac{1}{R} + 1$ (D) $\alpha_{T_1 - T_2} = \frac{1}{R} - 1$

Q.33 Which has maximum number of atoms of oxygen

(A) 10 ml $H_2O(l)$ (B) 0.1 mole of V_2O_5

(C) 12 gm $O_3(g)$ (D) 12.044×10^{22} molecules of CO_2

Q.34 In a mass spectrometry experiment, various ions H^+, Li^+, O^{2+} & N_3^+ were projected with a same velocity into a same magnetic field zone (alligned perpendicular to the direction of velocity). The sheet on which they are striking is pierced at certain points (marked as H_1, H_2 etc.) as shown in the diagram. **It is known that H^+ comes back to zone-I from H_2 when projected from H_1.** Mark out the correct options.



(A) Out of all remaining ions when projected from H_1, only N_3^+ will come back to zone-I.

(B) When all the remaining ions were projected from H_2, only O^{2+} will come back in zone-I.

(C) When all the remaining ions were projected from H_3, none of the them will come back to zone-I.

(D) When all the remaining ions were projected from H_4, none of the them will come back to zone-I.

EXERCISE # IV

Q.1 An evacuated glass vessel weighs 50 gm when empty , 148.0 g when filled with liquid of density 0.98 gml^{-1} and 50.5 g when filled with an ideal gas at 760 mm at 300 K . Determine the molecular weight of the gas . **[JEE '98,3]**

Q.2 At 100° C and 1 atmp , 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 L of steam at that temperature is :

(A) 6 cm^3 (B) 60 cm^3 (C) 0.6 cm^3 (D) 0.06 cm^3 **[JEE '2001 (Scr), 1]**

Q.3 How many moles of e^- weigh one Kg **[JEE'2002 (Scr), 1]**

(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.4 Calculate the molarity of pure water using its density to be 1000 kg m^{-3}. **[JEE'2003]**

Q.5 One gm of charcoal absorbs 100 ml 0.5 M CH_3COOH to form a monolayer, and thereby the molarity of CH_3COOH reduces to 0.49. Calculate the surface area of the charcoal adsorbed by each molecule of acetic acid. Surface area of charcoal = 3.01×10^2 m^2/gm. **[JEE'2003]**

Q.6 Calculate the amount of Calcium oxide required when it reacts with 852 gm of P_4O_{10}. **[JEE 2005]**

$$6CaO + P_4O_{10} \longrightarrow 2Ca_3(PO_4)_2$$

Q.7 20% surface sites have adsorbed N_2. On heating N_2 gas evolved from sites and were collected at 0.001 atm and 298 K in a container of volume is 2.46 cm^3. Density of surface sites is 6.023×10^{14}/cm^2 and surface area is 1000 cm^2, find out the no. of surface sites occupied per molecule of N_2. **[JEE 2005]**

