Chemistry Grade10

PREPARED BY: VIRTUAL STUDY

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UNIT ONE

Chemical reactions and stoichiometry

Introduction:

⇨ **Chemical reaction are :-** the process of converting reacting substance to product.

⇨ Change is the law of nature

⇨ There are so many types of changes around

These are:- ⊗ Growth of speed in to plant

⊗ Rusting of iron

⊗ Melting of ice

⊗ Evaporation of liquids … e t c

⇨ In general changes can be either physical or chemical changes.

⇨ **Physical change:-** is a change that does not involve the formation of new substance.

E g:- Powdering of sugar

- ✓ Tearing of paper
- ✓ Melting of ice - - - e t c

⇨**Chemical change:-** is a change that involves the formation of new substance with new composition

E g:- Lusting of iron

Burning of substance

Rotting of egg - - - e t c

⇨ Chemical change is the result of chemical reaction

⇨ There are some indicators that used to show whether the chemical reaction proceed or not. These are

- ✓ Formation of new substance
- ✓ Formation of precipitate
- ✓ Change in color
- ✓ Production of heat
- ✓ Change in temperature

1.2 Chemical equations

⇨ **Chemical equation :-** is a short hand representation of a chemical reaction in terms of chemical symbols & formulas.

⇨ Chemical equation are represented by:

Reactants ⟶ Products

⇨ **Reactants are**:- Starting materials (in put materials)

⇨ Substances that written on the let side of the arrow.

⇨ **Product are**:- new substance formed during a chemical reaction.

⇨ Substances that written on the right side of the arrow.

⇨ The characteristics of products are completely deterrent from those of the reactants.

1.2.1 Writing Chemical equations

Step to write a chemical equation

① Write a word equation

② Change the word equation in to symbols and formulas

③ Balance the chemical equations

Eg:- Write the balance chemical equation for the reaction between: Ⓐ hydrogen and nitrogen to product ammonia.

Step- 1:- Nitrogen + Hydrogen → Ammonia

Step – 2:- $N_2 + H_2 \rightarrow NH_3$

Step – 3:- $N_2 + 3H_2 \rightarrow 2NH_3$

Note:- A chemical equation has both qualitative and quantitative meaning.

⊗ **Qualitative Meaning:-** represents the identity (kind) of reactants and products in a chemical equation.

⊗ **Qualitative Meaning:-** represent the number of atoms or molecules of reactants and products in the chemical equations.

Eg:- For the reaction given below:

$2H_2 + O_2 \rightarrow 2H_2O$

⇨ **Qualitative Meaning:-** the reaction between hydrogen and oxygen forms water.

⇨ **Quantitative Meaning:-** Two units of hydrogen react with one units of oxygen to form two units of water.

1.2.2 Balancing chemical equations

⇨ Balancing chemical equation is an equation in which the total atoms of reactants are equal to that of the products.

⇨ We balance a chemical equation by changing a coefficient but not a subscript.

⇨ It a chemical equation is balanced:-

⊗ Atoms , Mass , Charge and energy of reactants are always conserved, but moles and molecules reactants and products are not always conserved.

⇨ Same balancing methods of chemical equations' are:-

① Inspection method

② Least common multiple method (LCM)

③ Algebraic method

①**Inspection method:-** - It is a trial and error method

- Has four steps

Step- 1:- Write a word equation

Step – 2:- Convert a word equation in to chemical and formulas.

Step – 3:- Count and tabulate the no of atoms of reactants & products from un balanced equation

Step – 4:- equalize the number of each type of atoms of reactants & products.

Eg:- Balance the chemical reaction that takes place b/n iron and water to form iron (IV) oxide and hydrogen gas by inspection method.

Step- 1:- Iron + Water → Iron (IV) oxide + Hydrogen

Step – 2:- $Fe + H_2O \rightarrow Fe_3O_4 + H_2$

Step – 3:- tabulate the no of atoms both sides

Atoms	Reactants Side	Products Side
Fe	1	3
O	1	4
H	2	2
Total no atoms	4	9 un balanced

⇨ Balancing " Fe " atom by adding coefficient three to the reactant side **i. e** :- $3Fe + H_2O \rightarrow Fe_3O_4 + H_2$ - - - equation ①

⇨ Balance " O " atom by adding coefficient four to water **i. e :-** $3Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$ - - - equation ②

⇨ Balance " H " atom by putting four the coefficient H_2 **i. e:-** $3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$ ⇒ Balanced

② Least common multiple (LCM) Method

⇨ This method focus on the valence of reactants and products.

⇨ It follows a series of steps.

Step- 1:- Write a word equation

Step – 2:- Change a word equation in to symbol and formulas.

Step – 3:- place the total valiancy of each atom above it.

Step – 4:- Find the LCM of each total valiancy & place on the arrow.

Step – 5:- Divide the LCM by each total valiancy to obtained the coefficient of reactants and products.

Eg:- Balance the chemical reaction that takes place between Aluminum and oxygen to form aluminum oxide.

Step- 1:- Aluminum + Oxygen → Aluminum oxide.

Step – 2:- $Al + O_2 \rightarrow Al_2O_3$

Step – 3:- $\frac{3}{Al} + \frac{4}{O2} \rightarrow \frac{6}{Al_2O_3}$

Step – 4:- $\frac{3}{Al} + \underline{4} \quad \underline{12} \quad \frac{6}{Al_2O_3}$

O_2

Step – 5:- $4Al + 3O_2 \rightarrow 2Al_2O_3$ - balanced

③ Algebraic Method

⇨ This method involves by assigning algebraic variable (a , b , C - - -) as stoichiometric coefficient to each species

⇨ Steps of algebraic method

Step- 1:- Write un balanced equation with the correct symbol and formula

Step – 2:- Assign algebraic, variables (a, b, C ---) in the coefficient of un balanced equation.

Step – 3:- Choose the smallest variable and assign arbitrary no to determine the remaining variables.

E g:- Balance the chemical reaction that takes place b/nitrogen and hydrogen to form ammonia.

Step- 1:- $N_2 + H_2 \rightarrow NH_3$

Step – 2:- $aN_2 + H_2 \rightarrow CNH_3$

Step – 3:- N: $a = C$ Let $a = 1$

H : $2b = 3C$ $C = 1$

$2b = 3(1) \Rightarrow \frac{2b}{2} = \frac{3}{2} \Rightarrow$ **b = 3/2**

Then eliminate traction by multiplying the value of all variables by the highest denominator (2).

a = $1 \times 2 = 2$

b = $3/2 \times 2 = 3$

C = $1 \times 2 = 2$

∴ $2N_2 + 3H_2 \rightarrow 2NH_3$ - balanced

Exercise 1.2

① Balance each of the following chemical equation by inspection method.

(a) $Na + H_2O \rightarrow Na\,OH + H_2$

(b) $FClO_3 \xrightarrow{\Delta} FCl + O_2$

(c) $HNO_3 + H_2S \rightarrow NO + S + H_2O$

Solution

① a) $2Na + 2H_2O \rightarrow 2NaOH + H_2$

b) $2KClO_3 \rightarrow 2KCl + 3O_2$

C) $2HNO_3 + 3H_2S \rightarrow 2NO + 4H_2O$

② Write the balanced chemical equation to represent the following reaction.

Ⓐ Sodium bromide react with chlorine to form sodium chloride and bromine.

⇒ $Cl_2 + 2NaBr \rightarrow 2NaCl + Br_2$

(b) Hydrochloric acid react with sodium carbonate to forms sodium chloride, water & carbon dioxide.

⇒ $2HCl + Na_2CO_3 \rightarrow 2NaCl + H_2O + CO_2$

ⓒ Silver oxide, decompose to silver & oxygen gas.

⇒ $2Ag_2O \rightarrow 4Ag + O_2$

③ Balance each of the following equation by LCM method

ⓐ $\frac{6}{Fe_2(SO_4)_3} + \frac{1}{KOH}$ 6 $\frac{6}{K_2SO_4}$ $\frac{3}{FE\,(OH)_3}$

⇒ $Fe_2(SO_4)_3 + 6KOH \rightarrow 3K_2SO_4 + 2\,Fe\,(OH)_3$

ⓑ $\frac{2}{CaCl_2} + \frac{3}{Na_3PO_4}$ 6 $\frac{6}{Ca_3(PO4)_2}$ + NaCl

⇒ $3\ CaCl_2 + 2Na_3\ PO4 \rightarrow Ca_3\ PO_4 \rightarrow Ca_3\ (PO4)_2 + 6NaCl$

④ Balance each of the following equation by algebraic method

ⓐ $Zn\ (NO_3)_2 \rightarrow Zn\ O + NO_2 + O_2$

$A\ Zn\ (NO_3)_2 \rightarrow b\ Z\ n\ O + NO_2 + dO_2$

Zn: a = b

N: 2a = C

O: 6a = b+ 2C + 2d

Let a = 1

b = 1

C = 2b = 2(1) = 2

6(1) = 1 + 2 (2) +2d

6 = 1 + 4 + 2d

2d = 6 -5 ⇒ $\frac{2d}{2} = \frac{1}{2}$ ⇒ **d = ½**

⇨ Then multiply each stoichiometric variable by two

a = 1 × 2 = 2

b = 1 × 2 = 2

C = 2 × 2 = 4

d = ½ × 2 = 1

$2Zn\ (NO_3)_2 \rightarrow 2ZnO + 4NO + O_2$ – balanced

ⓑ $C_6\ H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

$a\ C_6\ H_{12}O_6 + bO_2 \rightarrow C\ CO_2 + dH_2O$

C: 6a = C

H: 12a = 2d

O: 6a + 2b = 2C + d

Let a = 1

C = 6

d= 6

⇨ 6a = C

6(1) = C ⇨ **C = 6**

⇨ 12a = 2d

⇨ 12(1) = 2d ⇨ $\frac{2d}{2} = \frac{12}{2}$

d = 6

6(1) + 2b = 2 (6) + 6

6 + 2b = 12 + 6 ⇨ 2b = 12 + 6 – 6

⇨ $\frac{2b}{2} = \frac{12}{2}$ ⇨ **b = 6**

a = 1
b = 6
C= 6
D = 6 ⇨ $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$ Balanced

ⓒ $P_4O_{10} + H_2O \rightarrow H_3PO_4$

$aP_4O_{10} + bH_2O \rightarrow CH_3PO_4$ → P: 4a = C

O: 10a + b = 4C
H: 2b = 3C

Let a = 1 ⇒
C= 4
b= 6

4a= C
4(1) = C
C = 4

⇨ $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ balanced

2b-3C ⇨ 2b=3(4)

$\frac{2b}{2} = \frac{12}{2}$

b= 6

ⓓ $BaCl_2 + K_3PO_4 \rightarrow Ba_3(PO4)_2 + KCl$

$aBaCl_2 + bK_3PO4 \rightarrow CBa_3(PO4)_2 + d\,K\,C\,l$

$\frac{3C}{3} = \frac{1}{3}$ ⇨ C = 1/3

Ba: a = 3C
Cl : 2a = d
K: 3b = d
P: b = 2C
O: 4b = 8C

Let a = 1 ⇨
C = 1/3
d = 2
b = 2/3 ⇨ 3b = b = d ⇨ $\frac{3b}{3} = \frac{2}{3}$
b = 2/3

2a = d ⇨ 2(1)=d
⇨ d=2

⇨ Multiply the value of all variables by the highest denominator (3)

a = * 3 = 3
b = 2/3 * 3 = 2
C = 1/3 * 3 = 1
D = 2 * 3 = 6

⇨ $3BaCl_2 + 2K_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6KCl$

1.3 Types of Chemical reactions

→ There are **four** basic types of chemical reactions.

These are:- ① Direct combination reaction

② Decomposition reaction

③ Single displacement reaction

④ Double displacement reaction

① Direct combination reaction (Synthesis rxn)

→ A reaction in which two or more substances combine to form single product is called **Combination rxn.**

→ General reaction: A + B → AB, where A & B are e/t s or c p ds but AB is compound

E g:- $4Al + 3O_2 \rightarrow 2Al_2O_3$

$CaO + CO_2 \rightarrow CaCO_3$

② Decomposition reaction (Analysis teaction)

→ The braking down of a single reaction in to two or more elements or simpler compounds is called decomposition rxn

→ Decomposition reaction can be carried out using heat, Light, electricity or Catalyst.

⇨ General reaction: $AB \xrightarrow{\Delta} A + B$, where AB is CPd

A & B are e/ts or cpds

Eg:- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

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

③ Single displacement reaction /replacement rxn /

→ The reaction in which one element displaces another element from its compound is called Single displacement reaction

→ General reaction: ⓘ A + BC → AC + B . Where, "A" is more active metal that "B"

i i A + BC → BA + C, "A" is more active non-metal than "C"

→ Examples of Single displacement reaction

I The reaction b/n active metal (like C a, Na, Mg, Zn & K) and acids.

⇨ Active metals displace hydrogen from acids.

E g:- $2K + H_2SO_4 \rightarrow K_2SO_4 + H_2$

$Ca + 2HCl \rightarrow CaCl_2 + H_2$

II The reaction b/n reactive metal /C a, K, Na / with water

i. e:- Na, K & C a react with water vigorously to displace hydrogen

E g:- $2Ka + 2H_2O \rightarrow 2NaOH + H_2$

$Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$

III More active metal displace less active metal

E g:- $Zn + CU(NO_3)_2 \rightarrow Zn(NO_3)_2 + CU$

$Fe + CuSO_4 \rightarrow FeSO_4 + Cu$

④ Double displacement reaction /Metatlelis rxn /

→ A reaction in which two compounds react together to form another two new compounds by exchange.

→ General reaction: $AB + CD \rightarrow AD + CB$

E g:- $NaOH + HCl \rightarrow NaCl + H_2O$

$BaCl_2 + Na_2SO_4 \rightarrow BaSO_4 + 2NaCl$

Exercise 1.4

Give the correct answer for thr following questions

① What type of reaction usually does takes place in each of the following equations.

ⓐ An active metal react with water – Single displacement nrxn

ⓑ A metal react with a non – metal – Combination reaction

ⓒ An acid react with metal hydrogen – Double displacement rxn

ⓓ Heating of metal hydrogen carbonate- Decomposition reaction

Decomposition, Single or double displacement rxn

a) $2NH_3 + H_2SO_4 \rightarrow (NH_4)_2SO_4$ – Combination reaction

b) $CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$- Partial decomposition

C) $2Na_3PO_4 + 3Ca(OH)_2 \rightarrow Ca_3(PO_4)_2 + 6NaOH$- Double displacement reaction

1.4 Oxidation & Reduction reaction / Redox rxn/

Oxidation- - It is the lose of one or more electrons by an atom

- leads to increase oxidation number

E g:- $Zn \rightarrow Zn^{2+} + 2e^-$, "Zn" is oxidized from 0 to 2

Reduction - - gain of one or more electrons from the atoms

- leads to decrease , oxidation number.

E g:- $Na^+ + e^- \rightarrow Na$, "Na" is reduced from 1 to 0

Note: Ox isolation and reduction reaction occur simulator nicely. Hence if one atom lose electrons then other atom should gain that electrons.

Oxidation number / State/

→ It is the number of electrons that an atom appears to gained or last when it combined with another atom.

→ It can be integers including Zero and fractions.

Rules for assigning Oxidation number

Rule – 1:- The oxidation no of all elements in free state, is zero. This rule is also applied for diatomic & polyatomic e/ts.

Eg:- The oxidation no of Na = o, Sin $S_8 = 0$, C l, in $Cl_2 = 0$ - - - e t c

Rule – 2:- The oxidation number of mono atomic ion is equal to the charge on the ion.

Eg:- $Na^+ = +1$, $Mg^{2+} = +2$, $S^{2-} = -2$

Rule – 3:- The oxidation number of oxygen in most compound is – 2 except

→ Peroxide = -1 **E g:-** H_2O_2

→ Superoxide = $\frac{-1}{2}$ **E g:-** HO_2

→ Oxygen fluoride = +2 **E g:-** OF_2

Rule – 4:- The oxidation no of hydrogen in entire compound is +1, but in metal hydride is -1.

Rule – 5:- The sum of the oxidation number of all the atoms in a neutral compound is Zero.

E g:- $H^{+1}{}_2O^{-2}$ ⇨ 2-2=0

Rule – 6:- The sum of the oxidation number of all the atoms in a polyatomic ion is equal to the charge on the ion.

E g:- $SO^{2-}4$ ⇨ +6-8 = -2
-2=-2

Rule – 7:- The oxidation no of group IA and IIA elements are +1 & +2 respectively in their compound

Rule – 8:- In a compound the height electron negative elements assign a negative & less electro negative align a positive.

Exercise 1.5

① **Find the oxidation no for underline speciels**

ⓐ K_4 [$Fe(CN)_6$]

Solution

+1 × -1

K_4 $[Fe(CN)_6]$

$4(1) + \times -6 = 0$

$4 + \times -6 = 0$

$\times - 6 + 4 = 0$

$\times - 2 = 0$

$\times = +2$

ⓑ $K_2Cr_2O_7$

Solution

+1 × -2

K_2 Cr O_7

$2(1) + 2\times -2(7) = 0$

$2 + 2\times - 14 = 0$

$2\times - 14 + 2 = 0$

$2\times - 12 = 0$

$\frac{2\times}{2} = \frac{12}{2}$ ⇨ $\times = +6$

ⓒ $Fe_2(SO_4)_3$

Solution

+3 ×-2

$Fe_2(SO_4)_3$

$2(3) + 3\times -24 = 0$

$6 + 3\times -24 = 0$

$3\times - 24 + 6 = 0$

$3\times - 18 = 0$

$\frac{3\times}{3} = \frac{18}{3}$ ⇨ $\times = +6$

ⓓ $S_2O_8^{-2}$ ⇨

× -2-2

S_2O_8

$2\times -16 = -2$

$2\times = -2 + 16$

$\frac{2\times}{2} = \frac{14}{2}$ ⇨ $\times = +7$

ⓔ PO^{3-}_4 ⇨

× -23-

PO_4

$\times - 8 = -3$

$\times = -3 + 8$

$\times = +5$

② Determine each of the following process Oxidation or reduction reaction

ⓐ $Cu^{2+} + 2e^- \rightarrow Cu$ – Reduction reaction

ⓑ $N + 3e^- \rightarrow N^{3-}$ - Reduction reaction

ⓒ $K \rightarrow K^+ + e^-$ - Oxidation reaction

1.4.1 Oxidizing and reducing agents

⇨ Oxidizing agent:- In a redox reaction a substance that caused other substance to get oxidized is called Oxidizing agent

⇨ Oxidizing agent:- - by itself it gets reduced

- Contain elements whose oxidation number decrease

- Become more negative

⇨ Reducing agent:- a substance that cases other substance to get reduced is called reducing agent

⇨ Reducing agent:- - by itself it gets oxidized

- Contain elements whose oxidation number increase.
- Become more positive

Tests for oxidizing agent

I Permanganate ion:- In acidic solution change its color from purple to colorless

⇨ $2Mn\,O^{-1}_4 + 16H^+ \; 10e^- \rightarrow 2Mn^{2+} + 8H_2O$

I I Dichromate ion:- In acidic solution change its color from orage to green

⇨ $Cr_2O^{-2}_7 + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

⇨ Common oxidizing agent include $KCrO_3$, $NaClO_3$, MnO_2

⇨ The most common reducing agent include C, CO,

Sodium thiosulphate Na_2SO_3 & Iron (11) Salt

Note:- Oxidizing and reducing ability of a substance depends on:

⇨ Electro negative:- elements with high electro negativity (F_2, O_2, N_2, & Cl_2) are good oxidizing agent where as elements with low electro negativity are good reducing agent.

⇨ Oxidation State:- In a compound or ion it one of its element is in its higher oxidation no it becomes good oxidizing agent and if an elements in a compound or ion is its lower oxidation state, then it is reducing agent.

Eg:- 1 Identity the oxidized , reduced , oxidizing & reducing agent from the following reaction.

ⓐ $\overset{+2\;\;-2}{ZnO} + \overset{0}{C} \rightarrow \overset{0}{Zn} + \overset{+2-2}{CO}$

Oxidized = C Reducing agent = C

ⓑ $\overset{0\;\;\;0}{8Fe} + \overset{}{S_8} \rightarrow \overset{+2\;\;-2}{8FeS}$

Oxidized = Fe Reducing agent = Fe

Reduced = S Oxidizing agent = S_8

Eg:- 2 Where do the mast easily reducing & oxidized elements found in the periodic table

Ans:- Elements that exits on the let side of the periodic table is oxidized where as on the right side is reduced

Eg:- 3 Tell whether the oxidation no increase or decrease in a redox reaction.

ⓐ An oxidizing agent – decrease oxidation numbers

ⓑ A reducing agent – Increase oxidation number

ⓒ A Substance undergoing oxidation – Increase oxidation number

ⓓ A Substance undergoing reduction- decrease oxidation number

1.4.2 Analyzing redox reaction

Redox reactions	Non – redox reactions
→ There is change in Oxidation number	- There is no change in oxidation number
→ Oxidation and reduction Reactions are takes place	- Oxidation and reduction reactions are not take place

Eg: Identity the redox and non- redox reaction from the following reaction

ⓐ $\overset{+1\ -2\ +1}{NaOH} + \overset{+1\ -1}{HCl} \rightarrow \overset{+1\ -1}{NaCl} + \overset{+1\ -2}{CO-}$

non – redox /Xn b/C there is no oxidation no change

ⓑ $\overset{+3\ -2}{Fe\ 2O_3} + \overset{+2\ -2}{3CO} \rightarrow \overset{o}{2Fe} + \overset{+4\ -2}{3CO_2}$

Redox reaction b/c there is a change in oxidation no

1.5 Molecular and formula Masses, the mole Concept and Chemical Formulas

1.5.1 Molecular mass and formula Mass

→ **Molecular Mass:-** is the sum of the masse of all atoms present in a molecule

→ **Formula Mass:-** is the sum of the atomic masses of all atoms present in the formula units of a compound either in ionic or molecular compounds.

→ **Formula Mass is** mostly used for ionic compounds

Eg:1 Calculate the molecules mass of the following c p ds

ⓐ $C_6H_{12}O_6 \Rightarrow C_6H_{12}O_6$ - $C = 6 * 12 = 72$

$H = 12 * 1 = 12$

$O = 6 * 16 = 96$

$180\ a.m.u$

ⓑ $CO_2 \Rightarrow CO_2$ - C = 1 * 12 = 12

O = 2 * $\frac{16=32}{44\ amu}$

Eg 2 : Calculate the formula mass of the following c p ds

ⓐ $CaCO_3$ ⇒ Ca = 1 * 40 = 40

C = 1 * 11 = 12

O = 6 * 16 = $\frac{48}{100\ a.m.u}$

ⓑ $MgCl_2$

$MgCl_2 \Rightarrow$ Mg = 1 * 24

$\frac{Cl=2*35.5}{95\ a.m.u}$

1.5.2 Mole Concept

→ **A mole is :-** the amount of a substance contained in the same number of entities.

→ 1 mole = Avogadro's no of entities.

Avogadro's no = 6.02×10^{23} particles

1 mole = $6.02 * 10^{23}$ particle

⇒ Particles= atoms , ions, molecules Or formula units

1 mole of Na = 23g = $6.02 * 10^{23}$ atom of sodium

1 mole of H_2O = 18g = $6.02 * 10^{23}$ molecules of water

1 mole of NaCl = 58.5 g = $6.02 * 10^{23}$ formula unity of N a C l

1.5.3 Chemical formula

→ It is used to express the composition of compound in terms of chemical symbols.

→ Chemical formula can be classified in to two classes: These are: ① Molecular Formula &

② Empirical Formula / Simplest Formula /

① **Molecular Formula** is the formula that shows the actual no of atoms of each type of element present in a compound.

② **Empirical Formula** is the formula that shows then no of atoms of each type of element present in the compound in

the lowest possible ratio.

Eg

	Molecular Formula	Empirical Formula
Benzene	C_6H_6	CH
Glucose	$C_6H_{12}O_6$	CH_2O

Percentage Composition by mass

→ It is defined the ratio of the amount of individual elements present in a compound multiplied by 100.

→ Mathematically:

$$\text{Percentage Composition Of element} = \frac{Given\ mass\ of\ element}{Molar\ mass\ of\ Cpd} * 100\%$$

Eg Calculate the percentage composition of each element in H_2O? (AE . mass: H: 1, O= 16)

Solution

$H_2O \Rightarrow H = 2 * 1 = 2$

$O = 1 * 16 = 16$

Molar mass of H_2O = **18g**

$$\%H = \frac{MH}{H_2O} * 100\%$$

$$= \frac{2g}{18g} * 100\% = \frac{200\%}{18}$$

$$= \underline{11.11\%}$$

$$\%0 = MO * 100\% = \frac{16g}{18g} * 100\%$$

$$MH_2O$$

$$= \frac{1600}{18}\% = \underline{88.88\ \%}$$

Determination of empirical & mole cular formula

Determination of empirical formula of a compound

⇒ Steps for determining empirical formula

① Write down the symbol of the constituent elements

② Write the mass or mass percentage of elements under each element

③ Find the no of moles of each element.

④ Divided the no of moles of all elements by the smallest no of mole.

⑤ If the above ratio is not whole no multiply all values by a suitable integer.

⑥ place the symbol of elements side by side and insert the simplest whole no's obtained on the lower right corner of the symbol.

Eg 1 Find the empirical formula of an oxide formed by reacting 28g of iron and 12g of oxygen.

Solution

Fe	O
28g	12g

n Fe $= \frac{28g}{56gmol}$ no $= \frac{12g}{16gmol}$ → Find the no of moles of each element

$= \frac{0.5\ mol}{0.5\ mol} = \frac{0.75\ mol}{0.5\ mol}$ → Divide the no of moles of all element by the smallest no of mole.

$= 1 * 2 = \underline{2} = 1.5 * 2 = \underline{3} \Rightarrow$ **Empirical Formula $= Fe_2O_3$**

Solution

P	O
43.6 g	56.4 g

n P $= \frac{43.6}{31\ g\ mol}$ no $= \frac{56.4\ g}{16\ g\ mol}$ → Find the no of moles of each element

$= \frac{1.40\ mol}{1.40\ mol} = \frac{3.5\ mole}{1.40\ mol}$ → Divide the no of moles of all element by the smallest no of mole.

$= 1 * 2 = \underline{2} = 2.5 * 2 = \underline{5} \Rightarrow$ **Empirical Formula $= P_2O_5$**

Determination of mole cular formula

Molecular Formula = (Empirical Formula) n

$$n = \frac{Molar\ mass\ of\ molecular\ Formula}{Molar\ mass\ of\ empirical\ Formula}$$

Eg A compound of carbon and hydrogen contains 92.3%C and has molar mass of 78.1 g mol.

What is the molecular mass of the Formula?

C	H
92.3	7.7

n "c" $= \frac{92.3g}{12g\ mol}$ n"H" $= \frac{7.7g}{1\ g\ mol}$

$= \frac{7.7\ mol}{7.7\ mol} = 1$ $= \frac{7.7\ mol}{7.7\ mol} = 1$

Empirical formula = CH = **13** g mole then

$$n = \frac{Molar\ mass\ of\ molecular\ Formula}{Molar\ mass\ of\ empirical\ Formula}$$

$= \frac{78.1\ g\ mol}{13\ g\ mol} = 6 \Rightarrow$ Subscript of empirical formula

Molecular formula = (Empirical Formula)$_n$

$= (CH)_6 = C_6H_6$

Exercise 1.8

1, How many moles of each element present in 1.0 mole of $Cu_3(PO_4)_2$?

Solution

Moles of elements present in a compound is equal to mole of c p d times subscripts of element is the compound

ncu = 1.0 m o l * 3 = 3mol

n "p" = 1 m o l * 2 = 2 m o l

n "p" = 1 m o l * 8 = 8 m o l

2, How many atoms & ions are present in one formula unit of K_2CO_3

Answer **Atom** : 2K atom

1C atom

3O atom

Ion: two K^+ &

One $CO3^{-2}$

3, Calculate the molecular mass of a compound if 0.372 moles of it has amass of 152g.

Given Required

n = 0.372 mole Molar mass (Mt) = ?

m = 152g Solution

$$n = \frac{m}{Mt} \Rightarrow Mt = \frac{m}{n} = \frac{152\ g}{0.372\ mol}$$

$\Rightarrow$ Mt = **408.6 g m o l**

4, Calculate the percentage composition of each elements present in C_2H_5OH? Mt = **46g** mole

50/7 % "C" $= \frac{24}{46} * 100 =$

% "H" $= \frac{6}{46} * 100 =$

% "O" $= \frac{16}{46} * 100 =$

Stoichiometry

⇒ The quantitative study of ratio of mole , mass and volume of reactant & product ⇒ stoichiometry.

Major principles of stoichiometry are:-

⇒ Composition of any substance expressed in definite formula

⇒ Law of conservation of mass should be conserved

⇒ Balanced chemical equation also provide information about mole, molecule & mass of reactant & product.

Stoichiometric Calculate

In the stoichiometric calculation the ratio of mass, mole , & volume will involved

A Mass – Mass relation

⇒ In this relation we can calculate the mass of one substance from the give mass of other substance by using the following steps.

Step1:- Write balanced chemical equation.

Step2:- Place a given mass above the corresponding formula.

Step3:- Write the molar mass of the substance bellow its formula

Step4:- Set up the proportion.

Step5:- Solve the unknown mass " ×" .

E.g1: How many grams of C a O is produced when 50g of $CaCO_3$ decompose to from C a O & CO_2?

Solution

Step1:- $CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

×

Step2:- $CaCO_3$ $^{50}{}_{5}{}^{0}$ → C a O + CO_2

$50^0{}_5$ ×

Step3:- $CaCO_3$ → C a O + CO_2

100 56

Step4:- $\frac{50g}{100g/mol} = \frac{\times}{56g/mol}$

$\frac{1}{2} = \frac{\times}{56}$, $2\times = 56$

⇒ × = **28 g** of C a O .

E.g2: How many grams of ammonia will produced when 14g of nitrogen react with hydrogen?

Solution

14 ×

$N_2 + 3H_2 \rightarrow 2NH_3$

$\frac{14\ g}{28g\ mol} = \frac{\times}{34\ g/mol}$

$\frac{1}{2} = \frac{\times}{34}$, $2\times = 34$

$\times = \underline{17g}$ of ammonia

B Mole – mole relation

Calculate mole of one elements compounds from the given moles of others.

Step1:- Write balanced chemical equation.

Step2:- Place a given mass above the formula & × above the formula to be determined.

Step3:- Write the coefficient to corresponding formula.

Step4:- Set up the proportion.

Step5:- Solve the unknown mole " ×" .

E.g1: How many moles of sculpture trioxide will be formed when 6 moles of sculpture dioxide Buru with oxygen?

Solution

$$\begin{array}{ccc} 6 & & \times \\ 2SO_2 & \rightarrow & O_3 \\ & & \times \end{array}$$

$$\frac{6mol}{2mol} = \frac{\times}{2mol}, \frac{2\times}{2} = \frac{12mol}{2}$$

$$\Rightarrow \times = 6\text{moles of } SO_3$$

Exercise 1.9

1, How many moles of water are required to produce 4.5 moles of HNO_3 according to the reaction

$$3NO_2 + H_2O \rightarrow 2HNO_3 + No$$

$$\times \quad 4.5mol$$

$$3NO_2 + H_2O \rightarrow 2HNO_3 + No$$

Solution

$$\frac{\times}{1mol} = \frac{4.5mol}{2mol}$$

$$3\times = 2\text{ mol} \times 0.05$$

$$\Rightarrow \times = \frac{2mol \times 0.05}{3} = \underline{0.033\text{ mole}}$$

C Volume– Volume relation

Masterly common for gaseous state

- Molar Volume:- One mole of any gas at "STP" = 22.4 litter.

Avogadro's Law:- States that equal volume of different gases under "STP" contain equal number of moles.

E.g1: What volume of oxygen will react with ethane to produce 44.8L of CO_2 at "STP"

$$\times \quad 44.8$$

Solution $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$

$$\frac{\times}{7(22.4)e} = \frac{44.8\,e}{4(22.4)e}$$

$$\frac{\times}{7} = \frac{44.8e}{4}, \quad \frac{4\times}{4} = \frac{7*44.8e}{4}$$

$\Rightarrow \times =$ **78.4e** of O_2 will required

Exercise 1.10

1, How many litter of SO_3 will formed when 4800cm³SO_2 burned in air ?

4800 ×

Solution $2\,SO_2 + O_2 \rightarrow 2SO_3$ / $1e = 1000\ cm^3$ /

$$\frac{4.8e}{2(22.4)} = \frac{\times}{2(22.4)}$$

$$\frac{44.8\times}{44.8} = \frac{4.8\times44.8\,e}{44.8} \Rightarrow \times = \mathbf{4.8\ e} \text{ of } SO_3 \text{ formed}$$

C Mass– Volume relation

If the volume of one substance is given, the mass other substance is required and vice versa.

E.g1: How many grams of ammonia will be formed when 500mol of hydrogen gas react with nitrogen

Solution 1L = 100 m L.

0.5e ×

$N_2 + 3H_2 \rightarrow 2NH_3$

$$\frac{0.5}{3(22.4)e} = \frac{\times}{2(34.0)}$$

$$\frac{0.5}{3\times22.4} = \frac{\times}{34}, \quad \frac{3\times}{3} = \frac{0.5\times2}{3}$$

$$\times = \frac{34\times0.5}{3\times22.4} = \mathbf{0.25\ g} \text{ of } NH_3$$

Exercise 1.11

1, What mass of "Fe" metal completely oxidized by 89.6e of oxygen to produce Fe_2O_3 at STP.

Solution:- × 89.6e

$4Fe + 3O_2 \rightarrow 2Fe_2O_3$

$$\frac{\times}{4\times56g} = \frac{89.6e}{3\times22.4e}$$

$$\times = \left(\frac{89.9\times4\times56}{3\times22.4}\right) 9 = \mathbf{298.6g} \text{ of Fe}$$

2, How many litter of SO_2 are formed when 12.5g of F e S react with oxygen at STP. According to the equation

12.5g ×

$4FeS + 7O_2 \rightarrow 2Fe_2O_3 + 4SO_2$

$$\frac{12.5}{4\times32\times56} = \frac{\times}{4\times22.4}$$

$\times \left(\frac{4\times32\times56}{4\times32\times56}\right) = \frac{12.5\times4\times22.4}{4\times32\times56}$

$\Rightarrow \times = 6.08e$ = **6080mol** of SO_2will formed

1.6 Limiting and excess reactant

In a chemical reaction all reactants may not consumed equally.

Note:- The reactants that left after the reaction complete is called excess reactant whereas the reactant that consumed first is called "Limiting reactant"

The amount of product formed is determined by limiting reactant because the reaction product will stop after the limiting reactant completely consumed.

E.g1: How many moles H_2 will product where 3 moles of Mg added to 0.52 moles of H C l

Solution:- The reactant that produce the small amount of product is limiting reactant and reactants that produce . larger amount of product is excess reactant.

0.3 0.52

i. e $Mg + 2HCl \rightarrow MgCl_2 + H_2$

Calculate the mole of H_2 produced by using moles of Mg & H C l

i. e by using Mg: $\frac{0.3mol}{1mol} = \frac{\times}{1mol} \Rightarrow \times =$ **0.3 mole** of H_2

in the same way $\frac{0.52\ mol}{2mol} = \frac{\times}{1mol}$

$\Rightarrow \times = 0.26$ mol of H_2will produced

There fore:- H C l is limiting reactant because it produce lower product, then the mole of hydrogen is equal to **0.26** mole

Exercise 1.12

1, If 6.5g of zinc react with 5g of H C l for the reaction given bellow $Zn+2HCl \rightarrow ZnCl_2 + H_2$

a) Identify limiting reactant
b) How many grams of reactant remain un reacted?
c) How many grams of H_2 will be produced?
Solution

a) 1st Calculate the mole of Zn & H C l

n "Zn" $= \frac{6.5g}{65g/mol}$ n"HCl" $= \frac{5g}{73g/mol}$

n "Zn" = **0.1** mole n "H C l" = **0.068** mole

2nd Calculate the mole of H_2produced by using moles of Zn & H C l to determine limiting reactant

0.068 ×

($Zn + 2HCl \rightarrow ZnCl_2 + H_2$

- By using mole of "Zn" $\frac{0.1mol}{1mol} = \frac{\times}{1mol} =$ **0.1** mole
- By using moles of "H C l" : $\frac{0.068\ mol}{2mol} = \frac{\times}{1mol}$

$\Rightarrow$ **0.034** m o l of H_2 then,

"H C l" $\Rightarrow$ Limiting reactant because it produce lower product = 0.034 m o l of H_2 "Zn" $\Rightarrow$ excess reactant because it produce higher product = 0.3moles of H_2

b) un reacted mass obtained from excess reactant

6.5 5

$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

1st Calculate the reacted mass of "Zn"

$\frac{\times}{65} = \frac{5}{73}$, $\frac{73\times}{73} = \frac{5\times65}{73}$

$\Rightarrow \times = 4.45$g of "Zn" reacted Mass of "Zn" unreacted = given mass of "Zn" minus - M "Zn" reacted.

M "Zn" unreacted = (6.5 – 4.45)g

= **2.04g** of "Zn" unreacted

C) The amount of product formed is determined by the limiting reactant "H C l"

$\frac{5g}{73g/mol} = \frac{\times}{2g/mol}$

$73\times = 10$g

$= \times = 0.1369$ g of H_2 will produced.

1.6.1 Theoretical actual & percentage yield

- **Actual Yield:-** → a measured amount of product.
  → Experimentally determined.
  → Always less than theoretical yield.
- **Theoretically Yield:-** → Calculated amount of product.
  → Its value higher than actual yield
- **Percentage Yield:-** The ratio of actual yield to the ordeal yield × 100 .

Given by % yield $= \frac{Actual\ yield}{Theoretical\ yield} \times 100$

E.g1: When 14.5g of SO_2 react with 21g of O_2 , What will be theatrical & percentage yield if the actual yield is 12g.

Solution:- Theoretical yield of product obtained from limiting reactant.

$2\ SO_2 + O_2 \rightarrow 2SO_2$ is limiting

$$\frac{14.5}{128} = \frac{\times}{160}$$

$$128\times = 160\times 145$$

$$\times = \frac{160 \times 145}{128} = \underline{\mathbf{18g}} \text{ the vertical)}$$

$$\%\ \text{yield} = \frac{Actual\ yield}{Theortical} \times 100$$

$$\%\ \text{yield} = \frac{12}{18} \times 150\%$$

$$\%\ \text{yield} = \underline{\mathbf{66.66\%}}$$

2, In the reaction $2C_8H_{18} + 25O_2 \rightarrow 6CO_2 + 18H_2O$ when 52.7g octane burn with oxygen the percentage yield of CO_2 is 82.5% . What is the actual yield of the reaction?

Solution:- 152.7 ×

$$2C_8H_{18} + 2SO_2 \rightarrow 16\ CO_2 + 18\ H_2O$$

1st Calculate theoretic can yield

$$\frac{52.7g}{2\times2\times8+18g\ /mol} = \frac{\times}{16\times44g\ /mol}$$

$$\frac{52.7g}{228} = \frac{\times}{704}, \quad \frac{228\times}{228} = \frac{52.7 \times 704}{228}$$

$$\Rightarrow \times = \underline{\mathbf{162g}} = \text{Theoretic}$$

$$\%\ \text{yield} = \frac{actual\ yield}{Theoretical\ yield} \times 100\%$$

$$82.5\% = \frac{Actual\ yield}{162} \times 100\%$$

$$82.5 = \frac{AY}{162} \times 100\%$$

$$\Rightarrow Ay = \frac{82.5 \times 162}{100}$$

$$\Rightarrow Ay = \underline{\mathbf{133.6\ g}}$$

Chapter One Review exercise

Part I True / False type question

1. True 3. False 5. True
2. False 4. True

Part I I Writing the missing words for the following question.

6. +7
7. Limiting reactant
8. non – redox reaction
9. Molecular mass
10. Formula mass
11. Empirical formula
12. Molecular formula

Part I I I Choose

13. d 14. A 15. A

Part I V problem solving question.

16. Calculate the molecular mass line a mu of the following compounds

a) S^0_2 b) $C_8 H_{10} N_4 O_2$ / caffeine

Solution:- a) S^0_2 : $S = 32 \times 1 = 32$

$O = 16 \times 2 = 32$

Total $= 64$ g/m o l

b) $C_8 H_{10} N_4 O_2$: $C = 12 \times 8 = 96$

$H = 1 \times 10 = 10$ ⇒ Total

$N = 14 \times 4 = 56$ **194 g/**m o l

$O = 16 \times 2 = 32$

17. how many moles of C^0_2 are present in 176g Of C^0_2

Solution:- Given

M w t $C^0_2 = 44$g/m o l

M $= 176$g

Required

n = ?

Solution

$n = \frac{m}{Mwt}$

$n = \frac{176\ g}{44 g/mol}$

n = **4 m o l of** C^0_2

18. How many grams of oxygen can be prepared by the decomposition of 12 g of mercury oxide

Solution :- 12 ×

$2HgO \rightarrow 2Hg + O_2$

$\frac{12}{2(201+16)} = \frac{\times}{32}$, $\frac{12}{434} = \frac{\times}{32}$

$\frac{434\times}{434} = \frac{384}{434} \Rightarrow \times$ **0.885 g**

19. 25 g of NH_3 is mixed is 4 moles O_2 in the reaction given / $4NH_3\,(g) + 5O_2\,(g) \rightarrow 4NO + 6H_2O$

a) What is the limiting reactant

b) What mass of No is formed ?

C) What mass of water formed ?

Solution 25g 4mol ×

a) $4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

$n_{NH3} = \frac{25g}{68g/mol} =$ **0.36** m o l then $n_T O_2 = \frac{4\,mol}{5}$

0.36 m o l 68 g m o l $\Rightarrow n_T =$ **0.8**

$4NH_3 + 5O_2 \rightarrow 4NO + 6H_2O$

There for the limiting reactant is **NH_3**

b) $\frac{25g}{68g\,mol} = \frac{\times}{120\,gmol}$

$\frac{68\times}{68} = \frac{(120\times25)g}{68} \Rightarrow \times =$ **44.17g of No**

C) $\frac{25g}{68g/mol} = \frac{\times}{108} : \frac{68\times}{68} = \frac{25\times108}{68}$

$\Rightarrow \times =$ **39.7 g of** H_2O

20. Consider the reaction $2N_2O_5 \rightarrow 4NO_2\,(g) + O_2\,(g)$ when 40g of N_2O_5 decompose , 45g of O_2 is formed what is the percentage yield.

Solution :- $2N_2O_5 \rightarrow 4NO_2\,(g) + O_2$ (given actual yield 45)then find the critical yield

$\frac{40}{216} = \frac{\times}{32} \Rightarrow \times \frac{40\times32}{216} = 5.9$ g = Theoretical yield

∴ Percentage yield $= \frac{Actual\ yield}{The\ oretical\ yield} \times 100$

$= \frac{4.5}{5.9} \times 100\ \% \Rightarrow$ % yield = **76.3 %**

21. Two compound have the same composition 85.62 % C and 14.38% H .

a) Obtain the empirical formula corresponding to this composition.

b) One of the c p d has a molecular mass of 28.03 a mu the other 56.06 a mu.

Then obtain the molecular formula of both compounds

Solution

a) C H

85.62g 14.38g

$n_C = \frac{85.62\ g}{12g\ mol}$ $n_H = \frac{14.38\ g}{1\ g\ mol}$

$= \frac{7.13\ mol}{7.13\ mol}$ $= \frac{14.38\ mol}{7.13\ mol}$ → Divide all values to smaller mole

$= 1$ $= 2$

Empirical formula = $\underline{CH_2}$

b) **Given**

Molar mass of mole collar formula = 28.03

Empirical formula = CH_2

Molar mass of empirical formula = 14

Required

Molecular formula = ?

Solution

Molecular formula = (Empirical formula)

but $n = \frac{Molar\ mass\ of\ molecular\ formula}{Molar\ mass\ of\ empirecal\ formula}$

$n = \frac{28.03}{14} = \underline{2}$ = Subscript

∴ Molecular formula = $(\in . formula)_n$

$= (CH_2)_2$

$= \underline{C_2H_4}$

✵ For 56.06 g of compound Calculate "n"

$n = \frac{Molecular\ formula\ mass}{Emperical\ formula\ mass}$

$= \frac{56.06}{14} = 4$ Then molecular formula = $(E. formula)_n$

$= (CH_2)_2 = \underline{C_4H_8}$

22. Abrade has the empirical formula BH_3 & molecular mass of 28 a mu. What is its molecular formula.

Given

Empirical formula = BH_3

Empirical formula mass = 14g/mole

Molecular formula mass = 28g/mole

Required

Molecular formula = ?

Solution:- n = 28/14 = 2

M formula = (Empirical formula)$_n$

$(BH_3)_2$ = **B_2H_6**

23. The percentage composition of acetic acid is found to be 39.9%C, 6.7%h & 53.4 % 0 and its molecular mass was determined by experiment to be 60 a mu . Calculate the empirical & molecular formula of acetic acid.

Solution:-

C	H	O
39.9 g	6.7g	53.4g
$n_C = \frac{39.9\ g}{12\ g\ mol}$	$n_H = \frac{6.7\ g}{1\ g\ mol}$	$n_O = \frac{53.4\ g}{16\ g\ mol}$
= 3.325 m o l	= 6.7 mole	= 3.3375 mole

Divide all moles to the smallest one

i. e:- C: $\frac{3.325}{3.325}$ = 1

H: $\frac{6.7}{3.325}$ = 2 Empirical

O: $\frac{3.3325}{3.325}$ = 1 Formula = CH_2O

M w t CH_2O = **30**

Then Molecular formula = $\left[\frac{Empirical}{Formula}\right]_n$

$\Rightarrow n = \frac{M.formula\ mass}{E.formula\ mass}$, $\frac{60}{30}$ = **2**

Finally: Molecular $\left[\frac{Empirical}{Formula}\right]$

= (CH_2O_2 = **$C_2H_4O_2$**

Q 24. Balance each of the following using any method

a) $H_3BO_3 \rightarrow H_4B_6O_{11} + H_2O$

- $6H_3BO_3 \rightarrow H_4B_6O_{11} + H_2O$

b) $P_2I_4 + P_4 \rightarrow H_2O \rightarrow PH_4I + H_3PO_4$

- $10P_2I_4 + 13P_4 + 128H_2O \rightarrow 40PH_4I + 32H_3PO_4$

f) $KMnO_4 + HCl \rightarrow MnCl_2 + Cl_2 + Cl_2 + kCl + H_2O$

- $2KMnO_4 + 16HCl \rightarrow 2MnCl_2 + 5Cl_2 + 2KCl + 8H_2O$

g) $K + KNO_3 \rightarrow N_2 + K_2O$

- $10K + 2KNO_3 \rightarrow N_2 + 6K_2O$

UNIT – 2: SOLUTION

2.1 Heterogeneous & Homogeneous Mixture

- **Mixture :-** a combination of two /more substance with keeping properties.
- Its component separated by physical mean.
- Mixture is a part of our daily lite.

E. g: air that we breath , coffee, tea, food, fluids in our body & cosmetic etc.

Mixture → Homogeneous- have uniform composition

E. g:- Spoon of sugar in water

→ Heterogeneous:- has visible boundary has no uniform composition through out

E. g:- oil & water

❖ Mixture can be further classified as
- ✓ Suspension
- ✓ Solution
- ✓ Colloids

A. Suspension :- a heterogeneous mixture in which a solid particle spread throughout the liquid without dissolving.

E. g:- → a mixture of $Ca(OH)_2$ & H_2O

→ Chalk & water, flour & water.

B. Solution:- It is a homogeneous of solute dissolve in a solvent.

→ Have two major components - Solvent
- Solute

→ Have liquid solvent for most solution

When two liquids dissolve with each other, the liquid that cover major component used as a solvent. While a minor component ⇒ solute, but if solid & gas material dissolve in liquid the liquid is a solvent & solids are a solute

⇔ properties of solution

↳ Has no uisible boundary

↳ Has a single uniform phase

↳ Its component is not separate by filtration & do not settle down.

↳ They are very stable.

Types Of Solution

I, Gaseous Solution:- Formed by gas solute to a gas solvent| gas – gas| solution

E. g:- - atoms phere
- natural gas

II, Liquid Solution:- a solution form by gas, liquid & solid solute in a liquid solvent

E. g:- - carbonated beverage /liquid –gas/
- Sea water / solid in liquid /
- Alcoholic beverage / liquid – liquid /

Note:- In liquid – liquid solution, the solvent always liquid but the solute can be gas & solids.

III, Solid Solution:- In this solution there is no restriction on the state of solute but the solvent is solid state.

E. g:- - alloys / solid – solid /
- Waa & H_2 / gas in solid /
- Dental filling solution / liquid Hg to solid Ag /

C, Solution:- is a heterogeneous mixture in which in soluble particles are suspended uniformly.

Properties Of Colloids

- ↳ The size of the particle between solution & suspension
- ↳ Colloid particles are not separated by filtration because it pass through the filter paper.
- ↳ Have two phase * dispersed / solute /
- ↳ Quite stable * dispersion medium / solvent /
- ↳ Scatter abeam if light due to larger particle.

Q. What is Tyndall effect ?

Answer:- a pheromenonce in which particles of colloid scatter a beam of light &make the pasha of the light beam visible.

- ✓ This effect not observed in true solutions
- ✓ Tyndall effect in suspension disappear when its particle settle down.

Types Of Colloids

Depending on the sate of matter present in dispersed & dispersion medium, there are eight different types of colloidal solution.

No	Dispersed phase	Dispersing medium	Type	example
1	Liquid	Gas	Aerosol	- Fog , Cloud
2	Solid	Gas	Aerosol	- Smoke
3	Gas	Liquid	Foam	- Shaving cream
4	Liquid	Liquid	Emulsion	- Milk, face cream
5	Solid	Liquid	Sol	- $Mg(OH)_2$ mud
6	Gas	Solid	Foam	- Sponge
7	Liquid	Solid	Gel	- Cheese, butter
8	Solid	Solid	Sold sol	- Milky glass

Coagulation:- If the process by which dispersed phase of colloids made aggregate and separate from continuous phase
E. g :- Curdling of milk when it sours.

- **Association of Colloids:-** a colloids in which the dispersed phase consist of micelle.
  E. g :- ordinary soap.
- **Micelles:-** When a molecule or ion that have both hydrophobia 7 hydrophilic end they aggregately associate to form colloidal sized particle called micelles.
  - ✓ Ordinary soap form association colloid b/c it contains hydrophobic & hydrophilic end.

2.2 Solution Process

A solution is formed when a solute particle completely dissolved in a solvent.

I, Break Solute- Solute interaction

II, break Solvent- Solvent interaction

III, Formation of solve - solute interaction.

N.B:- The extent of dissolution of solute in a solvent is mainly depend on inter-molecular force.

2.2.1 Liquid solution & antiparticle force of attraction

When a solute dissolves in a solvent, the particle of the solute disperse through acet the solvent & solute particle occupy the position that normally taken by solvent molecule.

- The ease to which a solute article replace a solvent molecule depends on:-
  - ↳ **Solute** – Solute interaction
  - ↳ **Solvent** – solvent interaction
  - ↳ **Solute** – Solvent interaction

When inter particle interaction between solute – Solute & Solvent – Solvent interaction replaced by solute- Solvent interaction, the solute dissolves in a solvent.

N.B:- A substance that have similar type of inter molecular force dissolves each other . This similar type is predicted from molecular polarity.

- **Dipole moment (μ):-** a measure of molecular polarity which used to determine molecular polarity.

- Its SI Unit is Debye /D/ ⇒ Charge /C/ Metter (m) /d = 3.34×10^3 cm

A substance have net Zero dipole moment

i. e:- non-polar-molecule C P d (I_2, N_2, H_2, C H d $\mu = 0$

Polar substance like NH_3, H_2O, CO, NO, $\mu \neq 0$

⇔ The presence of polar bond does not always result in a polar molecules.

E. g:- is a non – polar molecule with polar bond. $\overleftarrow{O}=\overleftarrow{C} = 0$, the EN difference b/n "O" &" C" is high even if the factors cancel out.