ANSWER KEY

EXERCISE # I

Q.1 196.2 Q.2 7.09×10^7 Q.3 33.9 Q.4 19.09×10^6 years

Q.5 (a) 3.41×10^{-4} mole, (b) 5.68×10^{-3} mole, (c) 2.05×10^{22} atoms

Q.6 2.39 mole Pt, 21.7 cm^3

Q.7 (a) Y = 44.95%, Al = 22.73%, O = 32.32%, (b) 17.98 gm Q.8 8.8×10^{-8} mole

Q.9 9.063 gm Q.10 0.250 Q.11 1.14 g Q.12 49.9%

Q.13 76.15% Q.14 Al = 0.546 g; Mg = 0.454 g Q.15 28.4%, 71.6%

Q.16 %$NaHCO_3$ = 16.8, % Na_2CO_3= 83.2 Q.17 67.9% Q.18 1.14 gm

Q.19 CO : CO_2 = 21 : 11 Q.20 12.15 gm; 14.28%, H_2 42.86%, NH_3 42.86%

Q.21 ICl_3, I_2Cl_6 Q.22 0.532 : 1 Q.23 $C_5H_{14}N_2$ Q.24 m = 4, $C_6H_2Cl_3$

Q.25 (a) C_6H_{12}, (b) $C_5H_{10}O_5$, (c) H_2O_2, (d) Hg_2Cl_2, (e) H_4F_4

Q.26 H = 1.486%, C = 38.37%, O = 7.87%, Cl = 52.28% Q.27 CH

Q.28 6.67% Q.29 46.9% Q.30 CH_3Cl Q.31 $C_7H_{10}NCl$

Q.32 92.70 Q.33 70 Q.34 (a) 0.5 M, (b) 0.5 M, (c) 0.2 M

Q.35 1.445 M Q.36 1.088 M, 1.13 m Q.37 13.15 M

Q.38 0.25 Q.39 16.67% Q.40 2.7×10^{-4} m Q.41 1.288 gm/ml

Q.42 0.331, 2.25×10^{-4}, 2.81, 0.0482, 321, 5.72 Q.43 29.77% Q.44 1736.1 ml

Q.45 183.68 ml Q.46 XeF_6 Q.47 9 : 10 Q.48 1 : 2

Q.49 1.09×10^{-3} gm Q.50 (i) 60.71 gm/l, (ii) 1.78 M, (iii) 6.071%

Q.51 (a) pure H_2SO_4(109 gm); (b) 109 gm H_2SO_4, 9 gm H_2O; (c) 109 gm H_2SO_4, 111 gm H_2O

Q.52 CO = 5 ml ; CH_4 = 2 ml ; N_2 = 3 ml Q.53 10 ml

Q.54 (i) 7 volumes, (ii) $C_2H_6N_2$ Q.55 NO = 44 ml ; N_2O = 16 ml

Q.56 O_3 Q.57 NH_3

EXERCISE # II

Q.1 10.07 : 0.662 : 1 Q.2 0.5 : 0.1 : 0.4 Q.3 C_2H_6O Q.4 1.52 kg, 0.76 kg

Q.5 (a) $A_3B_4 = 2$ & $A_2 = 1$; (b) $A_2B_4 = \frac{1}{2}$ & $B_2 = 1$ (c) $A_2B_4 = 0.5$ & $A_3B_4 = 0.5$

Q.6 24. 51 ml Q.7 (a)10 mol, (b) 25 *lit.*, (c) 2.5 Q.8 $W_A : W_B = 0.524$

Q.9 122.6 Q.10 Brand B Q.11 5 molecule, $[Co(NH_3)_5(NO_2)]Cl_2$

Q.12 9.095×10^5 lit Q.13 $\frac{HCOOH}{H_2C_2O_4} = \frac{4}{1}$ Q.14 110.11% Q.15 1.041 gm/ml

Q.16 $H_2SO_4 = 35.38\%$, Free $SO_3 = 63.1\%$, combined $SO_3 = 28.89\%$ Q.17 18.38 ml

Q.18 0.9413 gram Q.19 (a) 56000 lit/day, (b) 2.6×10^8 litres, (c) 3510 kg/day, (d) 7.917×10^7 kg

Q.20 (b) 50 Q.21 $[Cl^-] = 13.36$ M Q.22 (i) 28%, (ii) 33.33%, (iii) 0.8g

Q.23 $N_2 = 30$ ml, $H_2 = 40$ ml

Q.24 (a) 100, 20, 10; (b) 33.33%, 16.67%, 50%; (c) 50%, 20%, 30%; (d) 0.0167 mol/min; (e) 12.5

Q.25 (a) 0.6, (b) 369.6 gm (c)6 (*l*) Q.26 (i) 521.25 gm, (ii) 2.24 *l*

Q.27 In initial gaseous mixture gases of same molar mass are present.
$\therefore$ Avg. molar mass of the mixture will be 28.
After the appropriate reactions , the gas that will remain will be N_2 only since both C_2H_4 and CO will get oxidised to CO_2 which is then removed from KOH.
$\therefore$ Average Molar mass of final gaseous mixture is 28

EXERCISE # III

Q.1	A	Q.2	A	Q.3	C	Q.4	B
Q.5	D	Q.6	A,B	Q.7	A	Q.8	A
Q.9	D	Q.10	A	Q.11	A,C	Q.12	C
Q.13	B	Q.14	C	Q.15	A	Q.16	B
Q.17	C	Q.18	B,C,D	Q.19	C	Q.20	B
Q.21	B	Q.22	A	Q.23	B	Q.24	C
Q.25	C	Q.26	B	Q.27	C	Q.28	B
Q.29	C	Q.30	A	Q.31	A	Q.32	D
Q.33	C	Q.34	B,C,D				

EXERCISE # IV

Q.1	123 g/mol	Q.2	C	Q.3	D	Q.4	55.5 mol L^{-1}
Q.5	5×10^{-19} m^2	Q.6	1008 gm	Q.7	2		