Inter particle Force:- a force of attract action b/n neigh boring molecule. This force includes

- ↳ Dipole – dipole interaction
- ↳ Dispersion / London / force
- ↳ Ion – dipole interaction
- ↳ Dipole induced dipole
- ↳ Hydrogen bonding

Order of strength given by dispersion force < dipole – induced dipole < dipole – dipole < hydrogen bonding < Ion dipole bond.

A. Dipole – dipole Force

- Occur between polar molecule as a result of electrostatic interaction among dipole.

E.g:- Solubility of HB & in water.

B. Dipole induced - dipole

Arise from when a polar molecule distorts electron cloud of a non – polar molecule.

E. g:- Cl_2 & H_2O interaction

O_2 in H_{20} e t c

C. Dispersion / London Force

- ❖ Occur between all neigh boring molecule and arise electron distribution with in a molecule is constantly charged.
- ❖ The force which arise constant charge of electron distribution in a molecule is called ***instantaneous dipole induced dipole***
- ❖ Dispersion Force mostly common in ***non- polar molecule.***

D. Ion – dipole Force

- ➢ Principal force that involved when ionic compound dissolves in water.

E. g:- Na C l in H_2O

- ➢ There are two types ion dipole interaction

A, anion Polar molecule

B,

Cation Polar molecule

E. Ion – induced dipole force

A type of charges induced dipole force, rely on polarize ability.

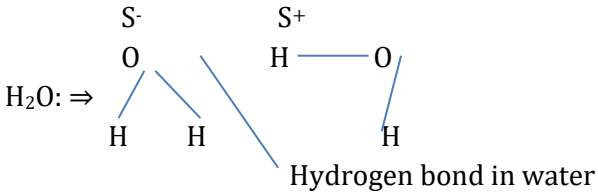
- Arises when an ion's charge distorts the electron cloud of nonpolar molecule

  E. g:- binding of Fe^{+2} to O_2 molecule in hemoglobin

F. Hydrogen bonding

- The bond formed b/n hydrogen & high electron negative element (N_2, O_2, F_2) etc

  E. g:- HF, H_2o, NH_3 e t c



Hydrogen bond in water

- Dot line ⇒ hydrogen bond
- Solid line ⇒ covalent bond

2.2.2 The Solidity of ionic Solid in Water

- Most ionic C P ds are soluble in water , but all ionic C P ds are not suble in water.

E .g:- Ag C l in soluble where as K C l readily soluble.

Solubility rules for ionic solids

Solubility:- Is a maximum amount of dissolved substance in a given volume of solvent at a given temperature.

Solubility rules for common ionic compounds:-

1. All salt of IA elements are soluble.
2. All common salts containing NO_3 is soluble.
3. All C P ds containing SO_4^{-2} are soluble except $BaSO_4$, $SrSO_4$, $PbSO_4$ & Ag_2SO_4.
4. All common chloride, bromide & Iodide are soluble except Ag^+ , Pb^{+2}, Hg^{+2} e t c .

Solution of Liquids in Liquid

When a solution made by compatible liquid, the liquid with higher concentration used as a solvent & lower concentration of liquid used as a **solute**

- Liquids that have similar polarity miscible with each other. / like dissolves like /

E. g:- CH_3CH_2OH in water ⇒ miscible. Oil & H_2O immiscible.

Exercise 2.3

1, Which force predominantly in water?

Answer:- Hydrogen bonding force

2, Arrange from the lowest to the highest induced dipole interaction for He, Ne, Kr, Ar

Answer:- He < ne < A r < Kr b/c no of electron cloud.

3, Why H_2S is a gas whereas H_2O is a liquid?

Answer:- due to hydrogen bonding of H_2O makes the bond strong & it require energy to break it.

4, What type of inter molecular force exist b/n

a/ H Br & H_2S ⇒ dipole – dipole

b/ I dipole – dipole

b/ I_2 & NO_3 ⇒ Induced dipole

C/ Cl_2n & CBr_4 ⇒ London dispersion force

Rate Of dissolution

- Dissolution:- a process through which a solute dissolves in a solvent to form solution.
- Rate of dissolution:- the speed at which solute dissolves in a solvent to produce Solution.

Major factors of rate of dissolution are temperature Surface are, Pressure for gases & inter-particle force

- Rate of dissolution largely depends in inter-particle force.

Note:- When solute- Solute- Solvent interaction is weaker than solute-Solvent interaction, dissolution become **faster**.

- The higher the surface area of the solute, the faster the dissolution process due to more contact with solvent.

Energy Change in solution Process

In solution process energy can be released or a absorbed.

When the energy released in mixing step larger than energy require to break the interaction b/n solute- solute or Solvent- Solvent interaction, energy is released and the dissolution process is **exothermic**

- When the energy released in mixing step is less than energy needed to break solute- Solte & Solvent – Solvent interaction, the dissolution process is **endothermic.**

Solvation:- a process of attraction solute and solvent molecule.

Solvation energy:- The energy released when solute solvated by solvent molecule.

- The solvation process takes place with H_2O is called **hydration**

Hydration energy:- energy released when solute molecule solvated by water molecule.

Heat of Solution:- Is amount of heat released / absorbed during dissolution process.

$q = MC\Delta T$ W/r

q = amount of energy
Δ T= Temperature change
M= mass of solution
C= Specific heat

Molar heat of solution (ΔHSol)

Is the heat absorbed / released when one mole of substance dissolved in water at a constant pressure.

$\Delta HSOl =$ q/mole of Solute

E.g1:- When 5g of K_2CO_3 dissolve in 50g of H_2O. the temperature of water rose by 4^0C. Calculate heat of solt & molar heat of so/1 Specific heat of H_2O 4.18 J/g.C^0 /

Given **Required**

$\Delta T = 4^0C$

M solution = 55g q & ΔHSOl = ?

$CH_2O = 4.18J./g.^oC$

Solution $q = MC\Delta T$

$= 55g \times \frac{4.18J}{g.℃} \times 4℃ =$ **-919.6J** the negative sign indicates release energy.

Δ HSol $= \frac{q}{mole\ of\ solute}$

but n solute = 5g/138 g /m o l = 0.036 m o l

$\Rightarrow \Delta H_{sol} = \frac{-919.6J}{0.036\ mol} =$ -**25545** m o l

If $\Delta H_{sol} = 0 \Rightarrow$ ideal solution, AA/BB interaction

$\Delta H_{sol} < 0 \Rightarrow$ exothermic, AA/BB < AA interaction

$\Delta H_{sol} > 0 \Rightarrow$ endothermic, AA/BB > AB interaction

How lattice energy affect Solubility of ionic Solid

- Lattice energy works against solution process because breaking the lattice is **endothermic** whereas hydration of ion favors dissolution.
- Ionic solid with larger lattice energy is usually in soluble. The higher lattice energy the lower solubility of ions.
  Lattice energy:- is the energy holding ions together in a crystal lattices
- It depends on the charge of the ion & size as the magnitude of the charge of ion increase, lattice energy also increase i. e:- Single charged ion more soluble than multi charged.
- Lattice energy is inversely proportional to the distance b/n center of the two ions.

E. g:- N a C l > C $_S$ C l b/c of Small size of Na than CS.

Exercise 2.4

1, w/c pairs ion has greater than by of hydration explain:-

a) Na+ or CS^{+1} :- Na^+ because of small size
b) Mg^{+2} or CS^+:- Mg^{+2} because of multiple charge
c) F^- or Cl^- Ex:- F^- because of Small size

2, A students added Δg Na_{OH} (s) to 100g of water in polystyrene foam cup. The temperature of water rose by 10°C and specific heart of water is (4.18J/g. °C) Then determine the molar enthalpy solution of Na $_{OH}$ in KJ /m o l

Given **Required**

M solution = 4+100 =104 g q & H_{Sol} = ?

$CH_2O = 4.18$ J/g . °C **Solution**

ΔT = 10°C $q = MC\Delta T$

n N a OH $= \frac{4g}{40g/mol} = 0.1$ mol $= 104g \times \frac{4.18J}{g\ ℃} \times 10℃$

$$q = \underline{4{,}347.25}$$

$$\text{Then } \Delta H_{Sol} = \frac{q}{n\ Solution}$$

$$\Delta H_{Sol} = \frac{4347.25}{0.1\ mol}$$

$$\Rightarrow \Delta H_{Sol} = \underline{43.472}\ \frac{KJ}{mol}$$

3, The molar heat of solution , ΔH_{Sol} N a OH is +445.1KJ/mol. In certain experiment 5g of N aOH completely dissolved in 1L of H_2O at 20°C in a foam Cup caller? Meter. Assume no heat is lost. Calculate the final temperature of water.

Give

$\Delta H_{Sol} = +445.1$ KJ/m o l

Mole of solute $= \frac{5g}{40g/mol} = \underline{0.125}$ m o l

$CH_2O = 4.18$ J/g . ℃

$SH_2O = 1$g/m o l

V = 1 L

Ti = 20 ℃

Required

Tinal temperature = ?

M solution = ?

Solution

$\Delta H_{Sol} = \frac{q}{n\ solute} \Rightarrow q = \Delta H_{Sol} \times n$, but $q = MC\Delta T$

$\Delta H_{Sol} \times n = MC\ \Delta T$

$\Rightarrow \Delta T = \frac{\Delta HSol \times n}{m\ .C}$, M = & ×V

$$\Delta T = \frac{0.125\ mol \times 445.1\ KJ/mol}{105\ g \times 4.18\frac{J}{g} \times ℃}$$

ΔT

$\Delta T = \frac{+55637}{4{,}2009}$, Tf – Ti = 13℃

$\Rightarrow$ Tf = 13℃ + Ti

= 13℃ + 20℃

$\Rightarrow$ Tf = <u>33℃</u>

2.3 Solubility as an equilibrium process

Solubility:- The maximum amount of substance dissolved in a given volume of solvent at a given temperature.

- **Recrystallization:-** a process of dissolved solute return to a solid state.

Solid / Solute $\frac{Dissolution}{Crystalization}$ Dissolved ion.

Note:- When the rate dissolution is equal to the rate crystallization dynamic equal rium is **achieved.**

2.3.1 Saturated, unsaturated & Super Saturated Solution

- **Saturated Solution:-** a solution at which dissolved and un dissolved solute are a dynamic equilibrium.
- **Un Saturated Solution:-** a solution that has no reach a maximum solubility this means move solute could be added to the solution and dissolving will occur.
- **Super Saturated Solution:-** The solution that have dissolved solute beyond normal saturation point.

OR the solution at which contain more dissolved solute than needed for preparing a saturated solution.

⇔ Temperature & Pressure are condition that are required to prepare saturated solution.

- **Factors affecting Solubility**
  - ↳ Inter particle Force
  - ↳ Surface area
  - ↳ Temperature & pressure for gases.

A, Effect of temperature on solubility of Solids

Generally the solubility of most solid solute increase with increase temperature.

E. g:- The solubility of Na C l is 36g/mℓ of water at 25°C & 39g/mℓ of water at 100°C

B, Effect of temperature on solubility of gas

The solubility of gas in liquid decrease with increase temperature because the molecules in gas state are enough far a part.

C, Effect of Pressure on solubility of gas

- Pressure has no effect on solubility of solids because its particle is held tightly.
- Solubility of gas increase with increase partial pressure of the gas above a solution from henry's Law

$C \times P$ where

C = Concentration of gas

P = piratical pressure

$\Rightarrow C = K p$

$K = C/p$, $C_1/P_1 = C_2/P_2$

E. g 1:- The concentration of CO_2 in a solution is 0.32 M at 3.0 atm. What is the concentration of CO_2 at 5 atm ?

Given

$P_1 = 3$ a tm

$C_1 = 0.32$ m o l/ℓ

$P_2 = 5$ a tm

Required

$C_2 = ?$

Solution from Henry's law

$C_1/p_1 = C_2/P_2$, $C_2 = P_2 \times C_1/P_1$

$$\Rightarrow C_2 = \frac{5\ atm \times 0.32\ mol/\ell}{3\ atm}$$

$$\Rightarrow C_2 = \underline{0.53\ m\ o\ l}\ /\ L$$

E. g 2 :- The solidity of N_2 Cg) at 25°C & 1 atm is 6.8×10^{-4} m o l/ℓ. What concentration of N_2 dissolved in water under atmospheric condition . The partial pressure of N_2(g) in the atmosphere is 0.78 atm.

Given

$P_1 = 1$ a tm

$C_1 = 6.8\times10^{-4}$ m o l/ℓ

$P_2 = 0.78$ a tm

Required

$C_2 = ?$

Solution

$$C_1/P_1 = C_2/P_2$$

$$\Rightarrow C_2 = \frac{P_2 \times C_1}{P_1}$$

$$\Rightarrow C_2 = \frac{0.78atm \times 6.8\times10\ \ mol/\ell}{1\ atm}$$

$$\Rightarrow C_2 = \underline{5.3\times10^{-4}mol}/\ell$$

This shows that decrease solubility results lower pressure from 1 a tm to 0.78atm.

a b C

Q: Which of the following has greater henery's law constant at 25°C / CH_4 , Ne, NH_3/

Answer:- Based on the formula The vapor pressure of Nn_3 is high, so K become CH_4 has higher mass than Ne ∴ vapor pressure become lower & larger "K" value obtained

2.4 Ways of expressing Concerntraction of solution

There are different ways of expressing concentration of solution

A. Percent by mass /Volume:- Percent by mass also called by weight

- Given by percent by mass of solute is the of mass of solute to the mass of solution ×100% percent by mass of solute $\frac{Mass\ of\ solute}{Mass\ of\ solute} \times 100\%$
- Unit less

E.g:- A sample of 0.892 g of K C l dissolved in 54.6g of water . What is the percentage by mass of KCl in the solution.

Solution:- % by mass of K C l= $\frac{Mass\ of\ \ KCl}{Mass\ of\ Solution} \times 100\%$

$$= \frac{0.8929}{0.892+54.6} \times 100\%$$

$$\Rightarrow \%\ \text{by mass of K C l} = \underline{0.016\%}$$

B. Percent by Volume:- The ratio of volume of solute to volume of solution times hundred

i.e:- Pressure by Volume $= \frac{Volume\ of\ solute}{Volume\ of\ solution} \times 100\%$

E.g:- A rubbing alcohol usually contain 70ml is propanol in 100ml of solution. What is % V/V of the solution?

Solution:- percent Volume $= \frac{Volume\ of\ Solute}{Volume\ of\ Solution} \times 100\%$

$= \frac{70ml}{100ml} \times 100\% = \underline{\mathbf{70\%}}$

For most diluted solution, P Pm & PP b are very important to calculate concentration of solution.

$$PPM = \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 10^6$$

$$PP\ b = \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 10^9$$

$PP\ b = 10^3\ PPM$

E. g 1 :- 3g of ground water found to contain 2.4 μg of Pb^{+2} . What is the concentration of Pb^{+2} in PPM & PPb?

Solution:- $PPM = \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 10^6$

$= \frac{2.4 \times 10^{-6}}{3} = \underline{\mathbf{0.8\ PP\ m}}$

$PP\ b = \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 10^9 = \frac{2.4 \times 10^{-6}}{3} \times 10^9$

$PP\ b = 0.8 \times 10^3 = \underline{\mathbf{8 \times 10^2\ PP\ b}}$

Exercise 2.6

1, It 150g of orange juice contains 120mg of ascorbic acid. What is the concentration of ascorbic acid in PP b? 1g 10^3mg

Solution:- $PP\ b = \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 10^9$

$= \frac{0.12}{150} \times 10^9 = \underline{\mathbf{0.0008\ PP\ b}}$

Mole fraction ( )

- It is the ratio of mole of substance to the mole of solution.

Given by $\times_A = \frac{Mole\ of\ A}{Mole\ of\ Solution} = \frac{n\ A}{n\ Solution}$

$\times_B = \frac{Mole\ of\ B}{Mole\ of\ Solution} = \frac{n\ A}{n\ Solution}$

$$\text{Mole percent} = \frac{Mole\ of\ Solute}{Mole\ of\ Solution} \times 100\%$$

E.g 1 :- What is the mole fraction of I_2 in a solution containing 30g of I_2 in 400g of CCl_4

Solution:- Mole $I_2 = \frac{MI_2}{MW+I_2}$ $\frac{30g}{254g/mol} = \underline{0.11mol}$

Mole of $CCl_4 = \frac{MCCl4}{Mw+CCl4} = \frac{400g}{154g/mol}$ **2.6 m o l**

Mw+ I_2

Then $\times I_2 = \frac{MI_2}{n\ Solution} = \frac{0.11\ mol}{0.11+2.6\ mol} = \underline{0.04}$

$\times CCl_4 = \frac{nCCI_4}{n\ Solution} = \frac{2.6\ mol}{2.71\ mol} = \underline{0.96}$

N. B:- The sum of mole fraction is **Zero**

E. g 2 :- A sample of running alcohol contains 142 g of is opropyl alcohol / C_3H_7OH / & 58g H_2O What ate the mole fraction of alcohol & water / Given Mw+ C_3H_7OH = 60g / m o l)

1st) Calculate the mole of alcohol & water

- n $C_3H_7OH = \frac{M_{C3H7OH}}{M_{W+C_3\ H_7OH}} = \frac{142g}{60g\ mol} = \underline{2.37}$ m o l
- n $H_2O = \frac{58g}{18\ g/mol} = \underline{3.22}$ m o l

2nd) $\times C_3H_7OH$ $\frac{n_{C3H7OH}}{n\ _{C3H7OHn\ H_2O}} = \frac{2.37}{5.59} = \underline{0.4}$

$\times H_2O = \frac{n\ H_2O}{n\ H_2O+ n_{C3H7OH}} = \frac{3.22}{5.59} = \underline{0.6}$

2.4.1 Molarity / M /

The most common unit of concentration

Given by $M = \frac{n\ Solute}{Volume\ /\ell\ of\ solution}$

E. g :- What is the molar concentration of a solution containing 8g of ethanol / CH_3CH_2OH / in 200Cm^3 of solution.

Given:-

V = 200Cm^3 = 0.2L

Mw+ C_2H_5OH = 46g/m o l

M = 8g

Required

M = ?

Solution

$M = \frac{n\ Solute}{V/\ell/of\ solution}$

but n solute = 8/46 = **0.17** m o l

$\Rightarrow = \frac{0.17\ mol}{0.2\ L} = \underline{0.89\ m\ o\ l}$

Exercise 2.8

1, 5.85g of Na C l dissolved in water to make 250m/ of solution . Assume the density of the solution as

1g/m/. calculate

a) Molarity of the solution

b) Mass Percentage of the Solute

a) **Given:-**

V Solution = 250m = 0.5L

M Na cl = 5.85g

Mw+ Na C l = 58.5 g/m o l/

Required

M = ?

Solution

$$M = \frac{n\ Solute}{V/\ell/\ solution}$$

$$M = \frac{0.1\ mol}{0.25\ L}\ \underline{\mathbf{0.4}}\ \text{m o l}$$

b) Percent by mass $= \frac{Mass\ of\ Solute}{Mass\ of\ Solution} \times 100\%$

but mass of solution obtained from density of the solution

$$S = \frac{M}{V}$$

, M = S × V

M Solution = 1g/m/× 250 m/

M Solution = 250g ⇒ mass of solution

% by mass of Na C l $= \frac{5.85}{250} \times 100\%$

⇒ % by mass Na C l = **2.34%**

2, A solution of hydro choric acid contains 36% CH C l, by mass, calculate the mole fraction of HCl in the solution.

Given

% H C l = 36% = 36g

% H_2O = 64% = 64g

Required

× HCl = ?

Solution

$$n\text{CCl} = \frac{M_{HCl}}{M_{HCl}} = \frac{36g}{36.5\ g/mol} = \underline{0.98\ \text{mole}}$$

$$n\text{H}_2\text{O} = \frac{MH_2O}{Mwt\ H_2O} = \frac{64g}{18\ g/mol} = \underline{3.56\ \text{mole}}$$

$$\times\text{HCl} = \frac{nHCl}{nHCl+nH_2O} = \frac{0.98\ mole}{4.54\ mol} = \underline{0.22}$$

2.4.2 Molality / M /

⇒ **Molality** is the ratio of no of moles of solute to mass of solvent in kilogram (Kg) , $m = \frac{n\ Solute}{m\ Solvent/Kg}$

- It does not contain volume in its ratio.

Q:- What is the advantage of molality over molarity?

Answer:- ↳ Has no effect on temperature because mass does not change with temperature

↳ Simple to mix **i. e:-** un like volume masses are additive 50g one solution add to 50g of other solution to produce 100g of final solution

E. g :- Calculate molality of a solution prepared by dissolving 30g of Na C l in 280g of water

Given

MN AC l = 30g

Mw t Na C l = 58.5g/m o l

$MH_2O = 280g$

M w t $H_2O = 18g/m\ o\ l$

Required

$Molality\ (m) = ?$

Solution

$m = \frac{mole\ of\ solute}{mass\ /Kg/Solvent}$

but n Na C l $= \frac{30g}{58.5\ g/mol} = 0.5$ mol

$\Rightarrow m = \frac{0.5\ mol}{0.28\ Kg} = \underline{1.78\ m\ o\ l\ kg}$

Exercise 2.9

1, how many grams of glucose / $C_6H_{12}O_6$ / must be dissolved in 563g of ethanol / $C_6H_{12}O_6$ / to prepare 2.4×10^{-2}m Solution?

Given

Molality $= 2.4 \times 10^{-2}$m

$MC_2H_5OH = 563g = 0.563$ Kg

Required

Mass of $C_6H_{12}O_6 = ?$

Solution

$M = \frac{n\ Solute}{mass\ /Kg/of\ Solvent}$

n solute = molality × mass of solvent /Kg/

$= 2.4 \times \frac{10^{-2}mol}{kg} \times 0.563\ Kg = \underline{1.35 \times 1}$

no of mole $= \frac{given\ mass}{Molar\ mass}$

1.35×10^{-2} m o l $= \frac{m\ glucose}{180g\ /mol}$

⇒ m glucose = 180g/ m o l × 1.35×10^{-2} m o l

m $C_6H_{12}O_6$ $= \underline{2.43\ g}$

2.4.3 Normality / N /

⇒ **Normality** is the no of equivalents of the solute contained in one litre of solution.

⇒

$$\text{Normality} = \frac{\text{no of equivalent of Solute}}{\text{Volume (L) of Solution}}$$

⇒ No of equivalent of solute $= \frac{mass\ of\ solute}{Equivalent\ weight}$

⇒ Equivalent weight $= \frac{Molar\ mass\ of\ Solute}{Z}$

Where "Z" = no of ignitable hydrogen ion & hydrogen ions per molecule for acid & bade, reactivity.
= total no of positive charge for salts.
= total no of electrons lost or gained in redox reactions.

$$N = M \times Z$$

E. g 1 :- Calculate the no of equivalent present in 0.5 m o l of H_3PO_4. If an acid is completely ionized to give $PO4^{-3}$

Solution:- $H_3PO_4 \rightarrow 3H^+ + PO4^{-3}$, Z = 3

No of equivalent = mole of solute × Z

= 0.5×3 = **1.5ℓg**

E. g 2 :- Calculate no of equivalent for 20g Na OH

Given

MN a OH = 20g

Z = 1 from Na OH → $Na^+ + OH^-$

No of equivalent

Required

no of equivalent =?

Solution

= mole × Z

n N a OH $= \frac{Given\ mass\ of\ NaOH}{Molar\ mass\ of\ NaOH}$

$= \frac{20g}{40g/mol}$ = **0.5 m o l**

∴ no of equivalent = 0.5 ×1 = **0.5ℓq**

E. g 3 :- Calculate the normality of 49g of H_2SO_4 in 500ml of solution?

Given

MH_2SO_4 = 49g

$MwtH_2SO_4$ = 98g/m o l

V = 500 ml = 0.5 L

Required

N= ?

Solution

$$N = M \,.\, Z.$$

$n_{H_2SO_4} = \frac{Given\ mass\ of\ H_2SO_4}{Molar\ mass\ of\ H_2SO_4} = \frac{49g}{98g/mol}$ = **0.5 m o l**

$M = \frac{n}{V(\ell)} = \frac{0.5mol}{0.5\ell}$ = **1 m o l/ℓ**

$H_2SO_4 \rightarrow 2H^+ + SO4^{-2}$, Z = 2 ⇒ no of H^+ qurushes

$\therefore N = M \times Z$

$= 1\ mol/l \times 2\ eq/mol$

$N = 2\ eq/L = \underline{\mathbf{2N}}$

Exercise 2.10

1, how many equivalent of solute is contained in 1 L of 2N solution

Given

V = 1L

N = 2N

Required

no of equivalent = ?

Solution

$N = \frac{no\ of\ equivalent}{volume/L/}$

No of equivalent = N × volume /L

$No\ of\ eq = 2\frac{eq}{\ell} \times 1\ \ell = \underline{\mathbf{2\ eq}}$

2, Calculate the molarity and normality of a solution that contain 16.2g of $Fe_2(SO_4)_3$ in 200ml of solution.

Given

$M\ Fe_2(So_4)_3 = 16.2g$

V = 200ml = 0.2 L

Required

M & N = ?

Solution

$M = \frac{n}{V}$ but $n = \frac{16.2g}{400g/mol}$

$N = \underline{\mathbf{0.04\ mol}}$, $M = \frac{n}{V} = \frac{0.04mol}{0.2\ L} = \underline{\mathbf{2\ mol}}/L$

$Fe_2(SO_4)_3 \rightarrow 2Fe^{+3} + 3SO4^{-2} \Rightarrow Z = 6$

Then N = M .Z

$= \frac{0.2\ mol}{\ell} \times \frac{6\ eq}{mol} = 1.2\ eq/L = \underline{\mathbf{1.2\ N}}$

3, Calculate the normality of 0.1381 m Na OH

Given

M = 0.138 mol/L

Z = 1 eq/mol

i. e :- $NaOH \rightarrow Na^+ + OH^-$, Z = 1eq/mol

Required

N = ?

Solution

N = M . Z.

$N = \frac{1eq}{mol} \times 0.381\ \frac{mol}{L}$

$N = \underline{\mathbf{0.1381\ eq/L}}$

2.5 Preparation Of Solution

Liquid solution can be prepared from solid & liquid solutes

A, Preparation of Liquid Solution From Solid Solute:-

Step 1 :- Calculate the required amount of mass
Step 2:- Weigh this mass with balance
Step 3:- transfer this mass in to beaker and add some solvent of shake it.
Step 4:- Transfer dissolved mixture to volume trick flask
Step 5:- Dilute by filling remaining portion
Step 6:- Cap & level the flask having solution
E. g:- prepare 100 ml of 1M Na OH using solid Na OH?
Step 1 :- Calculate amount of mass needed

$V = 10ml = 0.1\ L$

$M = 1\ mol / L$

$\frac{M}{1} = \frac{n}{V} \Rightarrow n = M \times V$

$= \frac{1\ mol}{\ell} \times 0.1 = \underline{0.1\ mol}$

$n = \frac{given\ mass}{Molar\ mass}$, $m = n \times met$

$n = 0.1\ mol \times 40g/mol$

$n = 4g$ of Na OH is required

Step 2:- Weight 4g of Na OH w balance .
Step 3:- Transfer in to beaker & add some water to dissolve.
Step 4:- Transfer the dissolved mixture in to volume-ethic flask
Step 5:- Dilute by filling the remaining portion
Step 6:- Cap & level the flask containing stock solution

B, Preparation Liquid Solution From Liquid Solute:-

- In this method liquid dissolving with other liquid. By using $V = M/d$

Where
d = density
m = mass
V = Volume

Step 1 :- use cylinder & measure volume directly and transfer in to volumetric flask by using funnel.
Step 2:- Dilute the mark by filling some water
Step 3:- Cap & level this prepared solution in the flask.

2.5 .1 Diluting a Solution

Dilution is a procedure for preparing less concentrated solution from more concentrated one by adding more solvent .

Dilution formula $M_1 V_1 = M_2 V_2$

Hence mole of solute before and after dilution are equal .s

E. g:- how would you prepare 2.0×10^2 ml of 0.866M COH solution, Starting with 5.07M stock solution

Given	Required	Solution
$M_1 = 5.07$ M	$V_1 = ?$	$M_1 V_1 = M_2V_2$
$V_2 = 200$ml		$\Rightarrow V_1 = \frac{M_2V_2}{M_1}$
$M_2 = 0.866$M		
		$V_1 = \frac{0.866 \times 200ml}{5.07}$
		$\Rightarrow V_1 =$ **34 mℓ**

Then we musk with draw 34ml from 5.07M KOH solution, transfer it to 200ml of volume ethic flask half filled with distilled water and dilute it with sufficient amount of water to the mark . finally cap & level it .

2.6 Solution Stoichiometry

I) Mole – Mole Calculation

E. g:- What is the concentration of Na OH that is required to react completely with equal volume of 0.104M H C l ?

Given	Required	Solution
MH C l = 0.104M	MN a OH?	Na OH + H C l → Na C l + H_2O
VN a OH = VH C l		1 m o l 1 m o l
		$n_{Na\,OH} = V_{Na\,OH} \times M_{Na\,OH}$
		$n_{H\,Cl} = V_{HCl} \times M_{H\,Cl}$
		$\frac{n_{NaOH}}{n_{HCl}} = \frac{V_{naOH}\times M_{NaOh}}{V_{HCl}\times M_{HCl}}$
		but $V_{Na\,OH} = V_{H\,Cl}$
		$\Rightarrow \frac{1}{1} = \frac{M_{NaOH}}{M_{HCl}}$
		$M_{Na\,OH} = 1 \times 0.104$ M
		$M_{Na\,OH} =$ **0.104 M**

II) Mole – Mass

E. g:- What mass of solid $Mg(OH)_2$ (s) can be produced if 45ml of a 0.63M Mg $(NO_3)_2$ solution react completely with excess Na OH?

Given	Required	Solution
V Mg $(NO_3)_2 = 0.045$ ℓ	$m_{Mg(OH)2}$=?	$2NaOH + Mg(NO)_2 \rightarrow Mg(OH)_2+2NaNO_3$
M Mg $(NO_3)_2 = 0.63$ M		0.028 ×
M w t $Mg(OH)_2 = 58$ g/m o l		$2NaOH + Mg(NO)_2 \rightarrow Mg(OH)_2+2NaNO_3$
n Mg $(NO_3) = 0.02835$ m o l		$\Rightarrow \frac{0.028\ mol}{1\ mol} = \frac{\times}{58\ g}$
From $n = M \times V$		$\Rightarrow \times = 58g \times 0.028$
		$\times = 1.6g$ of $Mg(OH)_2$

Mass – Volume

E. g:- What volume of 0.0995M $Al(NO_3)_3$ will react with 3.66g of Ag. According to the equation 3Agwt $Al(NO_3)_3 \rightarrow AgNO_3$ 3 Al(s)

Given

$M_{Ag} = 3.66g$

M w t Ag = 107g/m o l

$M_{Al(NO_3)_3} = 0$

0995M

Required

V Al $(NO_3)_3$

$n_{Ag} = ?$

Solution

$$\frac{n_{Ag}}{n_{Al(NO_3)_3}} = \frac{3\ mol}{1\ mol}$$

but $n_{Ag} = \frac{3.66g}{107g/mol} = \underline{0.034}$

$$\Rightarrow \frac{0.034\ mol}{n_{Al(NO_3)_3}} = \frac{3}{1}$$

$$\frac{3 \times nAlNO_3)_3}{3} = \frac{0.034\ mol}{3}$$

$\Rightarrow n_{Al(NO_3)_3} = 0.0114$ m o l

$$\therefore V = \frac{n}{M} = \frac{0.0114\ mol}{0.0995\ mol/L}$$

$\Rightarrow V_{Al}(NO_3)_3 = \underline{0.114\ \ell}$

Mole – Volume

E. g:- What volume of a 0.35 M $AgNO_3$ is required to react completely with 55ml of 0.24M Na C l solution

Given

$M_{AgNO_3} = 0.35m$

$M_{NaCl} = 0.24M$

$V_{NaCl} = 55ml = 0.055\ell$

Required

$V_{AgNO_3} = ?$

Solution

$AgNO_3$ (2of)+ Na C l (2 of) $\rightarrow$ Ag C l(s) + $NaNO_3$

$$\frac{n_{AgNO_3}}{n_{NaCl}} = \frac{1\ mol}{1\ mol}$$

but $n_{NaCl} = V \times M = 0.055 \times 0.24$

$\Rightarrow n_{NaCl} = \underline{0.0132}$ m o l

$$\frac{n_{AgNO_3}}{0.0132\ mol} = \frac{1}{1}, \quad n_{AgNO_3} = \underline{0.0132}\ \text{m o l}$$

$$n_{AgNO_3} = V_{AgNO_3} \times M_{AgNO_3}$$

$$\Rightarrow V_{AgNO_3} = \frac{n_{AgNO_3}}{M_{AgNO_3}} = \frac{0.0132\ mol}{0.35\ mol/L} = \underline{0.0377\ \ell}$$

Mole – number of particle

E. g:- What volume of a 0.5 M glucose / $C_6H_{12}O_6$ / contain 3.01×10^{22} molecule of glucose

Solution:- 1 m o l of $C_6H_{12}O_6 = 6.02 \times 10^{23}$ molecule

$x = 3.01 \times 10^{22}$ molecule

$$\frac{6.02 \times 10^{23} mol}{6.02 \times 10^{23}} = \frac{3.01 \times 10^{22} mol}{6.02 \times 10^{23}}$$

$\Rightarrow x = 0.05$ m o l then

$\mathbf{M = \frac{n}{V}}$, - V $= \frac{n}{M}$ $= \frac{0.05\ mol}{0.5\ mol/L}$ $=$ **0.1 Litter**

2.7 Describing Reactions in Solution

A) Molecular Equation

- It is a chemical equation in which the reactant & products written as a molecular substance, even through they may actually exist in solution as ions.

E. g:- $AgNO_3$ (a q) + Na C l (a q) → Ag C l(s) + $NaNO_3$ (a q) this is molecular equation

B) Ionic Equation:-

it gives information about the substance in the level of ions.

E. g:- The reaction of sliver nitrate & sodium chloride both are soluble & strong electrolyte, when they dissolve in water they go in to solution as ion.

i. e:- Ag^+(a q) + NO^-_3(a q) + Na^+(a q) + C l^-(a q) → Ag C l(s) + Na^+(a q) +NO^-_3 (a q) Na^+ 7 NO^-_3 are spectator ions.

net ionic equal : Ag^+(a q) + C l^-(a q) → $AgNo_3$(s)

- **Spectator ion:-** The ion that spears in both sided of the equation that does not take part in chemical reaction is called *Spectator ion.*

Exercise 2.17

1, For the molecular equation given bellow 2Ag NO_3(a q) + Na_2 Cr_2O_4(a q) → Ag_2 Cr_2 O_4 (s) + 2Na NO_3 (a q) write ionic & net ionic equation.

Solution:- Ionic equation given by

2Ag^+(a q) NO^-_3 (a q)+ 2Na^+ (a q)+ $Cr_2O^-_4$(a q) → Ag_2 Cr_2 O_4 (s) + 2Na^+-(a q) + NO^-_3 (a q)

Spectator ion Na^+ & NO^-_3

- Net ionic equation is given by 2Ag^+(a q) + Cr_2 O^{-2}_4 (a q) →Ag_2 Cr_2 O_4 (s)

⇔Chapter - 2 Review exercise

Part I multiple Choice question

The question is wrong it should be gas – Liquid solution rather Liquid - gas

1, ?	5. B	9. A	13. B	17. B	21. A
2. A	6. C	10. A	14. A	18. C	22. B
3. C	7. A	11. C	15. C	19. C	23. B
4. B	8. C	12. C	16. C	20. B	24. C

Part I I Short answer question

Q 25. Give example of gaseous solution, Liquid solution & sold solution?

Answer:- gaseous solution **E .g:-** air

Liquid solution **E .g:-** Milk

Solid solution **E. g:-** alloy

Q 26. What are the two factors needed to explain the difference in solubility of ionic solid in water.

Answer:- Lattice energy and hydration energy

Q 27. Explain the terms of intermolecular attractions why octane is immiscible in water

Answer:- Due to polarity difference

i. e H_2O is polar & octane is nonpolar,

Q 28. Give the type of colloid in each of the f/f

a) Rain cloud = aerosol
b) Milk of magnesia = sol
c) Silt in water = sol

Q 29. Concrete is a mixture of? →Sand

→ Cement

→ Water

→ stone

Q 31. Explain why ionic substance show a wide range of solubility's in water.

Answer:- The two poles of water have strong force of attraction to words other charged ion, due to H_2O breaks the ionic bond by hydrogen bond.

Q 32. Indicate the type of solute – solvent interact ion in each of the following

a) K Br in water ⇒ ion – dipole.

b) NH_3 in water ⇒ Hydrogen bonding
c) Hexane in gas online = dispersion

Q 33. Describe the characteristics of endothermic & exothermic dissolution process

Answer:- Endothermic dissolution / ΔH / lattice > /ΔH / hydrogen

Exothermic dissolution / ΔH / lattice < /ΔH / hydrogen

Q 34. Predict the following solute solubility low or high

a. K C l in water – high
b. HF in water – high
c. K C l in CCl_4 - low
d. H_2O in CH_3OH - high
e. CCl_4 in H_2O - low

Q 35. What is the usual solubility behavior of ionic compound in water. When temperature raised ? Give some exception

Answer:- Increase Except li_2SO_4, $CaSO_4$, C a $(OH)_2$

Q 36. Give one example of each. A salt whose heat of solution exothermic & a salt whose heat of solution Exothermic

Answer:- Na OH = Endothermic

NH_4NO_3 = Exothermic

Q 37. What do you expect to happen to a concentration of dissolved gas in a solution as the solution is heated ?

Decrease.

Q 38. Explain why a carbonated beverage must be stored in a closed container ?

Answer:- To control the pressure

Q 39. Pressure has effect on solubility of O_2 in water but little effect on solubility of sugar in water why ?

Answer:- pressure has a major effect on gases than solids – **i. e:-** sugar is solid & O_2 is gas

Q 40. Which one of the following have greater energy of hydration. Mg^{+2} Or Al^{3+} ?

Answer:-

Part I I I Work out question

Q 42. The solubility of CO_2 in water is 0.16 /g CO_2 in 100 m/ of water at 20°C & 1.00 atm . A soft drink is carbonated with CO_2 in water at this pressure ?

Given

$C_1 = 0.161$

$P_1 = 1$ a tm

Solution Henery's law C×P

$$\frac{C1}{P1} = \frac{C2}{P2}$$

$$\Rightarrow C_2 = \frac{C1\ P2}{P1}$$

$P_2 = 5.5$ a tm

Required $C_2 = ?$ Sec back

$$C_2 = \frac{P2\ C1}{P1} = \frac{5.5atm \times 0.161\ g}{1\ atm}$$

$$\Rightarrow C_2 \quad \underline{0.886\ g}$$

Q 43. Calculate the molarity of each of the following question

a) 10.5 g Na C l in 350.0 m. of solution

Given

MN a C l = 10.5 g

M w t Na cl = 58.5 g /m o l

V solution = 350 m/ = 0.35e

Required

Molarity = ?

Solution

$$M = \frac{"n"\ solution}{v(L) of\ solution}$$

but n $_{Na\,Cl} = \frac{10.5\ g}{58.5\ g/mol}$

n = <u>0.17948</u> m o l

$$M = \frac{0.1795\ mol}{0.35L} = \underline{0.5\ 1M}$$

b) 40.7 g $liClO_4 . 3H_2O$ in 125 m/ of solution.

Given

M $LiClO_4 . 3H_2^0O = 40.7$

M w t $LiClO_4 . 3H_2O = 159.5$

V solution = 125ml = 0.25L

Required

M = ?

Solution

M = n/V

$$n = \frac{40.7\ g}{159.5\ g\ /mol}$$

n = 0.255 m o l

$$\Rightarrow M = \frac{n}{v} = \frac{0.255\ mol}{0.125\ L} = \underline{2M}$$

Q 44. What mass of solution containing 500 % KI, by mass contain 258 mg KI ?

Given

MKI = 258 Mg = 0.258 g

% by mass of solution = 5.00%

Required mass of solution = ?

Solution

$$\text{Percent by mass of KI} = \frac{mass\ of\ KI}{mass\ of\ solution} \times 100$$

$$5 = \frac{0.258 \times 100}{mass\ of\ solution}$$

$$\Rightarrow \text{Mass of solution} = \frac{0.258 \times 100}{5} = \underline{5.16\ g}$$

Q 45. Caffeine $C_8H_{10}N_4O_2$, is stimulant found in tea & coffee. A sample of substance was dissolved in 45.g of chloroform $CHCl_3$ to give a 0.0946 m solution.

How many grams of caffeine were in the sample / molar mass of $C_8H_{10}N_4O_2$ = **194**

Given

Molality = 0.0946 m o l/kg

Mass of solvent = 45g = 0.045 kg

Molar mass of $C_8H_{10}N_4O_2$ = 194 g/m o l

Required

Given mass of $C_8H_{10}N_4O_2$ = ?

Solution Molality (m) $= \frac{mole\ of\ solute\ (n)}{mass\ /kg\ of solvent}$

But mole of solute $= \frac{given\ mass\ of\ solute}{molar\ mass\ of\ solute}$

$\Rightarrow \quad \frac{m}{1} = \frac{mole\ of\ solute}{0.045\ kg}$

$\Rightarrow$ mole of solute = molality × 0.045 kg

$= 0.09\frac{46\ mol}{kg} \times 0.045$ kg

"n" $C_8H_{10}N_4O_2$ = 0.0004257 m o l

$\therefore \frac{n}{1} = \frac{m}{M.wt}$

$\Rightarrow$ M = n×Mwt

= 0.0004257 mol × 194.19 g/mol

$\Rightarrow$ m $C_8H_{10}N_4O_2$ = **0.826 g**

Q 46. A 100 g of sample of brand of rubbing alcohol contain 65.0g of isopropyl alcohol C_3H_7OH and 35.0g of water. What is the mole fraction of alcohol & water?

Given

MH_2O = 35g

M C_3H_7OH = 65

M w t H_2O = 18g/m ol

Required

×H_2O 7 × C_3H_7OH = ?

Solution

$nH_2O = \frac{35g}{18g/mol}$ = **1.94**

n $C_3H_7OH = \frac{65g}{60g/mol}$ = **1.08**

"n" total = 1.94+ 1.08

= **3mol**

$\times H_2O = \frac{mole\ of\ H2O}{Total\ mole}$

$= \frac{1.94}{3}$ = **0.646**

$$\times C_3H_7OH = \frac{"n"C_3H_7OH}{Total\ mole}$$

$$= \frac{1.08}{3} = \underline{0.36}$$

Q 47. Able aching solution Na C l O dissolved in water. The solution is 0.65 m NaClO. What is the mole fraction of Na C l O.

Given

M Na C l O = 0.65 m o l/kg

Mass of water = 1 kg

Required

$\times$ Na C l O = ?

Solution

$$M\ Na\ c\ l\ O = \frac{n\ NaClO}{mass\ (kg) of\ H_2O}$$

$$0.65\ \frac{mol}{kg} = \frac{n\ NaClO}{1\ kg}$$

$$\Rightarrow n\ Na\ C\ l\ O = \underline{0.65}\ m\ o\ l$$

$$nH_2O = \frac{1000g}{18g/mol} = \underline{55.56}\ m\ o\ l$$

Total m o l = 56.21 m o l

$$\times Na\ C\ l\ O = \frac{n\ NaClO}{Total\ mol}$$

$$= \frac{0.65\ mol}{56.2\ mol} = \underline{0.0116}$$

$$\Rightarrow \times Na\ C\ l\ O = \underline{0.0116}$$

Q 48. The concentrated H_2So_4 is 98% H_2So_4 by mass. Calculate the molality and molarity of acid solution. The density of the solution is 1.83 g/ml.

Given

$\mathcal{S}$ solution = 1.83h/mass

$MH_2So_4 = 98g$

Required

M = ?

m = ?

Solution

$$\%\ H_2So_4 = \frac{M\ H_2SO_4}{Mass\ of\ Solution} \times 100\%, \text{ but } \mathcal{S} \times \frac{Msoution}{V\ solution}$$

M solution = $\mathcal{S}$ × V solution

M solution = $\mathcal{S}$ × V solution = 1.83g/ml × 100ml=

= 1830g

$$\%\ H_2So_4 = \frac{M\ H_2SO_4}{Mass\ of\ Solution} \times 100\%$$

$$M\ H_2So_4 = \frac{\%\ H_2SO_4 \times mass\ of\ solution}{100\%}$$

$$= \frac{98\%\ 1830g}{100\%} = 9.8 \times 183g = \underline{1793\ g}$$

$M\ H_2So_4 = \frac{n\ H_2SO_4}{V\ (1)}$, but $n = \frac{m}{M} = \frac{1793g}{98g/mol}$

$n = \underline{17.98\ mole} \approx \underline{18\ m\ o\ l}$

$M\ H_2So_4 = \frac{17.98\ mol}{1\ L} = \underline{17.98\ mass/L} \approx$

$\text{Molality} = \frac{\text{n bsolution}}{mass(kg)solvent}$ but M solvent = M solution – M solution

M solvent = 1830g – 1793 g

= 37g = $\underline{0.037kg}$

$\text{Molarity} = \frac{18\ mol}{0.037\ kg} = \underline{486.48mol/kg}$

Q 49. Calculate the approximate value of water that must be added to 250ml of 1.25N solution to make it 0.5N

Given

$V_1 = 250ml$

$N_1 = 1.25N$

$N_2 = 0.5N$

Required

V_{H20} added = ?

Solution

$N_1V_1 = N_2V_2 \rightarrow$ Dilution formula

$V_2 = \frac{N_1N_1}{N_2}\ \frac{1.25N \times 250ml}{0.5N} = 625ml\ N_1V_1$

V_{H20} add = $V_2 - V_1 = 625ml - 250ml = \underline{375ml}$

Q 50. An antiseptic solution contain hydrogen peroxide H_2O_2 , in water. The solution is 0.610m H_2O_2 . What is the mole fraction of hydrogen peroxide?

Given

$M H_2O_2 = 0.610m$

Required

$\times\ H_2O_2 = ?$

Solution

$\times\ H_2O_2 = \frac{n\ H_2O_2}{n\ Solution}$

$n\ H_2O_2 = 0.610mol$

$mH_2O = 1kg = 1000g$ $nH_2O = \frac{m\ H_2O}{M_{wt}H_2O} = \frac{1000g}{18g/mol} = \underline{55.56}$

$MH_2O = 18g/m\ o\ l$

$\underline{nH_2O = 55.56\ mole = n\ solvent}$

n solution = n solute + n solvent

$= 0.610\ mol + 55.56mole = \underline{56.17mole}$

Then $\chi\ H_2O_2 = \frac{n\ H_2O_2}{n\ Solution} = \frac{0.61mol}{56.17mol} = \underline{0.01}$

Q 51. Citric acid ($C_6H_8O_7$) occur in plant lemon contain 5% to 8% citric acid by mass. The acid is added to beverage and candy. All aqueous solution is 0.688m citric acid . The density is 1.049 g/ml. What is the molar concentration?

Given

$n\ C_6H_8O_7 = 0.688mol$

M solvent $= 1000g$

$\mathcal{S}$ solution $= 1.049g/ml$

Required

$M = ?$

Solution

$M = \frac{n\ solute}{V\ (L) solution}$

M solute $= n$ solute $\times M$ wt solute

$= 0.688mol \times 192g/mol$

$= \underline{132.096g}$

m solution $= m$ solvent $+ m$ solute

$= 1000g + 132.096g$

$= \underline{1132.096g}$

Then V solution $= \frac{m\ solution}{m\ solution} = \frac{1132.096g}{1.049g/ml}$

V solution $= 1079.2ml\ \underline{1.0792L}$

$\therefore M = \frac{n\ solute}{V\ (L) solution} = \frac{0.655mol}{1.0792L} = \underline{0.64\ mol/L}$

Q 52. A solution of vinegar is 0.763M acetic acid, $C_2H_5O_2$. The density of vinegar is 1:00& g/ml. what is the molar concentration of acetic acid ?

Given

$M = 0.763mol/L$

Solution

$molality = \frac{n.solute}{mass/kg/solvent}$

$n_{C_2H_5O_2} = 0.763mol$ $\mathcal{S} = \frac{m}{V}$

V solution = 1000ml $\Rightarrow$ m = $\mathcal{S} \times V$

S solution = 1.004g/ml $\Rightarrow m = \frac{1.004g}{ml} \times 100ml$

Required m solution = **1004g** - - - *

Molar of $C_2H_5O_2$ $m_{C_2H_5O_2} =$ "n" $C_2H_5O_2 \times M_{wt}\, C_2H_5O_2$, $C_2H_5O_2$, $M_{wt}\, C_2H_5O_2 = 60$ g/n

$= 0.763mol \times 60g/mol$

$m_{C_2H_5O_2} =$ **45.78g**

Mass of solvent = mass of solution – mass of solute

= 1004g – 45.78g = **958.22g**

$\Rightarrow$ m solvent = 958.22g = **0.95822** kg

Molality = $\frac{n\ solute}{mass\ /kg/solvent} = \frac{0.763\ mol}{0.95822\ kg}$

∴ Molality of $C_2H_5O_2$ = **0.796mol**/kg

UNIT – 3

Important inorganic Compound

In organic compounds mostly found in nature as silicates, oxides, carbonates, sulphides, sulphates, chlorides & nitrates.

- Generally found in nonliving things In organic compounds are generally classified as in to four groups.

3.1 Oxides

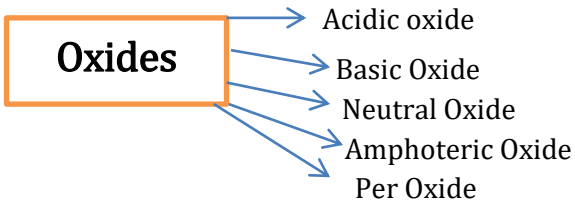
are a binary compounds containing oxygen and any other elements.

- It contain only two elements.

i. e:- Oxygen + element /metal, nonmetal or metalloid) → Oxide

E. g:- SO_2, C a O, Al_2O_3 , SiO_2 e t c

Based on their properties oxides classified as



A. Acidic Oxide

Acidic oxide is formed by chemical combination of oxygen with nonmetal. These oxide also called acid anhydrides since . They form acidic solution when dissolve in H_2O **E. g:-** NO, N_2O, CO, H_2O e t c

N.B:- All nonmetal oxide are not necessarily **E. g:-** NO, N_2O, CO, H_2O are neutral oxides.

Chemical Properties Of acidic Oxide

1, they dissolve in water to form acidic solution Acid an hydride + water → Acid

$CO_2 + H_2O \rightarrow H_2CO_3$, $SO_2 + H_2O \rightarrow H_2SO_3$

2, Acidic oxide react with basic oxide to form salt.

E. g:- $CO_2 + Na_2O \rightarrow Na_2CO_3$

$SO_3 + Ba\ O \rightarrow BaSO_4$

3, Acidic oxide react with base to form salt & H_2O

E. g:- $CO_2 + 2NaOH \rightarrow Na_2CO_3 + H_2O$

B. Basic Oxide

- Most metal react with oxygen to form basic oxide. Basic oxides also called basic an hydrides,
  - All metal oxides are not necessarily basic oxide: Al_2O_3, 2nO, PbO are amphoteric oxide WO_3 is acidic oxide, even through it is metallic oxide.

Chemical Properties Of basic Oxide

1, Basic oxide react with acidic oxide to form salt

E. g:- C a O + CO_2 → CaO_3

2, Basic oxide react with acid to form salt + water

E. g:- $Na_2O + 2HCl \rightarrow 2NaCl + H_2O$

C a O + $H_2SO_4 \rightarrow CaSO_4 + H_2O$

3, Basic oxides dissolve in water to form alkaline solution.

E. g:- Ba O + $H_2O \rightarrow Ba(OH)_2$

$Li_2O + H_2O \rightarrow 2$ Li OH

Exercise 3.4

1, Complete 7 balance the following chemical equation.

a) $Na_2 + CO_2 \rightarrow ?$ $Na_2O + CO_2 \rightarrow Na_2CO_3$

b) Cu +H C l → ? $CuO+2HCl \rightarrow CuCl_2 + H_2O$

2, Classified the oxides acidic or basic

a) B a O+ basic C) SO_2 - acidic

b) P_4O_{10} - acidic d) N_2O_5 - acidic

C. Amphoteric Oxide

Oxides which shows both acidic and basic be heavier is called **amphoteric oxide**

Note:- when they react with acids they act as a bas & when they react with base they act as acids.

E. g:- amphoteric oxides:- Zn O, PbO_2, Al_2O_3, S n O, P b O, e t c

- Al_2O_3 + H C l → $AlCl_3 + H_2O$: Al_2O_3 used as a base.

  Al_2O_3 + Na OH → $NaAlO_2 + H_2O$: Al_2O_3 used as an acid

⇒ Amphoteric oxide, acidic oxide & basic oxides are salt forming oxides.

D. Neutral Oxide

Neutral oxides react neither acids nor with bass to form salt and water.

- They are not salt forming
- They are few in numbers

E. g:- N_2O, CO, NO, H_2O etc.

E. Per Oxide

Compounds which contain oxygen with oxidation number - "1" is called per oxides. In peroxides two oxygen atom are linked with other and atoms of other element.

→ most peroxide of metals formed by burning the metals with sufficient oxygen .

E. g:- $2Na(s) + O_2(g) \rightarrow Na_2O_2(s)$

Some example of peroxide , H_2O, Na_2O_2 , CaO_2 e t c

Chemical Properties Of Per Oxide

1, They are power full oxidizing agent, they react with different substance by losing oxygen

E. g:- $Pbs(s) + 4H_2O(aq) \rightarrow PbSO_4(s) + 4H_2O(\ell)$

2, metal peroxide react with aqueous acid to form salt and hydrogen peroxide

E. g:- $Na_2O_2(s) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O_2(aq)$

Hydrogen Per Oxide / H_2O_2 /

- It is a colorless liquid whose solution is usually used as bleach & antiseptics.
- It decompose with MnO_2 or "P t" to release oxygen

  $2H_2O_2$ /a q/ —p t→ $2h_2O/\ell/ + O_2(g)$
- Due to its strong oxidizing agent it used for mouth wash & cleansing wounds.
- It used for beautisalloa to decolorized the hair from black to white

Exercise 3.4

1, Write an acid oxides for the following acids

a) H_2SO_3 = SO_2 C) H_2CO_3 = CO_2

b) H_2SO_4 = SO_3 d) H_3PO_4 = P_4O_{10}

2, Complete & balance each of the following equation.

a) $CaO + H_3PO_4 \rightarrow ?$ $3CaO + 2H_3PO_4 \rightarrow Ca_3(PO_4)_2 + 3H_2O$

b) $Al_2O_3 + 6HCl \rightarrow ?$ $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + 3H_2O$

3, How peroxides differ from other oxides Due to the presence of – O – O – link and its strong oxidizing agent

3.2 Acids

A group of compound which have sour task

- It comes from Latin word "Acids" meaning sour.
- It plays a vital role in our daily life

E. g:- In our body at home & in laboratory mostly applied.

Arrhenius Definition of Acids

According to Arrhenius definition, acids are a substance that release H^+ or $H3O^+$ in requests solution.

- To be Arrhenius acid it should contain ignitable hydrogen.

E. g:- H C l, HNO_3, H_2SO_4, H Br e t c

i. e:- $HCl(aq) \rightarrow H^+(aq) + Cl^-(aq)$ Or

$HCl(aq) + H_2O$ /L/ $H3O^+(aq) + Cl^-(aq)$

Classification of Acids

A, Based on number of ignitable hydrogen Acids are classified as

I, Monocratic:- acids that contain only one ignitable hydrogen per a molecule

E. g:- CH_3COOH, H C l, H Br, HNO_3 $HClO_3$ e t c

II, Diprotic acid:- acids that have two ionize hydrogen per a molecule

E. g:- H_2CO_3, H_2S, H_2SO_4

III, Diprotic acid:- acids that contain three ignitable hydrogen per a molecule.

E. g:- H_3PO_4 & Arsenic acid **(H_3ASO_4)**

B, Based on number of element they contain

I, Monocratic:- binary acids composed of only two different elements .

E. g:- H C l, HF, H_2S, H Br

II, Ternary acid /Oxy acids/:- Acids composed of three different elements usually H, O & non – metal

E. g:- H_2SO_4, $HClO_4$, HNO_3, H_2CO_3 & H_3PO_4

General Properties of acids

I, Acids have sour task

II, They change color of indicators

III, They react with active metal to produce hydrogen gas & salt.

$Zn + H_2SO_4$dilute $\rightarrow ZnSO_4 + H_2$, but the reaction of Na, C a & K with acid are very dangerous because of the reactivity nature of K, Na & Ca.

Note:- Concentrated HNO_3 7 hot concentrated H_2SO_4 react with "Cu" to produce NO_2 & SO_2 gas respectively, instead of hydrogen.

i. e:- $Cu + 4HNO_3 \xrightarrow{\text{conic}} Cu(NO_3)_2 + 2NO_2 + 2H_2O$

This is due to strong oxidizing acid of HNO_3

$Cu + 2H_2SO_4 \xrightarrow{\text{hot conic}} CuSO_4 + SO_2 + H_2O$

IV, Concentrated acid react with metal sulphites to form salt with SO_2

E. g:- $CaSO_3$ + Conic $H_2SO_4 \rightarrow CaSO_4 + SO_2 + H_2O$

$NaHSO_3 + H\ C\ l \rightarrow Na\ C\ l + SO_2 + H_2O$

V, They react with base to form salt & water

E. g:- $HNO_3 + KOH \rightarrow KNO_3 + H_2O$

$H_2CO_3 + CaCOHl_2 \rightarrow CaCO_3 + 2H_2O$

VI, Aqueous solution of acids are electrolytes electrolyte:- a substance that conduct electricity in aqueous state

- Strong acids are good electrolyte

C, Based on degree of dissociation

I, Strong acid:- acids that are completely dissociate in aqueous solution.

- ❖ These acid produce more H^+ ion in aqueous solution.

E. g:- H C l, H_2SO_4 , $HClO_4$ & HNO_3

II, Weak acid:- acids that dissociate partially in aqueous solution

E. g:- CH_3COOH, $H_2CO_3H_3PO_4$ & organic acids contain – COOH group.

D, Based on the relative amount of acid present in a given solution

I, Concentrated acid:- acids that have relatively large amount of solute dissolved in a solvent.

II, Dilute acids:- acids that have small amount of solute dissolved in a solvent

⇒ Dilute acid is not mean that weak acid like /wise/ concentrated is not mean that strong acid.

⋕ Precaution in handling of acids

→ Wear glove & Laboratory coat.

→ If your body splashed with conch acid, first wash affected part with running water then with 10% $Na_2 CO_3$ solution.

→ never work alone.

→ To dilute concentrated acid, pour acid in to water.

→ If corrosive acids are swallowed, weak base /$Mg(OH)_2$ or $Al(OH)_3$ will administer.

→ use pipette instead suck using lips.

⋕ PH & PH Scale

PH is a convenient quantity refers to power of hydrogen & used express relative amount of H^+ ion concentration.

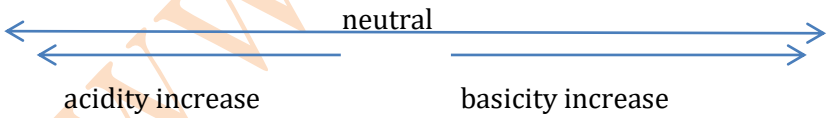
→ Given by PH = $\frac{Log\ 1}{CH^+}$ = Log 1 – Log (H^+)

⇒ PH = 0 – log(H^+)

⇒ **PH = Log [H^+]**

PH scale ranges from "0" to "14"

i. e:-



PH + POH = 14

Note:- If [H^+] = [OH^-] neutral solution.

[H^+] = [OH^-] acidic solution.

$[H^+] = [OH^-]$ basic solution.

⊗ PH meter:- a device which used to measure a PH of a solution.

From water dissociation $H_2O/\ell/ \rightleftharpoons H^+ + OH^-$

$Kw = [H^+][H^-] = 1\times10^{-14}$

E. g 1:- Calculate the "PH" of 0.01 M H_2SO_4?

Solution:- H_2SO_4 is strong acid so completely ionized in to $2H^+$ & $SO4^{-2}$

$H_2SO_4 \rightarrow 2H^+ + SO4$

0.01 2×0.01 0.01 $\Rightarrow[H^+] = 0.02$

$PH = -\log[H^+] = -\log[2\times10^{-2}]$

$PH = 2-\log 2 = \underline{1.69}$

E. g 2:- Calculate the PH of 0.5 m o l of HNO_3 dissolved in 500ml of solution.

Given

$n_{HCl} = 0.5$ m o l

$V = 500ml = 0.5L$

Required

PH = ?

Solution

$PH = -Log[H^+]$

$M = \frac{n}{V}$

$= \frac{0.5\ mol}{0.5\ \ell} = \underline{1M}$

$HNO_3 \rightarrow H^+ + NO_3^-$ $[H^+] = 1$

1 1 1

$PH = -\log[1]$

$PH = \underline{0}$

E.g 3:- Two solution A & B have PH value 2 and 6 respectively . How many times greater is the H^+ in solution "A" than solution "B"

Solution:- Solution "A" PH = 2 , $[H^+]_A = 10^{-2}$

Solution "B" PH = 6 , $[H^+]_B = 10^{-6}$

Take ratio solution "A" to solution "B" $\frac{[H^+]}{[H^+]_B} = \frac{10^{-2}}{10^{-6}} = \frac{[H^+]_A}{[H^+]_B} = \frac{10^4}{1} \Rightarrow [H^+] = \underline{10{,}000\ [H^+]_B}$

⋕ Preparation Of acid

⇔ Acids can be prepared by

1, Acidic oxide react with water

- $N_2O_5 + H_2O \rightarrow 2HNO_3$
- $CO_2 + H_2O \rightarrow H_2CO_3$

2, Direct combination of some nonmetal

- $H_2 + S \rightarrow H_2S$, $H_2 + Cl_2 \rightarrow 2HCl$

3, Heating of salts of volatile acid with nonvolatile acid.

E. g:- $NaCl(s) + H_2SO_4(\ell) \rightarrow NaHSO_4(s) + HCl(\ell)$

$NaNO_3(s) + H_2SO_4(\ell) \rightarrow NaHSO_4(s) + HNO_3(\ell)$

⋕ Use Of acid

⊗ H_2SO_4:- → electrolyte for car batteries

→ For petroleum retiming

→ fertilizer production

→ Production of drug, detergent e t c

⊗ H C l :- → digestion of food

→ To product polyvinyl chloride / PVC/

→ To remove magnesium from sea water

⊗ HNO_3:- → To manufactory explosive

→ To manufactory explosive

→ To manufactory fertilizer (KNO_3, NH_4NO_3)

→ To make chemicals, plastics

Exercise 3.9

1, What are the bases of classification of acid as strong & weak

Answer:- based on degree of dissociation

2, What is the OH of the solution having 0.01M

Solution:- $OH = \log[H^+]$, $PH = 109[0.01) = -\text{Log } 1\times 10^{-2}$

$PH = 2 \text{ Log} = \underline{2}$

3, How many moles of H_2SO_4 are present in 0.5 ℓ of 0.15M H_2SO_4 Solution

Given	**Solution**
$M = 0.15M$	$M = \frac{n}{V}$
$V = 0.5\ \ell$	$\Rightarrow n = M\times V$
Required	$n = 0.5\ell \times 0.15$ mol/L
$n = ?$	$n = \underline{0.075}$ m o l

4, Calculate the $[H^+]$ in the solution having PH = 4?

Answer:- PH = Log $[H^+]$ anti Log of this $[H^+] = 10^{-PH} \Rightarrow [H^+] = \underline{10^{-4}}$

3.3 Bases

Bases are either oxide or hydroxide of metals **E. g:-** KOH , NAOH, $Al(OH)_3$

Arrhenius Definition Of Base

- Bases are a substance that produce OH^- when dissolved in water.

E. g:- $NAOH \rightarrow Na^+ (a\ q) + OH^- (a\ q)$

$C\ a(OH)_2 (a\ q) \rightarrow Ca^{+2} (a\ q) + 2OH^- (a\ q)$

General Properties of base

1, Have bitter taste
2, Alkalis change color of indicator
3, Alkalis release OH^- in aqueous solution
4, It neutralize acids
5, Aqueous solution of base conduct electricity. **i. e:-** soluble base are electrolyte

Strength base / Strong & Weak /

Strong base:- bases that are completely ionize in aqueous solution **E. g:-** KOH, Na OH e t c

Weak base:- bases that ionize slightly **E. g:-** NH_3, $Mg(OH)_2$ & $C\ a(OH)_2$.

Weak base is weak electrolyte.

Concentrated & dilute bases

Concentration of base is a measure of mole of alkali present in 1L of solution

- Expressed by molarity , $\underline{mol/\ell}$

- **Concentrated base:-** base that contain relatively large amount of base in a given volume of solution.
- **Diluted base:-** bases that contain small amount of base than water.

ǂ Precaution for Handling of base

Strong bases are harmful to our skin, it requires precaution **Example:-**

1, Wear eye goggle, glove and laboratory coat
2, If the base spilled on your working table wipe the spilled immediately.
3, If a base enter your eyes, wash with water repeatedly & consult to a doctor.

⊗ **H C l :-** Is a measure of concentration of hydroxide ion acidic or basic solution.

Given by:- $POH = Log\ [OH^-]$, $[OH^-] = 10^{-POH}$

Relation Ship b/n POH & PH

From self-ionization of water, $H_2O + H_2O \ /\ell/ \rightleftharpoons H_3O^+ (a\ q) + OH^- (a\ q)$

$$\frac{K}{1} = \frac{[OH^+]OH^-]}{[H_2O]\ell}$$

$$K\ [H_2O],\ [OH^-]\ [OH^-] = \underline{1\times10^{14}}$$

$\Rightarrow$ - Log $[H^+]\ [H^-]$ = - Log $/1\times10^{-14})$

$\Rightarrow$ - Log $[H^+]$ + [- Log $[H^-]$ = 14 Log 1

$\Rightarrow$ **PH + POH = 14**

E. g:- Calculate PH & POH of a 0.0001M of Na OH?

Solution:- Na Oh (a q) $\rightarrow Na^+ (a\ q) + OH^- (a\ q)$

0.001M 0.0001M 0. 0001M

$[OH^-] = 1\times10^{-14} \Rightarrow$ POH $= -$ Log $1\times10^{-14} = 14 - $ Log 1 POH = **14**

Then PH = 14 – POH , 14 – 4 = **10**

Exercise 3.10

1, Which solution has a higher $[H_3O^+]$ & $[OH^-]$, one with PH = 5 or with PH = 6?

Solution:- PH = 5 $\Rightarrow [OH^+] = 10^{-5}$

PH = 6 $\Rightarrow [OH^+] = 10^{-6}$ then PH value "5" has higher $[H_3O^+]$

If $[H_3O^+]$ is higher $[OH^-]$ become lower

i. e:- PH value 6 has higher $[OH^-]$ than PH = 5

2, Given P h & POH for $[OH^+] = 1\times10^{-5}$

Solution:- PH = Log $[OH^+] = -$ Log 1×10^{-5}

PH = **5**

POH = 14 – PH , 14-5 = **9**

Preparation for base

1, Very active metal (Na, K, Li & C a react with water

E. g:- $2K(s) + 2H_2O(\ell) \rightarrow 2KOH\ (a\ q) + H_2\ (g)$

2, Group IA & group IIA metal oxide react with water

- $Na_2o\ (s) + 2H_2O\ (\ell) \rightarrow 2NaOH\ (a\ q)$

  C a O (s) + $2H_2O\ (\ell) \rightarrow Ba(OH)_2\ (a\ q)$.

Common uses of Na OH & C a$(OH)_2$

- **Na OH:-** - Used manufacture soap & detergent
  - Main ingredient in oven cleaner.
- **Ca$(OH)_2$:-** - To manufacture cement.
  - To manufacture lime water.

⋕ 3.3 Salt

Salts are ionic compounds generally formed by neutralization of acid with a bases.

- A salt gets its name from the name of metal ion derived from base & acid radical derived from acid.

For Example:- from Na^+ derived from Na Oh & C l derived from H Cl. ⇒ Sodium Chloride.

⋕ Classification Of Salt

Salts can be classified as in to three main groups.

A, Normal Salt

A salt formed by complete replacement of ignitable H^+ ions of acid by a positive metal ion or NH_4^+
These salt are neutral to litmus.

E. g:- $H\,C\,l\,(a\,q) \rightarrow K\,C\,l\,(a\,q) + H_2O\,(\ell)$

$HNO_3\,(a\,q) + NH_4OH\,(a\,q) \rightarrow NH_4NO_3\,(a\,q) + H_2O\,(\ell)$

B, Acidic Salt

Acids that formed by partial replacement of H^+ ions acid by positive metal ion – $H_2SO_4(a\,q) + Na\,OH(a\,q) \rightarrow NaHSO_4(a\,q) + H_2O$ This salt turn blue litmus to red.

⊗ Acidic salt react with base to produce normal salt.

$NaHSO_4\,(a\,q) + Na\,OH\,(a\,q) \rightarrow Na_2SO_4(a\,q) + H_2O(\ell)$

C, Basic Salt

The salts in which not all OH^- in abase have been salt replaced by an ion of acid .

- Basic salt formed by incomplete neutralization of poly hydroxyl base with acids.

E. g:- $Al(OH)_3\,(a\,q) + H\,C\,l\,(a\,q) \rightarrow Al(OH)_2\,C\,l\,(a\,q) + H_2O$ $Zn(OH)_2\,(a\,q) + HNO_3\,(a\,q) \rightarrow Zn(OH)\,NO_3\,(a\,q) + H_2O(\ell)$

General methods for preparation of salt

Usual soluble salts are prepared by the method that involves crystallization, while insoluble salt prepared by a method of involves precipitation.

1, Preparation of Soluble Salt

a) Direct displacement of H^+ by reactive metal (Ca, Fe, Zn & Mg).

i. e:- Active metal + acid → Salt & hydrogen

$Zn(s) + 2HCl\,(a\,q) \rightarrow ZnCl_2(a\,q) + H_2\,(g)$

$Mg\,(s) + H_2SO_4(a\,q) \rightarrow MgSO_4(a\,q) + H_2(g)$

b) The reaction of acid & base

i. e:- Acid + base → salt + water

$HCl(aq) + NaOh(aq) \rightarrow NaCl(aq) + H_2O(\ell)$

C) by the reaction of acid & metallic oxide

i. e:- $ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(\ell)$

D) The reaction of acid with metal carbonate on bicarbonate.

i. e:- Metal carbonate / bicarbonate + dilute acid → salt + water carbon dioxide

E. g:- $Na_2CO_3(aq) + 2HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(\ell) + CO_2(g)$

2, Preparation of Soluble Salt

Formed by exchange of ionic radicals b/n two salts which are soluble.

E. g:- $AgNO_3(aq) + NaCl(aq) \rightarrow AgCl(s) + NaNO_3(aq)$

$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl$

Some important Salts & their use

⊗ **Na Cl:-**
- Preservation of food
- Main components of "ORS"
- To manufacture Na_2CO_3 & $NaHCO_3$
- Raw material for the manufacture of Na, Cl & Na OH

⊗ **NH_4NO_3:-** - To produce nitrogenous fertilizer
- To produce explosive

⊗ **$FeCl_3$:-** - For treatment of west water
- Used for etching printed circuits

⊗ **$CaSO_4.2H_2O$:-** - Plastering wall
- Supporting fractured bones

⊗ **KNO_3:-** - To make gun powder / a mixture of KNO_3, C, S & other explosive

⊗ **$FeSO_4$:-** → Prevent deficiency of iron

⊗ **$BaSO_4$:-** - Used to × - ray photography

Properties of Salt

Depending on the an ion they possess, because an ion is party responsible for the solubility of salt.

1, Solubility of Salts

Some salts are in soluble in water , some are in soluble while others are slightly soluble

2, Tendency to absorb /released from or to atmosphere

Salts → Hydroscopic
→ Efflorescent
→ Deliquescent salt

I. Hydroscope Salt

Salts that absorb water from atmosphere but remain Solid.

Example:- an hydrous copper sulphate

II. Efflorescent Salt

Salts that lose their water to the atmosphere

Example:- $Na_2CO_3.10H_2O$ & $Na_2SO_4\ 10H_2O$

III. Deliquescent Salt

Salts that absorb water from atmosphere to form a solution **E. g:-** Na C l, $NaNO_3$, $CaCl_2$ e t c

Note:- All deliquescent salts are hydroscopic but all hydroscopic salts are not deliquescent.

3, Thermal Stability of salt

It is a property of salts to resist irreversible change in its chemical & physical structure.

A. Thermal decomposition of carbonates

All group IIA metal carbonates decompose on heating to produce metal oxide & CO_2

E. g:- $CaCO_3 \xrightarrow{\Delta} CaO(s) + CO_2(g)$

Thermal decomposition of carbonates of group IIA elements decrease down a group

- Except Li_2CO_3 all group IA metal carbonates do not decompose at laboratory temperature.

B. Thermal decomposition of nitrates

- Group IIA & all most all transition metal nitrates are decomposed on heating to produce metal oxide NO_2, & O_2.

E. g:- $2\ Zn(NO_3 \xrightarrow{heat} 2Zno + 4NO_2 + O_2$.

Nitrates of K & Na on heating produce metal nitrite & oxygen.

E. g:- $2\ Na\ NO_3(s) \xrightarrow{\Delta} 2\ NaNO_2(s) + O_2(g)$.

Note:- All nitrates & carbonates of lithium are there molly unstable similar to group IIA metal.

Chemical test of Some ions in a salt

- Flame test:- used to identify the presence of small no of metal ion in a compound.
- Commonly used for Li^+, Na^+, Ca^{+2}, Ba^{+2}, Sr^{+2} e t c
- Some metal ion & corresponding flame color

$Li \rightarrow$ Cry some $\quad Ca^{2+} \rightarrow$ orange red

$Na^+ \rightarrow$ yellow $\quad Ba^{2+} \rightarrow$ green

$K^+ \rightarrow$ Violet $\quad Sr^{+2} \rightarrow$ Cry some

Exercise 3.12

1, Why aqueous of soluble salt conduct electricity? Due to the presence of mobile ions.

2, What recants do you use to identify the presence of the following ions in a salt.

a) SO_4^{2-}

b) Fe^{+2} / Fe^{3+}

Solution a) $BaSO_4$ Common reagent for SO_4^{-2}

b) Na OH / Na_2CO_3 **i. e:-** for Fe^{2+} green color observed where for Fe^{3+} brown color observed.

Plant Nutrients

Depending on the amount required by plant nutrients can be micro & macro nutrient.

- **Micro nutrient:-** elements that required by plants in small /trace/ amount E.g:- Cu, Zn, Mo, Cl, B etc
- **Macro nutrients:-** elements that required by plants in a large amount. E.g:- N, P, K, C, H, S, Mg etc
- "N"," P" & "K" are called primary mineral nutrients
- **Nitrogen:-** important nutrient used by plant in NO_3^- form. If helps to produce amino acid.
- **Phosphorus:-** Facilitate early growth & root formation & taken by plants in $H_2PO_4^-$ & HPO_4^- form .
  - Helps to increase amount of water that enter to the cell osmotic ally.

⊗ **Fertilizer:-** are a material that added to the soil to increase growth & yield value of crops.

- It can be either natural or synthetic.
- **Organic natural fertilizer:-** which derived from decay of plant & animal.
- **Synthetic artificial Fertilizer:-** also called complete fertilizer because it contain N, P & K.

E.g:- $(NH_4)_2SO_4$, NH_4NO_3 , KNO_3, $(NH_4)_2HPO_4$ etc.

- Pesticides:- a chemical that apply to crops to kill pests, that affect plant growth & developments.
- Herbicides:- a chemical used to control un wanted plants .

E. g:- $CuSO_4$, $NaASO_2$ / Sodium arsenate, $NaClO_3$ e t c

Unit – 3 Review Exercise

1, Why acetic acid is amino parotic acid?

Answer:- Only H atom from carboxyl group /- COOH/ react with base & it has a tendency to lose only one proton .

2, Why do termers use fertilizer?

- Increase soil fertility & crop production.

3, DO all c P ds contain H are acids?

Answer:- Compounds that contain H is not necessarily acids

4, Calculate PH & POH of a solution that contain a 0.0001M H C l?

Solution:-

H C l is strong acid which is completely dissociate

$HCl \rightarrow H^+ (aq) + Cl^- (aq)$

0.0001 0.0001 0.0001

H C l is monocratic, so $[H^+]$ is equal to its concentration of initial acid

$PH = -\log [H^+]$

$= -\log (0.0001)$

$= -\log 1 \times 10^{-4}$

$= 4 - \log$, but $\log 1 = 0$

$\Rightarrow Ph = 4 - 0 = \underline{4}$

$PH + POH = 14$

$POH = 14 - PH$

$POH = 14 - 4$

$POH = \underline{10}$

UNIT – 4

Energy Change & electro Chemistry

All most all chemical reactions involved in energy change. Some reaction release & other chemical reaction absorb energy.

- To study energy change in a chemical reaction , scientists classify universe as

I, System:- Is a part of universe that is being studied.

II, Surrounding:- anything else in the universe & it is broader than system.

Universe = System + Surrounding

- Internal energy:- the sum potential energy & kinetic energy of components of a system.

Internal energy = **Potential energy "+" Kenotic energy**

⇔ **Potential energy:-** the energy stored in a chemical bond.

⇔ **Kinetic energy:-** the energy due to motion.

- It causes work to be done through movement
- When the reaction in the chemical system change to product, the system internal energy is changed .

i. e:- $\Delta E = E_{final} - E_{initial}$ where

E_{Final} = Internal energy after change

$E_{initial}$ = Internal energy before change.

Note that:- The total energy in the universe is constant because when a system loss a certain amount of energy, the surrounding gain the same amount of energy.

Energy transfer from system to surrounding or vice versa appears in two forms "Heat & Work" for example when anabolic that contain a various chemical . burned in an engine of car, some of the potential energy transfer in to work which used to move a car, at the same time same of potential energy converted to heat & makes a car engine very hot. There for the energy change of a system occur as either heat (q) or work (w).

4.1.Exothermic & endothermic chemical reaction

All combustion reaction is exothermic reaction / heat released / . Similarly when Na OH dissolve the solution become hot since heat is **released.**

When $KNO_3(s)$ dissolves in water, the mixture gets colder that means heat is **absorbed**.

$KNO_3(s) + heat \rightarrow K^+(aq) + NO_3^-(aq)$

⇔ To study whether the energy being released or absorbed during a chemical reaction, we need to set temperature & pressure constant.

The heat of reaction takes place at a constant temperature & pressure given by

$$\Delta H = H_{\text{product}} - H_{\text{reactant}}$$

If $\Delta H > 0 \Rightarrow$ endothermic

$\Delta H < 0 \Rightarrow$ exothermic reaction

Calorimeter:- a device used to measure the heat released or absorbed by a chemical reaction is called **calorimeter.**

To find energy change during a chemical reaction we measure change in temperature & determine the quantity of heat absorbed or released. $q \times \Delta T$

$q = C \Delta T$ where "C" hear capacity.

- Heat capacity of a substance is defined as the quantity of that required to change its temperature by 1 "K" . $C = q/\Delta T = J/K$
- Specific heat capacity of a substance is defined as the quantity of heat required to change the temperature of 1 "g" an object by 1K.

Given by $C = C/\text{mass}$ but $C: = q/\Delta T$

$C = q/m \Delta T$, **$q = cm\Delta T$**

Exercise 4.1

1, What makes water used for a coolant in a car radiator & industries?

Answer:- Water is a substance that heats & cools slowly, So it takes a long time to increase its temperature of a gram of water by 1 "K"

2, Where does the energy released comes from during chemical reaction?

Answer:- Energy is stored in the bonds of atoms and molecules.

3, how the energy that you get from food stored in your body? How it is supplied to cellular process when needed?

Answer:- Energy derived from food in the form of glycogen. Chemical energy obtained from food.

- By using cellular respiration by w/c cells derive energy from glucose.

4, Explain the energy change involved when

a) $CaO + H_2O(\ell) \rightarrow Ca(OH)_2$ (aq)

b) Lime stone / $CaCO_3$/ decompose to give $CaO + CO_2$

c) Nitrogen cerise / major component of dynamic- te decompose

Answer:- a) The formation of $Ca(OH)_2$ is exothermic this reaction occurs when H_2O is added to dry Portland cement to make concrete & heat evolution of energy a sheet is evident because the mixture become warm.

b) CaO is more ordered than state than $CaCO_3$, So this reaction require additional energy ⇒ endothermic.

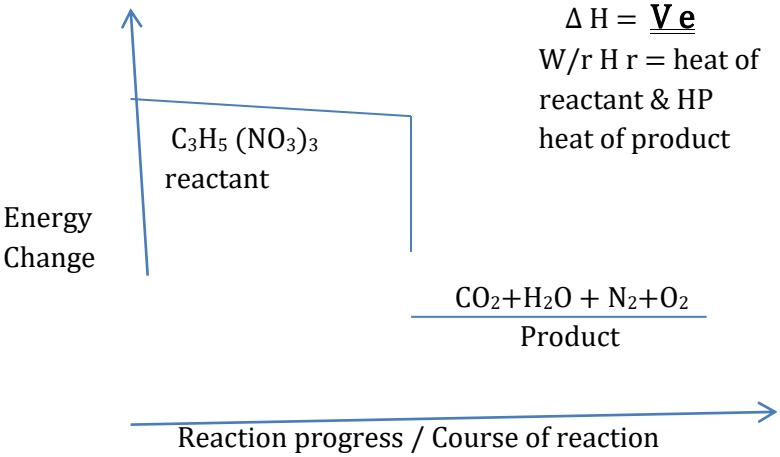
C) It decompose rapidly up on ignition or sudden impact & have Δ H reaction = -56 78KJ

$$C_3H_5N_3O_9(\ell) \rightarrow 12CO_2(g) + H_2O + 6N_2(9)$$

$+ O_2(g)$ Δri reaction = -5678 KJ

4, $C_3H_5(NO_3)_3(\ell) \rightarrow 12\,CO_2(g) + 10H_2O(g) + O_2(g) + 6N_2(g)$ Is exothermic or endothermic? Explain Draw enthalpy diagram for this reaction.

Answer:- It is exothermic $\Delta Hr > Hp$



5, on a hot summer day water in a lake stays cool even through the air above it heats quickly, and water stays warm at night after the air has cooled. Can you explain this?

Answer:- Because water has higher specific heat capacity than earth, warm quickly 7 cool down loony whereas water does not heat quickly but it can stay warm after heated.

⇒ During night water is hotter than earth because of its capacity to store heat for a long time compared to earth. During night earth cool down hence heat stored in temporary.

During summer day wind flow from sea to earth. Thus flow is from high concentration to low concentration.

i. e high concentration means more cooled & low concentration means hot particle.

4.1.1 Importance of Chemical Change

The two principal advantage of chemical changes are ↳ production of energy &

↳ Production of use full substance

4.2 Energy change in electron Chemistry

4.2.1 Electro Chemistry

⊗ Electro Chemistry:- a field of chemistry that deals with the inter conversion of electrical & chemical energy.

- It concerns how electricity consumed or generated during a chemical reaction or charging & discharging.

4.2.2 Electrical Conductivity

Electrical conductivity is the ability of a substance to transmit electricity.

⊗ Electrical Conductor:- a material that allow the passage of electricity through them are called electrical conductor.

Depending on the nature of the particle responsible for the flow of electric charge through conductor, electrical conductivity classified as

I, Metallic Conductivity

↳ Caused by the movement of free valance electron

↳ Electrons by itself is charge carrier.

↳ No charge in chemical properties of the conductor.

↳ It does not involve transfer of matter.

↳ Resistance of metal decrease with increase temperature.

Q:- What makes graphite a good conductor of electricity?

Answer:- Due to the movement of electron through hexagonal layer.

II, Electrolytic Conductivity

↳ Caused by the presence of mobile ions.

↳ Ions are charge carrier.

↳ Depends on the type & concentration of ions.

↳ Also called ionic conductor.

↳ It may cause chemical decomposition of the electrolyte.

↳ Involves transfer of matter as ions.

↳ Electrolytic conductivity increase with increase temperature.

N.B:- The basic conductivity apparatus are source, bulb, wire, switch & electrode.

Exercise 4.2

1, Why are solution of strong electrolyte better conductor of electricity than weak electrolyte?

Answer:- Strong electrolytes have more charge carrier positive & negative ions than weak electrolyte. And electrolytic conductivity depends on the concentration of ions, as concentration of ions increase conductivity become better.

2, Which of the following substance are capable of conduct electricity? Q

a) **Iron:-** conduct electricity because of the presence of freely move valence electron.
b) **Sulphur:-** not conduct because it does not have freely moving electron.
c) **Molten $CaCl_2$:-** conduct electricity because the existence of mobile ions.

⊗ Electrolyte & non electrolyte

A, Electrolyte:- a substance that conduct electricity in molten state.

For example:- Na C l (a q) & $CaSO_4$ (a q)

B, Non electrolyte:- a substance that does not conduct electricity either in solid or molten state.

For example:- Sugar & all nonpolar covalent compound . b/c when they dissolve in water, no ions are produced.

⊗ Strong & Weak electrolyte

- **A strong electrolyte:-** is a substance that completely dissociate when they dissolve in water.
- All ionic compounds are strong electrolyte.

For example:- Na OH, H C l, HNO_3, $HClO_4$ & ionic compound

- **Weak electrolyte:-** a substance that dissociate partial when they dissolve in water

For example:- CH_3COOH, H_2O, HF, NH_3

4.3 Electro Chemical Cells

→ **Electro Chemical Cell:-** is a device that used to convert chemical energy to electrical energy or electrical energy to chemical energy.

→ Depending on the purpose or type of reactions takes place, electro chemical cells are divided in to ***Two***

These are:- ① Galvanic or voltaic cell

② Electrolytic cell

① Galvanic or (voltaic) cell

→ Galvanic cell is an electro chemical cells that converts chemical energy to electrical energy.

→ It is a spontaneous process.

→ Produce electricity.

E. g:- hand battery, Flash Light battery, Cameras & Car battery.

⇒ Galvanic cells can be classified in to ***Three*** classes.

These are:- ① Primary cell

② Secondary cell

③ Fuel cells

Primary Cells

- Cells that are not recharzable, b/c the entire reaction in the cell is not reversed on charging.

E. g:- Daniel cell, Zn-C dry cell

⇒ the electrolyte in Galvanic cell can be exist the form of **wet or dry cell**

⇒ **Wet cell** - the cell containing electrolytes in solution form **E. g:-** Daniel Cell

⇒ **Wet cell** - the cell containing electrolyte in paste form **E. g:-** Leclanche dry cell

Daniel Cells

→ It is the most common wet cell.

→ It consist of a zinc strip placed in $ZnSo_4$ solitary in one compartment and copper strip placed in $CuSO_4$ solution in another compartment.

→ These two compartment connected with **Salt bridge**

→ In the anode compartment the zinc atom from the zinc electrode lose two electrons and become Zn^{2+} and enter in to the solution . There fore, the electrolyte have total positive charge , to neutralize this positive charge chlorine ion from the salt bridge, enter in to the electrolyte solution. On the other hand the electron loosed by Zn^{2+} enter in $CuSo_4$ solution and discharge the Cu^{2+} from the electrolyte to convert Cu atom. This Cu atom deposit at Cu- electrode, the electrolyte on trains more negative ion this negative ion neutralize by K^+ from salt bridge.

⇒ The half and cell reactions in Daniel cell.

Anode reaction: $Zn(s) \rightarrow Zn^{2+}(a\ q) + 2e^-$

Cathode reaction: $Cu^{2+}(a\ q) + 2e^- \rightarrow Zn(s)$

Cell reaction: $Zn(s) + Cu^{2+}(a\ q) \rightarrow Zn^{2+}(a\ q) + Cu(s)$

Purpose of Salt bridge

- ✓ Haitian electrical neutrality b/n the two solutions.
- ✓ Allow electrical contact between the two solutions.
- ✓ Prevent mixing of the electrode solution.

Leclanche Cell

→ It is the most common dry cell.

→ It consists of zinc Cup as anode & graphite rod. As cathode.

→ It is easily portable b/c it contains NH_4Cl, $ZnCl_2$ & MnO_2 electrolytes in paste form

⇒ The half and cell reactions in Leclanche cell

Anodes reaction: $Zn(s) \rightarrow Zn^{2+}(a\ q) + 2e^-$

Cathode reaction: $2NH^+_4(a\ q) + 2MnO_2(s) + 2e^- \rightarrow Mn_2O_3(s) + H_2O\ (1) + 2NH_3(a\ q)$

A build up of ammonia disrupt current flow. However this prevented by the reaction b/n Zn & NH_3 to form a complex ion, $[Zn(NH_3)_2]^{2+}$ which crystalize as a chloride salt through the reaction with chloride , $Zn^{2+}(a\ q) + 2NH_3\ (a\ q) + 2Cl^-(a\ q) \rightarrow Zn(NH_3)_2Cl_2(s)$.

Cell reaction:- $Zn(s) + 2NH_4Cl(a\ q) + 2MnO_2(s) \rightarrow$
$Zn(NH_3)_2Cl_2(s) + Mn_2O_3(s) + H_2O(1)$

Secondary Cell

- Secondary cells are rechargeable b/c the electrode reaction can be repressed.

E. g:- Lead storage battery

- ✓ In Lead storage battery, P b – used as anode
  PbO_2 – used as cathode
  H_2SO_4 – used as electrolyte
- ✓ A single lead storage cell deliver 2volts. Therefore lead storage battery contains six cells = 12volt
- The half and cell reaction in lead storage battery.

Anodes reaction: $P\ b(s) + So^{2-}{}_4(a\ q) \rightarrow PbSo_4(s) + 2e^-$

Cathode reaction: $PbO_2(s) + 4H^+(a\ q) + SO_4^{2-}(a\ q) + 2e^- \rightarrow PbSo_4(s) + 2H_2O(1)$

Cell reaction: $P\ b(s) + PbO_2(s) + 4H^+(a\ q) + 2SO_4^{2-}(a\ q) + 2So_4^{2-}(a\ q) \rightarrow 2PbSo_4(s) + 2H_2O(1)$

②Electrolytic cell

→ Electrolytic cell is an electro chemical cell that convert electrical energy to chemical energy.

- It is a non- spontaneous process

- Consume electricity.

N.B:- In electrolytic cell two electrodes are placed in one compartment.
In electrolytic cell anode is connected to the positive terminal of the source whereas cathode is connected to the negative terminal of the source.

Electrolysis

→ **Electrolysis:-** is the process that covert electrical energy to chemical energy.

→During electrolysis, the ions of the electrolyte migrate to the electrode of opposite charge.

i. e :- Captions migrate to wards cathode
Anions migrate to wards anode.

Electrolysis of molten (Fused) electrolytes

- ✓ **Fusion:-** melting of ionic solid at elevated temperature

E. g:- Melts of Na C l(s) at 80/°C

$Na\ C\ l(s) \xrightarrow{80/°C} Na^+(1) + C\ l^-(1)$

Cathode reaction: $2Na^+(1) \rightarrow 2Na(s)$

Anodes reaction: $2Cl^- \rightarrow Cl_2 + 2e^-$

Cell reaction: $2Na^+(\ell) + 2Cl^-(1) \rightarrow 2NA(s) + Cl_2(g)$

Exercise 4.6

① Write the half reaction for molten KOH & K C l

Solution:- $KOH \rightarrow K^+(\ell) + OH^-$

Anode, reaction : $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

Cathode reaction: $4K^+10 + 4e^- \rightarrow 4K(s)$

Cell reaction: $4KOH \rightarrow 4K(s) + 2H_2O(1) + O_2(g)$

$K\,C\,l \rightarrow K^+ + C\,l^-$

Anode, reaction : $2Cl^- \rightarrow Cl_2 + 2e^-$

Cathode reaction: $2K^+ 2e^- \rightarrow 2K(s)$

Cell reaction: $2K^+ (\ell) \rightarrow 2K(s) + Cl_2(g)$

Chapter - 4 Review exercise

Part -1 Choice

1. A	5. A	9. C	13. C
2. C	6. C	10. D	
3. B	7. A	11. C	
4. D	8. B	12. C	

Part -2 Short Answer

14. Under constant pressure

15. Endothermic reaction: a reaction in which absorb heat from atmosphere

E. g 1:- $KNO_3 + H_2O + \Delta \rightarrow K^+(a\ q) + NO^-_3(a\ q)$ where

Δ is heat absorbed

E. g 2:- NH_4NO_3

✲ Exothermic reaction: a reaction in which heat released to atmosphere

E. g:- - $2NaOh\ (s) + 2H_2O \rightarrow 2Na^+\ (a\ q) + \Delta OH^-\ (a\ q) + heat$

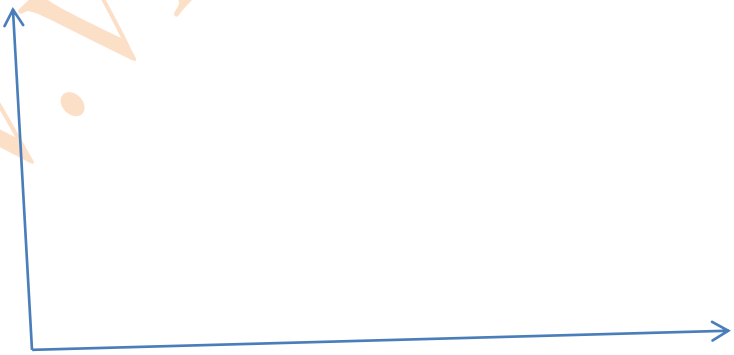
- $CaCl_2(s) + 2H_2O(e) \rightarrow CaCOH_2\ (a\ q) + 2HCl(g) + heat$

If $\Delta H < 0 \Rightarrow$ Exothermic

$\Delta H < 0 \Rightarrow$ endothermic

16. Because to break the bond energy is required / absorbed), while to form a bond energy is released.
So decomposition is involved by bond breaking ⇒ endothermic process but combination reaction release energy ⇒ exothermic process.

17. Draw enthalpy diagram for a general endothermic reaction and level axis, reactant, product & ΔH with its Sig **Answer**



19. Consider these changes

a) $Hg\ (e) \rightarrow Hg(g)$ it is endothermic because to change liquid to gas energy is needed

b) $3O_2$ (g) → $2O_3$ (g) is endothermic because energy is required to break stable bond of O_2 to form ozone

C) $CUSO_4 . 5H_2O$ (*e*) → $CUSO_4$(s) + $5H_2O$ (g)

- It is endothermic because it is a decomposition reaction

d) H_2(g) + F_2 (g) → 2HF(g)

It is endothermic because the reaction is combination reaction which is exothermic.

20. Why Na C l, K C l, C a C l & $PbBr_2$ are not conduct electricity in solid state but conduct in aqueous solution?

Answer:- Ionic compounds in solid state have no free mobile ion to carry charge to conduct electricity where are ionic compounds in aqueous form can conduct electricity this is due to the presence of free ions that can carry charge,

21. Describe the basic features of galvanic cell. Why are the two components of the cell separate each other?

Answer:- The basic feature of galvanic cell is it contain two electrolytes with isolated two compartment This two compartment is not allowed to contact in order to prevent the mixing of the two solution salt bridge helps to prevent the mixing the electrolyte solution.

22. Explain difference between the primary & secondary cell?

Answer:- Primary cell are cell that are not reversed on charging after use it Example Dry cell

- It is simple through it after the reaction inside the cell is consumed .
- It leads was tag of many.
- Secondary cell:- a cell that can be reversed on charging after we use it
- They are rechargeable
- They are cost effective

Example lead storage batteries

23. During electrolysis of fused $CaCl_2$

a) which ion is responsible for conduction electricity through molten salt?

Answer:- Both ions are responsible to conduct electricity (Ca^{+2} , $C l^-$)

b) Which ion migrate to wards anode?

Answer:- an ion migrate to wards anode **i. e** $C l^-$ migrate to wards anode

c) Which ion migrate to wards cathode

Answer :- Cation migrate to wards cathode i. e Ca^{+2} migrate to wards cathode.

d) Write half – cell reaction.

Answer:- Anode reaction : 2 $C l^-$ (a q) → Cl_2(g) + $2e^-$

Cathode reaction: 2 Ca^{+2} +2 $C l^-$ → 2Ca(s) + Cl_2 (g)

(a q) (a q)

UNIT – 5

METALS AND NON METALS

5.1. Introduction:

Natural resource:- are resource that exist without any action of human kind.

It can be classified as: ① Renewable &

② Non – renewable

⊗ **Renewable resource:-** are resources that replaced by natural process.

E. g:- Water, air, plant material

⊗ **Non Renewable resource:-** are resources that exist in a fixed amount in nature

E. g:- Fossil fuels, nuclear energy ------ etc.

5.2 General properties of metals

A, Some physical properties of metals

- They are malleable & ductile
- They have relatively high density
- They are usually sonorous produce metallic sound when stock.
- They have a shiny appearance.

B, chemical properties of metals

- They have positive valance
- They have 1, 2 or 3 valence electrons
- They act as reducing agent
- They form mostly basic oxide
- They form hydrides
- They usually replace hydrogen from dilute acid

C, Reactivity Series of metals

→ The arrangement of metals in the decreasing order of their activity is called reactivity series

⊗ Reactivity series of some metals

⇒ Metals at the top of the reactivity series are strong series are strong reducing agent

⇒ Metals at the bottom of the reactivity series are weak reducing agent.

D, Natural Occurrence & extraction of metals

⇒ **Noble metals:-** exist in nature as free state.

E. g:- Ag, Au, P t, P d, Bi--- e t c

⇒ **More active metals:-** like alkali & alkaline, earth metals never exist in free state.

Alloys

Alloys are a mixture of two/more metals or metals & non- metals

- The constituent elements are melted together and then allowed to cool to form a solid material called **alloy** .
- Alloying of metal increase hardness, strength, resistance of corrosion and decrease electrical conductivity.

E. g:- a magma is alloy of H_9 & other metal Gun metals an alloy of Cu(87%) 10% S n & 9% z n.

- **Solder:-** its composition is 67% S n & 33% P b.

- It metals at 183°C which is lower than m.pt of S n (232°C)

- It used to join wires & electrical resistance

- **Gold alloy:-** a very soft metal that hardened by alloying it with "Cu & Ag"

Production Al, Fe & Cu

Al Aluminum

Occurrence & extraction

"A l" is the most abundant metal on the earth crust after oxygen & silicon.

- It is the 2nd most important metal next to iron"

- Does not occur in free state in nature.

N.B:- The principal are of "Al" is bauxite/Al_2O_3/ . $2H_2O$ other mineral contain "Al", corundum /Al_2O_3/ china clay($Al_2Si_2O_7$. $2H_2O$) Cry lite / Na_3 Al F_6. Industrial preparation of "Al" from bauxite is called **Hall** process.

Q:- What is the purpose of cry lite in hall process?

Answer:- To reduce melting point & a good conducting medium in electrolysis process.

Physical Properties

↳ It has low density (2.7 g/cm^3.

↳ It is a good conductor of heat and electricity.

↳ It is sliver whit & soft metal.

Chemical Properties

Δ It is reactive metal.

Δ It react with atmospheric price oxygen to form thin layer of aluminum oxide on its surface's

$4Al(s) + 3O_2(g) \rightarrow 2Al\ 2O_3\ (s)$.

- This thin layer resist corrosion.

Δ "Al" burn in N_2 (g) to form aluminum nitride.

$2Al\ (s). + N_2(g) \rightarrow 2AlN\ (s)$.

Δ "Al" react with some dilute acid or concentrated HNO_3 due to the formation of protective layer.

E. g:- $2Al\ (s) + 3H_2SO_4\ (a\ q) \rightarrow Al_2\ (SO_4)_3\ (a\ q) + H_2(g)$.

Δ "Al" burn in $Cl_2(g)$ to form aluminum chloride $2Al(s) + 3Cl_2\ (g) \rightarrow 2Al\ Cl_3\ (s)$.

Δ "Al" react with sodium hydroxide solution. $2Al\ (s) + 2NaOH\ (a\ q) + 6H_2O(\ell) \rightarrow 2Na\ Al(OH)_4\ (a\ q) + 3H_2\ (g)$.

Uses of "Al"

⊗ Used to make house hold cock wares, packing material in food industry.

⊗ To make air planes & ships.

⊗ To make door & windows.

⊗ Used thermite welding process.

⇞ **Thermite Welding:-** Use full in welding rails thermite – the mixture of powder Al & iron oxide is called **thermite.**

B, Iron

- It is the second most abundant metal on the earth crust.
- It is the fourth most abundant element.
- Never found in free metal in nature.

⇔ The chief ores are hematite / Fe_2O_3, limonite / $FeO_3.\ H_2O$). Magnetite / Fe_3O_4) & $FeCO_3$

Production of Pig Iron

- The extraction of Fe from its are carried out in blast furnace.

⊗ The raw material for extraction of iron are → iron ore, coke, lime stone & hot air. Iron ore, coke & limestone charged at the top of blast furnace where as hot air is blown at the bottom.

- The reaction takes place in blast furnace.

i, Oxidation of coke to CO_2: $C(s) + O_2(g) \rightarrow CO_2\ (g)$

ii, reduction of CO_2 to Co: $CO_2(g) \rightarrow C(s) + 2CO(g)$

iii, Reduction of Fe_2O_3 to metallic Fe by CO

$3fe_2O_3(s) + CO\ (g) \rightarrow 2Fe_3O_4(s)\ CO_2(g)$.

iv, Decomposition of $CaXO_3$ by heat in blast furnace .serve as flux to remove impurities.

$CaCO_3$ (s) → C a O (s) + CO_2(g)

v, C a O removes the impurity like sand or silica (SiO_2) to form calcium suicide which is a glass. Like material called **Slag**.

C a O + SiO_2 → C a SiO_3

Lime Sand Calcium Silicate

(flux) (impure) (slag)

⊗ The "Fe" that obtained directly in blast furnace is called **Pig iron.**

- It is impure & contain 2% Si 1% "P" & M n
- Pig iron is easily brittle
- Also called a crude iron which means an intermediate produce of "Fe" industry in the production of steel.

⊗ **Wrought iron:-** It is the purest form of commercial iron.

- Obtained by removing impurities from pig iron.

Steel making from Pig iron

These are three distinctive techniques that used to convert pig iron in to steel these are

i, Bessemer converter:- molten pig iron from blast furnace is transfer to cylindrical vessel containing refractory lining of $CaCO_3$ & Mg CO_3.

ii, Open hearth furnace:- it has a large shallow hearth which lined with basic oxide refractory (Mg O & C a O)

iii, Basic oxygen process:- involving forcing a mixture of powdered C a O & oxygen gas directly in the surface of molten pig iron .

- The oxygen reacts exothermically with C, S, Si, P & impure metal

Tempering of steel:- a process by which steel is conditioned to desired hard ness by heating & controlling rate of cooling.

- Some of the carbon, present in steel called cementite /FeC_3/
  Cementite reduce hardness of steel, but it can be removed by tempering.

Physical Properties of iron

- It is a gray lustrous, malleable & ductile metal.
- It is a good conductor of heat & electricity.
- Has high m p t (1580°C) high density (7.87g cm^3)
- It is ferromagnetic metal / permanent magnetite.

Chemical properties of iron

Iron is are active metal. Its reactivity is very slow compared to group IA & IIA metals

- Iron react with dilute acid to form iron salt & H_2(q)

E. g:- $Fe(s) + 2HCl \xrightarrow{(aq)} FeCl_2(aq) + H_2(g)s$

- It has variable valence.
- Aqueous solution of iron (II) compounds are pale green & iron (III) compounds are yellow with brown.
- Heated iron react with "S" to form sup hide. $Fe(s) + S(s) \rightarrow Fe\,S\,(s)s$
- Iron displace less active metals from solution of their salts.

Uses of iron

↳ For construction of buildings & bridges.

↳ Used to make domestic boiler, hot water radiators, water pipe.

↳ Used to make nails, sheets, horse shoes & farmer machinery.

↳ To make alloy such as carbon steel & alloy steel.

C, Copper

Occurrence & extraction

- "Cu" occasionally found as native, but it is found mainly in compounds like oxides carbonates & sulphides.

⊗ "Cu" principally extracted from **chalcopyrite**

Electrolytic refining of copper

The main part of electrolytic cell are:-

Anode:- A thick block of impure copper.

Cathode:- a thin strip of pure copper.

Electrolyte:- aqueous solution of $CuSO_4$, small quantity of dilute H_2SO_4 is added to the salt solution to prevent hydrolysis.

⇵ When electric current is passed, the "Cu" of anode is oxidized to Cu^{+2} ions. The Cu^{+2} ion pass in to the solution.

Cu/ impure metal) $\rightarrow Cu^{2+}(aq) + 2e^-$ = oxidation at the same time equal no of Cu^{2+} ion of the solution move to words cathode where they are reduced & deposited as metallic copper.

i. e:- $Cu^{+2} + 2e^- \rightarrow Cu(metal)$ = reduction.

The process oxidation at anode & reduction at cathode continues as long as current is passed. Thus cathode become thicker & anode become thinner.

Physical Properties of copper

- ✓ Cu is ductile & malleable metal.
- ✓ It melts at 1086°C & boils at 2310°C
- ✓ It is 2nd to Ag in electrical conductivity.

Chemical properties of "Cu"

↳ Less reactive metal that is why it is found in the native state.

↳ Have variable valence.

↳ Heated with air to form black powder of copper (II) oxide, Cu O.

$2Cu(s) + O_2(g) \rightarrow 2\,Cu\,O$.

↳ It does not react with dilute acid b/c it cannot displace hydrogen from acids.

↳ It oxidized by oxidizing acids / dilute HNO_3 & hot concentrated H_2SO_4

i. e:- $3Cu(s) + 8HNO_3(a\,q) \xrightarrow{\text{dilute}} 3Cu(NO_3)_2(a\,q) + 2NO(q) + 4H_2O(\ell)$

$Cu(s) + 2H_2SO_4 \xrightarrow{\text{hot \& consent rated}} CuSO_4(a\,q) + SO_2(q) + 2H_2O(\ell)$

Uses of "Cu"

↳ To manufacture alloy / bronze: alloy of Cu & S n.

↳ To make medals, machinery parts & bells brass is an alloy of Cu & Zn which used hard ware tops, terminal & pipes.

↳ Used in electrical industry in the form of wire, cables etc.

↳ To make alloy such as carbon steel & alloy steel.

Production of some important non metals

General properties & Common uses of some non – metals Compounds

⊗ Physical Properties

Non- metals are:- ↳ nonmalleable & non ductile

↳ Do not show any metallic luster.

↳ are non sonorous.

↳ Poor conductor electricity etc.

⊗ Chemical properties of non- metal

- They react with oxygen on heating to form their oxides.
- Do not displace H on the reaction with dilute acid.
- Do not react with water.
- Good oxidizing agent.

A, Nitrogen

- It occur in elemental form. It also exist in the form of compounds
- It is the most a abundant in the atmosphere form of compound it exist as $NaNO_3$ / Chile salt prefer, KNO_3 / salt peter & DNA mole-cu le.
- In laboratory , nitrogen is prepared by warm- in g an aqueous solution containing NH_4Cl and $NaNO_2$.

NH_4Cl)a q) + $NaNO_2$ (a q) → Na C l (a q) + $N_2(g)$ + $2H_2O$ (ℓ)

⊗ Physical Properties of nitrogen

↳ It is colorless, odorless & tasteless gas.

⊗ Chemical properties of nitrogen

↳ It is inert at low temperature.

↳ They react with Li, C a, Mg to form nitrides.

↳ Nitrogen react with oxygen at elevated temperature to form oxides

N_2 (g) + O_2 (g) → 2NO(g)

↳ It react with hydrogen to form ammonia in Haber process.

↳ To produce nitrogenous fertilizer, **i. e:-** N_2 directly react with hydrogen

/$N_2(g)$ + $3H_2(g)$ $\xrightarrow[400\text{-}600°C]{\text{Fe /200-300 a tm}}$ $2NH_3(g)s$

Uses of nitrogen

↳ Used in food packaging to prevent oxidation.

↳ To produce fertilizer.

↳ Liquid nitrogen used as **refrigerant**

B, Phosphorus

Occurrence & extraction.

- Phosphorus exist in naturally only in the combined state, such as rock phosphate / Ca_3 $(PO_4)_2$, flour apatite / $Ca_{10}(PO_4)_6$ F_2 or $3Ca_3(PO_4)_2$ C a F_2. It is also found in teeth, bones & DNA.

⊗ **Allotropes:-** are different form of the same element with the same physical sate but to different physical properties

This is due to different arrangement of atom.

- The two common allotropic form of "P" are white phosphorus & red phosphorus.

⊗ Physical Properties of Phosphorus

↳ White "P" very poisonous & metals at 44.1 °C & boils 287 °C

⊗ chemical Properties of Phosphorus

↳ P react with limited & excess supply of oxygen to form P_4O_6 & P_4 O_{10} respectively

i. e:- $P_4(s)$ + $3O_2(g)$ →P_4 O_6 (s)

$P_4(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$

↳ P react with limited & excess supply of chlorine to form PCl_3 & PCl_5 respectively

Uses of Phosphorus

↳ Red phosphorus used to make watches.

↳ most white phosphorus produce rat. Poisons 5 make bomb etc.

↳ It is essential for plant growth.

↳ To produce fertilizer.

C, Oxygen

- Oxygen is the most abundant element on the earth . It covers 46.6 % by weight.
- Industrially manufactured by fractional distillation of liquid air similar to nitrogen.
- Oxygen has two allotropic form these are O_2 & O_3

⊗ Physical Properties

- It is colorless, odorless & taste less gas.
- At – 182.96°C it changes from gas to liquid.
- Has a density of 1.429 g/L.
- It is denser than air.

⊗ Chemical Properties

↳ It is relatively reactive & combined directly with most metals to form oxides.

↳ It combine with metal to form basic oxide **E. g:-** $2Mg)s) + O_2(g) \rightarrow 2MgO(s)$.

↳ Oxygen combined with nonmetal to form acidic oxide **E. g:-** $S_8 + 8^0_2 \rightarrow 8S^0_2$.

↳ It support combustion & necessary for the burning of substance.

E. g:- $C(s) + O_2(g) \rightarrow CO_2(g)$

D, Sulphur

- It found in nature & in compound form such as galena (pbs) , pyrite (FeS_2), cinnabar (Hgs), gypsum ($CaSO_4.2H_2O$), barite ($BaSO_4$)

⊗ Fresh process:- extraction of suphure underground deposited of elemental sulphure.

Uses of Sulphur

↳ To reduces the demand for the element from natural deposite.

↳ Reduce the pollution of atmospheric air & formation of acid rain.

Allotropic form of Sulphur

- The most important allotropes of sulphur are rhombic & monocle sculpture.

I, Rhombic Sulphur (a – sulphur)

- It is crystalline in nature & has octahedral shape. It obtained from heating CS_2.
- It is yellow with m p t 385.8K
- It cannot be dissolved in water, but it can dissolved in benzene, ether & alcohol.
- It is the most stable form of sculpture / S_8/

II, Monocle Sculpture (B – sculpture)

- It is less denser than Rhombic sculpture.
- It contain puckered S_8 ring only differ from the way rings are packed in crystal.
- It is only stable above 95.3°C , bellow this temperature it converts to x – sulphur.

⊗ Physical properties of Sculpture

- Pure sculpture is Fast less & odder less.
- Poor conductor electricity.
- In soluble in water.

⊗ Chemical properties of Sculpture

- Relatively stable & un reactive at room temperature.
- It react with metal & nonmetal when heated ($8\,Fe + S_8 \rightarrow 8\,Fes$.
- It burn with oxygen to form oxides $S_8(s) + 8O_2\,(g)$
- It is a raw material for H_2SO_4 production

Step1:- Sculpture oxidized to produce sculpture di oxide ($S_8(s) + 8^0{}_2(g) \rightarrow 8\,S^0{}_2(g)$

Step2:- $S^0{}_2$convert to $S^0{}_3$ at high temperature in the presence of catalyst

$$2S^0{}_2(g) + O_2(g) \rightarrow 2S^0{}_3(g)$$

Step3:- $S^0{}_3$ is absorbed in to conc. $H_2S^0{}_4$ to produce ileum ($H_2S_2O_7$)

Step4:- Ileum is diluted with water to produce desired concentrated H_2SO_4

$$H_2S_2O_7\,(\ell) + H_2O \rightarrow 2H_2S^0{}_4(a\,q).$$

D, Chlorine

- It belongs to group VIIA. Also called halogen.
- It is the most a bound ant element among halogen.
- It is found in nature in the form of compound only.
- Na C l is the chief source of chlorine
- Commercially chlorine is manufacture by the electrolysis of concentrate aqueous solution of sodium chloride.

i. e:- $\frac{Anode\ raction}{Cathode\ raction}$ $2Cl^-(a\,q) \rightarrow Cl_2(g) + 2e^-$

$$2H_2O(\ell) + 2e^- \rightarrow H_2(g) + 2OH^-(a\,q)$$

Cell reaction:- $2NaCl(a\,q) + 2H_2O(\ell) \rightarrow 2NaO\,H(a\,q) + Cl_2)g) + H_2(g)$

⊗ Physical properties of Chlorine

↳ It is greenish yellow gas at room temperature.

↳ It melts at -102°C & boils at -34°C

↳ It is fairly soluble in water.

⊗ Chemical properties

- ✓ Highly reactive non-metal
- ✓ It react directly a most all elements
- ✓ It is a powerful oxidizing agent
- ✓ It react with heated metals to form salts ($2Fe(s) + 3Cl_2(g) \rightarrow 2feCl_3(s)$.
- ✓ Chlorine react with hydrogen smoothly.
- ✓ It can displace less reactive halogen.

E. g:- $Cl_2(g) + 2Kbr(a\ q) \rightarrow 2KCl(a\ q) + Br_2(\ell)$

Uses of Chlorine

↳ Used to bleaching agent.

↳ Used to killing germ from water.

↳ To remove yellow or brown colors from wood pulp & paper.

Chapter - 5 Review exercise

Part -I Choice

1. C	5. D	9. A	13. C
2. C	6. C	10. C	
3. C	7. D	11. C	
4. B	8. C	12. D	

Part –I I Short Answer

14. A, up on hammering , a metal will expand but not non metal

- The bulb glows on passing electricity through metal but not nonmetal except graphite.

B, Except graphite these test mutely used identify

15. Anode = Impure metal

Cathode = pure metal

Electrolyte = aqueous solution of metal salt

16. → Plating

→ Greasing

→ Alloying

17. A, It can form protective coat on its surface & Al_2O_3 first formed sticks on the surface of cooking untensils.

B, Carbonates & basic hydroxide tarnish the copper vessels which are neutralized by acids or lemon juice.

18. Chlorine gas, Bromine liquid & Iodine solid because of the difference strength of the dispersion force.

i.e as atomic number increase the magnitude of Vander Waal's force also increase, that why I_2 become solid.

19. AU

20. Ag

21. metal liquid = Hg

22. nonmetal liquid = Br_2

22. To remove impurities from blast furnace Impurities like SiO_2

24. Steel alloy are – harder

- tougher &

- Heat resistance than pure iron

25. A) $Fe_2O_3(g) + 3CO(g) \rightarrow 2Fe(e) + 3CO_2(g)$

B) $CaO(s) + SiO_2(s) \rightarrow CaSiO_3(e)$

Part –I I I Fill the blank Space

26. malleable

27. ductile

28. Silver

29. Wrought iron

30. $Al_2O_3 , 2H_2O$ / bauxite

UNIT – 6

Hydro carbons & Their natural source

6.1 History of organic Chemistry

According to Vitalize theory organic compounds were comes from living organism where as in organic compounds comes from nonliving things.

- Fried Wohler discover organic compound called urea in 1828

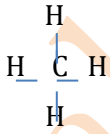
Structural Representation of Organic molecules.

- Structural representation of organic includes
  - Δ Structural formula
  - Δ Condensed structural formula
  - Δ Bond line representation
  - Δ Polygon formula.

A, Structural Formula

- It obtained by representing the two electron covalent bond by single dash. Single dash represent single bond & double dash represents double bond etc.

E. g:- CH_4 has structural formula



B, Condensed Structural Formula

- It is the short test formula that abbreviated from structural formula.
- Obtained by omitting all dashes that represent covalent bond.

E. g:- $CH_3\ CH_2\ CH_3$

C, Bond line Structural representation

- In this structural representation, carbon & hydrogen atom are not shown but it represented by a Zig Zag fashion.

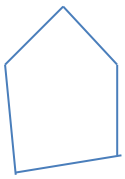
E. g:- $C_6\ H_{14}$ written as

Note:- The terminal of bond line structure de not methyl group (CH_3)

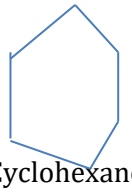
D, Polygon Formula

- Most cyclic compounds represented by polygon using bond lines wit out showing carbon & hydrogen atom.
- The corner of polygon represents **"C "** atom & the side of polygon represent carbon – carbon bond

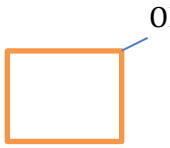
E. g:-



Cyclopentane ,



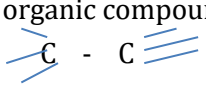
Cyclohexane



Cyclobutanol.

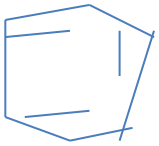
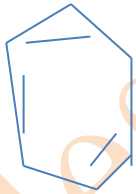
Classes Of Organic Compound

- Functional group:- is a group of atoms bonds with in a molecule that has a characteristic chemical behavior.
- Some classes of organic compound and their functional group

① Alkane  **E. g:-** CH_4

② Alkene C - C **E. g:-** $CH_2 = CH_2$

③ Alkyne C ≡ C **E. g:-** CH ≡ CH

④ Aromatic  **E. g:-** 

Benzene

Saturated hydrocarbon : Alkane / C_nH_2n+2)

⊗ **Hydro carbon:-** Compounds that contain only carbon & hydrogen is called **hydro carbon.**

- Hydro carbon classified as aliphatic (fat like) or aromatic.

↳ Aliphatic hydro carbon exhibit a fat-like behavior.

E. g:- alkane, alkene, alkyne & their derivatives.

↳ A romantic hydro carbon:- a hydro carbon that contain low hydrogen to carbon ratio. **E. g:-** benzene

Note:- Based on the type of bonding between carbon atom , hydro carbon classified as **Saturated** & **Un saturated**

I, Saturated hydro carbon:-

- A compound of carbon & hydrogen containing only carbon – carbon single bond.

Example:- alkane / CH_4, C_2H_6, C_3H_8 etc.

II, Un Saturated hydro carbon:- Compounds that contain carbon-carbon double triple bond.

Example:- alkene & alkyne

Alkanes

- They are saturated hydro carbon which have carbon – carbon single bond.

E.g:- General formula $C_nH_{2n}+2$ where

"n" no of carbon starts from 1, 2--- n .

Homologous Series Of alkane

Homologous series a group of compound in which one member differ from the next member by – **"CH_2"** is called **homologos** series.

⊗ Characteristics of homologous Series

↳ Has a constant unit between two consecutive member.

↳ Show trends in physical properties.

↳ Consecutive member differ by a constant molecular mass of **"14" .**

Physical properties of alkane

↳ At room temperature, $C_1 – C_4$ are gases

$C_5 – C_{17}$ are liquids

$> C_{18}$ are solids

↳ They are nonpolar organic compounds

↳ They have weak inter molecular force

↳ Have low density

↳ B.pt & m.pt of straight chain alkane increase with increase carbon number.

↳ With the same carbon number branched chain alkane have lower boiling point than straight chain because as branch increase , surface area become decrease.

↳ They are soluble in nonpolar solvent like C_6H_6, CCl_4, C_7H_8, ether e t c

Nomenclature of alkane

- It can be named in two ways

I, Common name

- Common name used lower member of alkanes
- It uses the prefix neo, is o & normal.

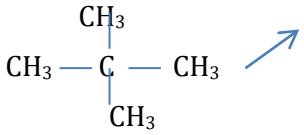
E. g:- $CH_3\ CH_2CH_3 \Rightarrow$ n – butane.

- all carbon atom continuous chain

⊗ **ISO:-** all carbon atom continuous chain except the one next to the last carbon.

E. g:- $CH_3—CH(CH_3)—CH_3$ → ISO butane.

⊗ **Ne O:-** When a central carbon is bonded to four other carbon atom.

E. g:-  neo pentane

II, IUPAC name

A chemical name for branched alkane has four parts in IUPAC nomenclature:-

① Locate:- Position of substituent & function group.

② Prefix:- What are substituents.

③ Parent:- How many carbon.

④ Suffix:- What is primary functional group.

Naming of alkyl radical

- Alkyl radical obtained by removing one from corresponding alkane.
- General formula C_nH_{2n+2} where n= 1, 2—

E. g:- CH_4 CH_3 Methyl

- C_nH_2n+2 - C_nH_2n+1

⊗ Rules for naming of branched Chain alkane

Rule 1:- Select the longest continuous chain of carbon in a molecule.

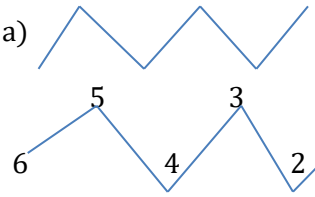
Rule 2:- Assign the numbers to the carbon atom of the longest chain at the end closer to branch chain.

Rule 3:- Indicate the position of side chain, if the same substituent appears more than once use prefix di, tri & tetra etc.

Rule 4:- numbers are separated by comma whereas numbers & name of substituent separated by hyphens.

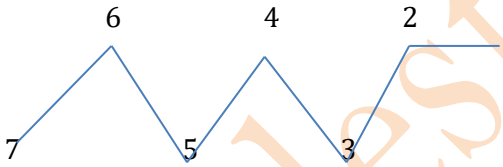
Rule 5:- Arrange the name of side chain alphabetical before the name of parent chain.

Examples:-

a) 

Give name for this alkane

= 2- methyl hexane

b) 
=


⇒ 3- ethyl heptane

C) Longest chain ⇒ hexane's

1	2	3	4	5	6
CH_3	CH	CH_2	CH	CH_2	CH_3
	Br		CH_3		

Br & CH_3 – side chain

1st arrange the name of Br & CH_3 alphabetically. Broom in comes first.

2, broom – 4- methyl- hexane

1, Draw the structure for

a) 2 – chloral- 3 – methyl hexane
b) 2,2 – di broom – 3- chloral hexane.

Answer:- Q/ 1st connect six carbon in a continues chain

2nd 2 indicate position of chlorine and 3 indicate position of methyl

∴ $CH_3 - CH - CH - CH_2 - CH_2 - CH_3$

Cl CH_3

Br

b) $CH_3 - C(Br) - CH(Cr) - CH_2 - CH(Br) - CH_2(CH_3) - CH_3$

Q2:- Give name for $CH_3 - CH(Br) - C(CH_3)_2 - CH_2 - CH_3$

1 Br CH_3

Answer:- $CH_3 - C^2(Br) - C^3(CH_3)_2 - C^4H_2 - C^5H_3$

2,2 – dayroom – 3,3 dimethyl pentane.

Isomerism in alkane

⊗ **Isomerism:-** is the existence of two or more chemical compound with the same molecular formula but different structure.

⊗ **Isomer:-** a compounds that have the same number of atoms but different in the way of atom arranged.

N.B:- Alkanes exhibit structural isomer two / more d/t compounds that have that have the same molecular formula but d/t in structure or connectivity.

- Structural isomers have different physical properties like b.pt, m, p t, density etc. no of isomers from carbon no one to carbon no seven is given by.

$$2^{n-4} + 1$$

Where " **n** " is no of carbon

E. g:- How many isomers has for pentane

Answer:- Pentane has 5 carbon ⇒ n = 5

# of isomer $= 2^{5-4} + 1$

$= 2^1 + 1$

$= 3$ ⇒ pentane has three structural isomer

Preparation Of alkane

Alkanes are a major constituent of petroleum & natural gas. They are mainly obtained by fractional distillation of petroleum . Alkanes can also prepared in laboratory by the following methods.

1, Hydrogenation of alkene with metal catalyst

General reaction:- $RCH = CH_2 + H_2 \xrightarrow[Heat]{pt} RCH_2 - CH_3$

E. g:- $CH_2 = CH_2 + H_2 \xrightarrow{pt} CH_3 - CH_3$

alkane alkane

2, Wurtz raction:- $2R\text{-} \times + 2Na \rightarrow R\text{-}R + 2Na\times$

alklhalide alkane

E.g:- $2CH_3Cl + 2Na \rightarrow CH_3 - + 2NaCl.$

3, Heating sodium salt of organic acid with sodalime /a mixture of CaO & NaOH).

- Removal of carboxylate group from sodium salt of carboxylic acid
- Also called decarboxylation reaction general reaction.

$RCOO\,Na + Na\,OH \xrightarrow[heat]{CaO} R - n + Na_2CO_3$

E. g:- $CH_3\,COO\,Na + Na\,OH \xrightarrow[heat]{CaO} CH_4 + Na_2CO_3\,.$

Chemical properties of alkane

- Alkanes have little chemical affinity and they inert in most laboratory reagents like acids, base, reducing agent etc. But in appropriate condition they undergo the following reaction.

1, Combustion reaction

- The most important reaction of alkane when alkane burn with oxygen, CO_2 , H_2O & heat will formed.

Given by: $C_n H_{2n+2} + \left(\frac{3n+1}{2}\right)O_2 \rightarrow nCO_2 + (n+1)H_2O + heat$

Where n = no of carbon.

For example:- metal has carbon no one

$CH_2 \times 1+2 + \left(\frac{3+1}{2}\right)O_2 \rightarrow CO_2 + 2H_2O$

$CH_4 \pm 2O_2 \rightarrow CO_2 \rightarrow \pm 2H_2O \pm heat$

2, Substitution reaction

This reaction involves replacement of one atom or a group of atoms by other.

E. g:- Halogenation chlorination of alkane is good example of substitution reaction.

- Chlorination of metal has a series of steps

Step 1:- Chain initiating

This step involves a absorption of energy to break Cl_2 in to produce free radicals.

i. e:- $Cl - Cl \xrightarrow{Light} 2Cl.$

Step 2:- Chain Propagating

In this step consume free radicals that produced in first step & producing other new free radicals.

i. e:- $Cl - + CH_4 \rightarrow H Cl + CH_3$

Step 3:- Chain terminating

In this step all free radical are consumed but not generated.

i. e:- $Cl. + Cl. \rightarrow Cl_2.$

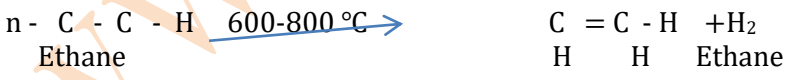
$. CH_3 + . CH_3 \rightarrow CH_3 - CH_3$

$. Cl + . CH_3 \rightarrow CH_3Cl$

3, Elimination reaction

This step involves removal of smaller molecule from the compounds and leads to the formation a compound containing multiple bond. Or removal of hydrogen a toms from adjacent carbon at high temperature.

E. g:-



Ethane Ethane

Cycle alkane

Cycle alkanes are alkanes in which all or some the carbon atom are arranged in airing.

- General formula $C_n H_2 n$ Where $n \geq 3$

Note:- cycle propane is the simplest a cyclo alkane.

If n – 3 C_3H_6 Or  Cycle propane

n = 4 C_4H_8 or Cycle butane.

⊗ Uses of alkane

↳ Alkanes are primarily used as fuel.

↳ They are used as solvent & raw materials for making alkene, alcohol, soap and detergent & plastics.

Un saturated hydro carbon & aromatic hydro carbon.

Alkene (Olefins)

↳ Are un saturated hydro carbon that contain carbon carbon double bond.

↳ Also called plains.

↳ have general formula C_nH_2n, n = 2,3--- n where **"n"** is no of carbon.

N.B:- Ethan is the simplest alkene.

Homologous Series of alkene

Ethan is the simplest alkene which used as starting material for synthesis of ethanol, ethanol, ethylene & poly ethylene.

- Ethane exist in nature as plant hormone.

Numen Cloture Of alkene

Alkenes can have common name as well as IUPAC name.

- The common name of alkene obtained by replacing the – **"a n e"** of the corresponding alkane with –**ylene.**

E. g:- $CH_2 – CH_2 \Rightarrow$ Ethylene

$CH_2CH = CH_2 \Rightarrow$ propylene

⊗ Rules of IUPA naming of alkene are

Rule 1:- Select the longest chain containing double bond.

Rule 2:- Give no to the longest chain at the end closer to double bond.

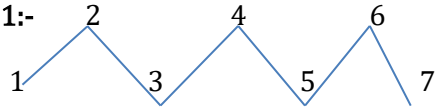
Rule 3:- Indicate the position of double bond.

Rule 4:- Identity the position of substituent.

Rule 5:- Two frequently encountered alkenyl groups are vinyl & allyl group

$CH_2 = CH_2$ Vinyl $C H_2 = CH - CH_2$ ally

E. g 1:-



= - heptane

E. g 2: -

C, Physical properties of alkenes

↳ Have weak intermolecular force.

↳ They are non- polar & soluble in non polar solvent.

↳ As carbon number increase density and b.pt of alkene also increase.

↳ At room temperature $C_2 - C_4 \Rightarrow$ gases

$C_5 - C_{17} \Rightarrow$ liquid

$\geq - C_{18} \Rightarrow$ solids

↳ Have lower density than water.

↳ Trans isomer of alkene have lowerb.pt than C is isomer.

b/c C is isomer is more polar than trans isomer

D, Isomerism in alkenes

Alkene containing two / three carbon atom have only one possible structure. Alkenes whose carbon number greater than 3 have isomerism.

⊗ Alkenes show two or more types of isomerism.

I, Chain isomerism:-This is due to different arrangement of carbon atom in the longest continuous carbon chain.

E. g:- 1- Pentene & 2- methyl-1- butane have one pair of chain isomer.

i. e:- $CH_2 = CH - CH_2 - CH_2 - CH_3$ & $CH_2 = C - CH_2 - CH_3$

1- pentene CH_3 2 – methy1- 1- butane

II, Position isomer is midge:- to different position of double in the carbon chain.

E. g:-1

E. g:-2 2- methyl -2- hexane & 2-methyl hexane are one pairs of position isomerism.

II, Position isomer is midge:-

This due to spatial arrangement of atoms/ group of atoms about a double bond are called **geometrical isomerism**.

⊗ **C is:-** Two similar groups are in the same side of the double bond.

E. g:- CH_3 C = C CH_2 - CH_3 ⇒ C is – 2- pentene
H H

⊗ **Trans :-** Two similar groups are exist in opposite side of the double bond.

E. g:- CH_3 C = H Trans -2- pentene.
H C CH_2CH_3

Note:- When two identical groups are attached to one carbon that bearing in double bond, geometrical isomer is not form.

E. g:- -1- butane ⇔ H C = C - H ⇒ has no geometrical isomerism
H $CH_2 – CH_3$

Because two similar H atom attached to one carbon that bearing to double bond.

Q_1:- What type of isomer exist in 2- pentene & 2- methyl – 2 butane.

Answer:- $CH_3 – CH = CH – CH_2 – CH_3$ ⇒ 2- pentene
$CH_3 – C = CH_2 – CH_3$ ⇒ 2- methyl -2- butane
CH_3

There is no change position of double bond change in carbon atom arrangement on the longest chain, so it has Chain isomer.

Q_2:- Draw goniometrical isomer for 2 – butane

Answer:- CH_3 H
C = C
H CH_3 Trans – 2- butane.

CH_3 C H_3
C = C
H H C is -2- butane.

E, Preparation Of alkenes

Alkenes mainly obtained by fractional distillation of petroleum when cracking is carried out.

In laboratory It can be prepared by:-

A) Dehydration:- of alcohol with concentrated H_2SO_4 or Alumina (Al_2O_3)

Dehydration:- removal of water from cpd. General reaction: $RCH_2CH_2OH \xrightarrow{H_2SO_4} RCH = CH_2 + H_2O$

heat

E. g:- $CH_3CH_2OH \xrightarrow[\text{heat}]{H_2SO_4} CH_2 = CH_2 + H_2O$

$CH_3 - CH - CH_2CH_2OH \xrightarrow{H_2SO_4} CH_3 - CH - CH_2 = CH_2 + H_2O$

CH_3 CH_3

3 – methyl -1- butane 3- methyl -1- butane

B) De hydro halogenation:- of alkyl halide with base /KOH/.

- De hydro halogenation is a process of removing H× from " **R**× " .

General reaction:- $RCH_2CH_2 \times + KOH \rightarrow RCH = CH_2 + K\times + H_2O$

E. g:- $CH_3 - CH_2Br + KOH \rightarrow CH_2 = CH_2 + KBr + H_2O$

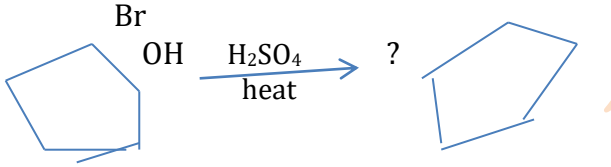
- $CH_3 - CH_2 - Ch_2Cl + KOH \rightarrow CH_3CH = CH_2 + KCl + H_2O$

Exercise 6.11

1, Complete the following equations

a) $CH_3 - CH - CH_3 \xrightarrow[\text{heat}]{H_2SO_4} ? \quad CH_3 - CH = CH_2 + H_2O$
OH

b) $CH_3 - CH - CH_3 + KOH \rightarrow ? \; CH_3 - CH = CH_2 + H_2O + KBr$
Br

c)  OH $\xrightarrow[\text{heat}]{H_2SO_4}$? $+ H_2O$

F, Chemical properties Of alkenes

Alkenes are more reactive than alkane because of double bond that helps to proceed further reaction.

- Alkenes under go several type of reactions

1, Combustion reaction:- Alkenes burn with oxygen with aluminous flame to form CO_2 & H_2O

General reaction:- $C_nH_2n + \frac{3n}{2} O_2 \rightarrow n\,CO_2 + H_2O + \Delta$

Q:- Write the general composition reaction of alkene whole carbon no " **4** " , n = 4

Answer:- $C_4H_8 + 6O_2 \rightarrow 4C^0{}_2 + 4H_2O$

2, Addition reaction:- Alkenes under go mainly addition reaction.

- Addition reaction occur at carbon-carbon double bond.

i, Halogenation:- when halogen molecule ($\times_2$) added to alkene, dialog alkane will produce .

General reaction : $RCH = CH_2 + \times_2 \rightarrow RCH - CH_2$

$\times \quad \times$

Example:- $CH_3CH = CH_2 + Cl_2 \rightarrow CH_3 - CH - CH_2$
Cl
Propene 1, 2 – dichloride propane
$CH_3 - CH - CH = CH_2 + Br_2 \rightarrow CH_3 - CH - CH - CH_2$
CH_3 CH_3 Br Br

ii, Addition of hydrogen:- hydrogenation addition of H_2 to alkene with p t catalyst produce alkyne.

General reaction $RCH = CH_2 + H_2 + H_2 \xrightarrow{pt} RCH_2CH_3$ OR $C_nH_{2n} + H_2 \xrightarrow{pt} C_nH_{2n+2}$

Example:- $CH_3CH = CH_2 + H_2 \xrightarrow{pt} C_nH_{2n+2}$

iii, Hydro halogenation:- addition of hydrogen halide (H×) to alkene produce alkyl halide .

- It follows markovnikou's rule. States that when alkene react with H×, H from H× is added to carbon – carbon double bond that have greater hydrogen. While × from H× is added to carbon-carbon double bond that have low hydrogen atom.

General reaction:- $RCH = CH_2 \rightarrow RCH - CH_2$
× H

Example:-

- $CH_3 - CH = CH_2 + HBr \rightarrow CH_3 - CH - CH_3$
Br
Propene 2-bromo propane
- $CH_3 - CH - CH + HBr \rightarrow CH_2 + HCl \rightarrow CH_3CH - CH - CH_3$
CH_3 CH_3 Cl

Note:- for symmetrical alkene, Markovnikous rule not applied:

E. g:- $CH_2 = CH_2 + HCl \rightarrow ?$

iv, Oxidation of alkene

Oxidation of alkene with cold alkaline potassium per manganite solution ($KMnO_4$), forms die / or two hydro oxygen group.
General reaction:- $RCH = CH_2 \xrightarrow{KMnO_4} RCH - CH_2$
OH OH

Example:- $CH_3 - CH = CH_2 \xrightarrow{KMnO_4} CH_3 - CH - CH_2$
OH OH 1,2- propane idol

$CH_2 = CH_2 \xrightarrow{KMnO_4} CH_2 - CH_2$
OH OH 1, 2, ethane idol

v, Polymerization

(Self addition of alkene) polymerization is the union of small molecule called monors to form large molecule to form polymer.

$CH_2 = CH_2 \xrightarrow[O_2 \text{ catalyst}]{1000 \text{ a tm}, 473K} (-CH_2 - CH_2 -)_n$

Ethan Poly ether

G, Uses of Ethane

↳ It is starting material for the production of – ethanol, ethanol, poly ethane.

↳ Used to synthesis polystyrene, Teflon, PVC.

↳ Used to artificial ripening of fruit.

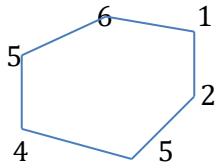
H, Cycle alkene

- It is unsaturated cyclic hydro carbon the carbon atom is linked in a ring structure.

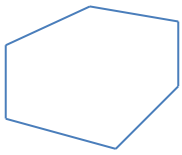
General formula $C_n H_2 n$, $n \geq 3$

If n = 3 : $C_3 H_4 \Leftrightarrow$  Cycle propene

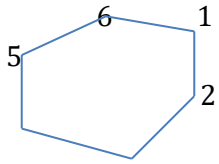
The Simplest cycle alkene is **cycle propene**



CH_3 ⇒ 1 – methyl cycle hexane



1 , 4 – cycle hex dyne OR (cycle hex – 1,4- dyne)



1,5 – di methyl cycle - pentene

Alkynes & their physical Properties

Alkynes are unsaturated hydro carbon that contain at least C ≡ c bond in a molecule.

- Its name ending by – yen.
- **Ethane:-** is the simplest alkyne

General formula $C_n H_2 n - 2$ $N \geq 2$

If n = 2, $C_2 H_2$ acetylene.

Note:- The homologous series of alkyne is called a acetylene Series.

A, Numen cloture of Alkyne

- Alkynes have both common & IUPA name.

I, Common name:- Lower member of alkyne is named by common name

E. g:- $CH \equiv CH$ - acetylene

$CH_3 - C \equiv CH$ - Propylene

II, IUPA name

Rule 1:- Select the longest chain having C ≡ C

Rule 2:- Give no to the longest chain at the triple bond.

Rule 3:- Assign the position of triple bond.

Rule 4:- Identify the position of side chain by no.

Rule 5:- Arrange the name of side chain alphabetical order before parent name.

Example:- $CH_3 - C \equiv CH$ / ≡ 3- methyl
CH_3 1- butane
3- methyl -1- butane

a)  ($HC \equiv CH$) ⇒ Ethyne.

b) $CH_2 = CH - CH_2 - C \equiv CH$  ⇒ 1- butane -4 – yne.

5 4 Cl C
C) $CH_3 - C - CH - C - \equiv CH$ ⇒ 3- brome – 4,4- dichloride
Cl Br 2 1 1- pentane

B, Isomerism in Alkyne

Alkynes have both chain & position isomer but not have geometrical isomer.

⇒ 1- butane & 2- butane are one pairs of position isomers. Where as 1- pentane & 2- methyl -1- butane one pairs of chain isomer.

C, Preparation of Alkyne

Alkynes can be prepared by several method

① De hydro halogenation of vicinal (adjacent) di halides with a base Na OH /$NaNH_2$

General reaction:-

$RCH - CH_2 + 2NaOH \rightarrow RC \equiv CH + 2Na \times + 2H_2O$

× ×

Example:- $CH_2 - CH_2 + 2NaOH \rightarrow HC \equiv CH + 2NaCl + 2H_2O$

Cl Cl

② Alkylation of sodium a citywide with

Primary alkyl halide

General reaction:

$HC \equiv CNa + CH_3CH_2Br \rightarrow HC \equiv C - CH_2CH_3 + NaBr$

$HC \equiv CNa + CH_3CH_2Br \rightarrow HC \equiv C - CH_3 + NaCl$

→ Alkyne can be prepared by the reaction of calcium carbide with water.

$CaC_2 + 2H_2O(\ell) \rightarrow Ca(OH)_2 + C_2H_2(g)$

D, Chemical Preparation of Alkyne

- Alkynes are more reactive than alkene & alkane due to the presence of triple bond b/n two carbon.

⊗ Some common reaction of alkyne

1, Combustion reaction:- when alkyne burn with smoky luminous flame, CO_2, H_2O & large amount of heat will produce.

General reaction: $C_nH_{2n-2} + (\frac{3n-1}{2})O_2 \rightarrow nCO_2 + (n-1)H_2O + \Delta$

Example:- If n = 3

$C_3H_4 \pm 4O_2 \rightarrow 3CO_2 \pm 2H2O \pm$ heat.

2, Addition reaction:- It can be / H_2, $\times_2$ & H×)

a) Hydro genetic:- when two mole of H_2 is added to alkyne with p t catalyst , alkane will form where as hydrogenation of alkyne with landler's catalyst produce alkene .

Example:- $HC \equiv CH + H_2 \xrightarrow{pt} H_2C = CH_2 + H_2 \xrightarrow{pt} CH_3 - CH_3$

Ethane Ethane Ethane

$HC \equiv CH + H_2 \xrightarrow{Linda} H_2C = CH_2$

Q:- Complete the produce for:-

$CH_3 - CH - C \equiv CH + H_2 \xrightarrow{pt} ?$

CH_3

Answer:- $CH_3 - CH - CH = CH_2 + H_2 \xrightarrow{pt} CH_3 - CH - CH_2 - CH_3$

CH_3 CH_3

b) Halogenation of alkyne

When one molecule of halogen is added to alkyne, dialog alkene will produce .

General reaction:-$RC \equiv CH + \times_2 \rightarrow R\ C = C\ H$

× ×

E.g:- $CH_3\ C \equiv CH + Br_2 \rightarrow CH_3\ C = CH$

Br Br 1, 2 broom propene

When two molecules of halogen is added to alkyne, tetra halo alkane will form.

× ×

General reaction:-$RC \equiv CH + 2 \times_2 \rightarrow R\ C = CH \rightarrow R - C - CH$

× × × ×

Cl Cl

E.g:- $CH_3\ C \equiv CH + 2Cl_2 \rightarrow CH_3 - C = CH \rightarrow CH_3 - C - CH$

Cl Cl Cl Cl

C) Addition of hydrogen halide

When H× is added to alkyne, monohalo alkene or dihalo alkane will produce

General reaction:- $RC \equiv CH \xrightarrow{R\times} R\ C = CH_2$

×

Example:- $CH_3\ C \equiv CH + HCl \rightarrow CH_3 - C = CH_2$

Cl

Q:- $CH_3 - C \equiv CH + 2HCl \rightarrow ?$ Cl

$CH_3 - C \equiv CH + HCl \rightarrow CH_3 - C = CH_2 + H\ Cl \rightarrow CH_3 - C - CH_3$

Cl

E) Properties & Uses of Ethyne

Acetylene is a colorless, sweet smelling gas. In pure for insoluble in water.

- It usually stored in cylinder as a solution of acetone.

⊗ The main advantage of $C_2 H_2$ is as a fuel in oxy- a acetylene torch for cutting & welding metals.

- $C_2 H_2$ also used to prepare a acrylonitrile w/C starting material for the production of poly acrylonitrile for textile fiber.

↳ For electrical in sulator, PVC, making floor tiles & water pipes

↳ To produce 1,1,2,2 – tetra chloral ethane which used to solvent for wax & grease.

Aromatic hydro carbon : Benzene

The term aromatic comes from Latin word aroma meaning pleas ant smell. Aromatic hydro carbon are generally obtained from petroleum & coal tar.

Examples of aromatic hydro carbon are bonze

Benzene

- Benzene is the simplest aromatic hydro carbon
- The bonds in benzene is neither single nor double because of resonance structure.

i. e

Resonance structure

Nomen cloture of Substituted benzene

I, Mono Substituted benzene

Mono substituted benzene are named in a similar manner as hydro carbon with benzene as the parent name.

Example:-

II, Di substituted benzene

When two substituents occur on a benzene ring, three constitutional isomer s are possible . We locate substituents either by numbering the atoms of the ring or by using the locators 1,2 or ortho (0), 1,3- metha (m) and 1,4 or para (p)

Example:-

a)  ⇒ 4- broom to luene (p- broom toluene.

b)  ⇒ 3- chloral aniline (m- chloral aniline

C)  ⇒ 3- chloral ethyl benzene (O- chloral ethyl benzene)

Physical properties of benzene

↳ It is highly flammable

↳ volatile liquid

↳ In soluble in water.

↳ Less denser than water

↳ It is soluble in nonpolar solvent.

Chemical properties of benzene

- It is more stable than alkene & alkyne due to stability of aromatic ring.
- It neither decolorize bromine water (Br_2 in CCl_4) nor react to wards cold $KMnO_4$

⇔ Benzene undergo the following reaction.

1, Combustion reaction:- Benzene is highly inflammable . It burns with smoky luminous flame to form CO_2 , H_2O & heat.

General formula:- C_nH_{2n-6} +

$$\left[\frac{3n-3}{2}\right] \quad O_2 \rightarrow nCO_2 + (n-3)H_2O$$

E.g:- Benzene: $n = 6$

$$C_6H_2 \times 6 - 6 + \left[\frac{3\times6-3}{2}\right] \quad O_2 \rightarrow 6\,CO_2 + (6-3)H_2O + \text{heat}$$

$$\Rightarrow C_6H_6 + 15/2 \quad O_2 \rightarrow 6\,CO_2 + 3\,H_2O + \text{heat}$$

2, Substitution reaction:- This the characteristic reaction of benzene and other or matric hydro carbon

a) Halogenation:- benzene react with Br & C l $FeCl_3$ catalyst to form substitution product.

Example:- $C_6H_6 + Br_2 \xrightarrow{FeBr_3} C_6H_5\,Cl + H\,Br$

Or  $+ Br_2 \xrightarrow{FeBr_3}$  Br $+ H\,Br$

b) Nitration:- a mixture of concentrated HNO_3 & concentrated H_2SO_4 react with benzene at moderate temperature to nitro benzene.

Example:- $C_6H_6 + HNO_3 \xrightarrow[50\,^\circ C]{H_2SO_4} C_6H_5 + NO_2 + H_2O$

Or  $+ HNO_3 \xrightarrow[50\,^\circ C]{H_2SO_4}$  NO$_2$ $+ H_2O$ nitro benzene

C) Sulphonation:- benzene react with concentrated H_2SO_4 at room temperature to form benzene sulphonic acid.

$C_6H_6 + H_2SO_4 \rightarrow C_6H_6\,S^{O}_{2}\,OH + H_2O$

Or  $+ H_2SO_4 \rightarrow$  $+ H_2O$

3, Addition reaction:- under normal conditions, aromatic compounds do not undergo addition reaction. But benzene under go addition reaction in special condition.

Example:- When a mixture of benzene vapor & hydrogen is passed over a finely divided nickel catalyst at 200 °C, cyclo hexane is formed .

$C_6H_6 + 3H_2 \xrightarrow[200^\circ C]{Ni} C_6H_{12}$

Or  $+ \; 3H_2 \xrightarrow[200^\circ C]{Ni}$  Cyclo hexane

benzene

Natural Source of hydro carbon

- The major source of alkanes are natural gas & petroleum.

A, Natural gas:- a mixture of gases that consists CH_4 90% , ethane, propane, butane & other gases CO_2, N_2 , O_2 & H_2S.

↳ Natural gas is found associated with petroleum or a lone.

↳ It found underground deposited bellow the earth surface.

↳ Composition of natural gas varies from place to place.

↳ Natural gas widely used as a fuel.

B, Petroleum (Crude oil):-

Petroleum comes from Latin word Petra meaning rock & oleum meaning oil

⇒ Petroleum means rock oil

↳ petroleum mainly contain alkane, cycle alkane & aromatic hydro carbons.

Refining Of Crude oil

Petroleum refining begins by fractional distillation of crude oil in to three principal cuts according to boiling points.

i. e:- Gas online (b.pt = 30 - 200℃)

Kerosene (b.pt = 175 – 300 ℃)

Diesel fuel (b. p t = 275 – 400 ℃)

C, CO al :- It is formed naturally by decomposition of plant matter over several millions of years.

- It is not pure form of carbon.
- It is important source of aromatic hydro carbon.
- Heating of mineral Coal in the absence of air is called coking of Coal.

Note:- When Coal is heated in the absence of air, it gives volatile produce & **COOke,** The volatile products are separated in to Coal gas and liquid Coal tar by fractional distillation.

- Coke:- It is a solid & relatively pure form of carbon used as a fuel in blast furnace.

- It also used to produce gaseous fuel like

↳ Water gas (a mixture of H_2 & CO)

↳ producer gas (a mixture of N_2 & CO)

Chapter - 6 Review exercise

Part -I Multiple Choice

5. C	5. D	9. C	13. A
6. C	6. C	10. D	14. D
7. B	7. B	11. C	15. C
8. A	8. B	12. D	16. C

Part –I I Supply types questions

17. Complete the following reaction

a) $CH_2 = CH_2 + \frac{H_2Ni}{heat}$? CH3CH3

b) $CH_3\,COO\,Na + Na\,OH \xrightarrow{CaO_3,\ heat}$?

$\rightarrow CH_4 + Na_2\,CO_3$

C) $2CH_3\,CH_2Br + 2Na \rightarrow$?

$\rightarrow CH_3\,CH_2\,CH_2\,CH_3 + 2NaBr$

d) $CH_3, CH, CH_2 + 2NaOH \rightarrow$?

Br B r

$\rightarrow CH_3\,C \equiv Ch + 2NaBr + 2H_2O$

e) $CH_3\,CH_2\,CH_2\,OH \xrightarrow[heat]{H_2SO_4}$?

$\rightarrow CH_3\,CH = CH_2 + H_2O$

f) $CH_3\,CH_2\,CH_2\,Cl + KOH \xrightarrow{heat}$?

$\rightarrow CH \equiv CCH_2\,CH_3 + Na\,Br$

h) $CH_3\,CH = CH_2 + Br \rightarrow$? $CH_3\,CH\,CH_3$.

Br

i) $HC \equiv CCH_2\,CH_3 + 2HCl \rightarrow$

Cl

$\rightarrow CH_3\,C - CH_2\,CH_3$

Cl

j) $CH_3CH_2CH = CH_2 + H_2O \xrightarrow{H^+}$?

$\rightarrow CH_3\,CH_2C\,H\,CH_3$

OH

K) $CH_3\,CH_2\,CH = CH_2 + H_2O \xrightarrow[Alkaline]{KMnO_4}$?

$\rightarrow CH_3CH_2\,C\,H\,C\,H_2$

OH O H

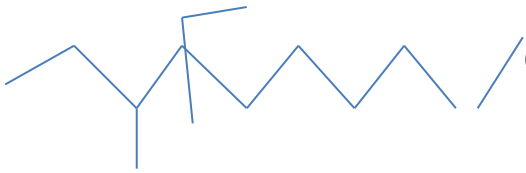
Part –I I I Work Out type questions

18. Draw the structure for the following

a) 2- methyl heptane. 

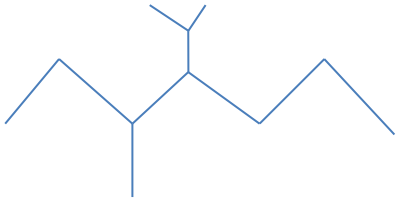
CH_3 , $CHCH_2CH_2CH_2CH_2CH_3$
CH_3

C) 4- ethyl – 3,4 – dimethylnonane.



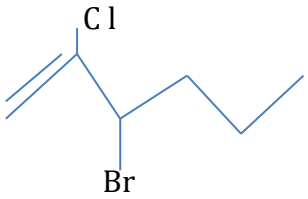
C_2H_5
CH_3 , CH_2 CH C $CH_2CH_2CH_2CH_2CH_3$
CH_3 CH_3

f) 4- Iso propyl -3- methyl heptane



CH_3- CH – CH_3
CH_3 , CH_2 CH C H $CH_2CH_2CH_2CH_3$
CH_3

h) 3- Bromo – 2- chloro hex- 1-ene



19) Name the five isomers of C_6H_{14}

①. CH_3 CH_2 CH $_2$ CH_2 CH_2CH_3 → n- hexane.
1 2 3 4 5

②. CH_3 – CH CH_2 CH_2 CH_3 → 2- methyl pentane
CH_3
1 2 3 4 5

③. CH_3 CH_2 CH CH_2 CH_3 → methyl pentane
CH_3
CH_3
1 2 3 4

④. CH_3 – C CH_2 CH_3 → 2, 2- dimethyl butane

CH_3
1 2 3 4
④. $CH_3 - CH\ CH\ CH_3$ → 2, 3- dimethyl butane
CH_3 CH_3

20) Explain why each of the following names is incorrect.

a) 2,2- Dimethyl -6- Ethel heptane ? → No of C & alphabetical order is wrong
⟶ 6-ethyl -2,2- dimethyl octane

b) 4- Ethyl -5,5- dimethyl hexane → Direction of numbering Wrong
⟶ 3- Ethyl – 2,2 – dimethyl hexane.

C) 3- Ethyl -4,4- dimethyl hexane → Direction of numbering wrong
4- Ethyl -3,3- dimethyl hexane.

d) 5,5,6- Tri methyl octane → Direction of numbering wrong
3, 4, 4 – Tri methyl octane

e) 2- Isopropyl- 4- methyl heptane → No of C & alpha biotical order wrong
⟶ 2, 3, 5- Tri methyl octane

21) Cyclo propane is the structural isomer of propene

1 2 3 4 5

22) $CH \equiv C\ CH_2\ CH_2\ CH_3$ → 1- Pentene
1 2 3 4
$CH \equiv C\ CH\ CH_3$ → 3- methyl-1 –butane
CH_3

23) Give IUPAC names for the following compounds

1 2 3 4 5

a) $CH_3\ CH\ CH_2\ CH_2\ CH_3$ → 2- methyl pentane
CH_3
CH_3
4 3 2 1

b) $CH_3\ CH_2\ C - CH_3$ → 2, 2- dimethyl butane
CH_3
H_3C CH_3
1 2 3 4 5 6

C) $CH_3\ CH\ C\ CH_2\ CH_2\ CH_3$ → 2, 3, 3- Tri methyl hexane
CH_3
CH_2CH_3 CH_3
7 6 5 4 3 2 1

d) $CH_3\ CH_2\ CH\ CH_2\ CH_2\ CH\ CH_3$ → 5- Ethyl -2- Methyl heptane.
2 1

$CH_2 - CH_3$

8 7 6 5 4 3

e) $CH_3 - CH_2 - CH_2\ CH - CH_2 - C - CH_3$

CH_3 CH_3

⟶ 3, 3, 5- Tri methyl octane

CH_3 CH_3

1 2 3 4 5 6

f) CH_3- C – C- $CH_2 - CH_2 - CH_3$

CH_3 CH_3

⟶ 2, 2, 3, 3- Tetra methyl hexane.

Br H

1 2 3 4 5 6

g) $CH_3 - C - C - CH_2 - CH_2 - CH - CH_3$

H CH_3 7 CH_2

8 CH_3

⟶ 2- bromo – 3,6 – dimethyl octane.

1 Br 3 4 5 6

h) $H_3C - CH - C \equiv C - CH_2 - CH - CH_3$

7 CH_2

8 CH_3

⟶ 2- bromo – 6 – methyl -3- octyne.

Br CH_3

1 2 3 4 5 6

i) $CH_3 - CH - CH - CH - CH - CH - CH_3$

H CH_3 7 CH_2

8 CH_3

⟶ 2- bromo – 5,6- di methyl -3- octane.

1 2 3 4 5 6

j) $CH_3 - CH = C - CH_2 - CH_2 - CH - CH_3$

CH_3 7 CH_2

8 CH_3

⟶ 3, 6 – dimethyl -2- octane

K) $CH_3 - CH - CH = CH - CH_2 - CH - CH_3$

3 4 5 6 7

2 CH- CH_3 8 CH_2

1 CH_3 9 CH_3

⟶ <u>2, 3, 7 – Tri methyl -4 – nonene.</u>

Br CH

L) $CH_3 - CH - CH = CH_2 - CH - C - CH_3$ ⟶ 7- Bromo -3, 4, 6- Tri methyl

8 7 6 5 4 3 <u>2- octene</u>

CH_3 2 CH

1 CH_3