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Ch-1
SOME BASIC CONCEPTS OF CHEMISTRY

• NOTES

* Matter :- Anything that occupies space and has mass is termed as matter.

Types of matter :- (1). Solid → Definite volume & shape
(2). Liquid → Definite volume but indefinite shape
(3) Gas → Indefinite shape & volume

{Note} - The three states of matter are interconvertible :

$$\text{Solid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Liquid} \underset{\text{cool}}{\overset{\text{heat}}{\rightleftharpoons}} \text{Gas}$$

→ Classification of matter

- Matter
  - Mixture
    - Homogeneous
    - Heterogeneous
  - Pure Substances
    - Elements
    - Compounds

• Terminology :-

1) Mixture :- A mixture contains particles of two or more pure substances which may be present in it in any ratio. Eg. Sugar solution, air, tea etc.

+ Homogeneous mixture - (1) Components are completely mixed with each other.
(2) Particles of the components are uniformly distributed throughout the mixture.

+ Heterogenous mixture - (1) The composition is not uniform throughout.
(2) Sometimes components are visible.

Imp! → The components of a mixture can be separated using physical methods. Eg: crystallisation, filtration, hand picking etc.

2) Pure Substances - Constituent particles have fixed composition.
Eg. Copper, silver, gold.

+ Elements - Particles consist of only 1 type of atoms. These may exist as atoms or molecules.

+ Compounds - When two or more elements combine in a definite ratio, a compound is formed.

Imp! - The constituents of compound can't be separated through simple physical methods.
They can be separated only by chemical methods.

→ Properties of matter

(1) Physical Properties → Include colour, odour, melting & boiling point etc.
- Can be measured without changing composition of a substance.

(2) Chemical Properties → Combustibility, reactivity, acidity, basicity etc.
- Measurements of properties requires a chemical change to occur.

★ Mass & Weight

↳ Mass of a substance is the amount of matter present in it.
- It can be measured in the laboratory by using an analytical balance.
- SI unit → kilogram (kg)

↳ Weight of a substance is the force exerted by gravity on it.
- It varies from place to place as the value of 'g' varies from place to place.
- SI unit → newton (N)

★ Volume

→ It is the space occupied by a substance.
→ Unit ⇒ (length)^3. for ex - m^3, cm^3, km^3 etc
SI → m^3

→ litre is used for volume of liquids.

★ Density

→ Density of a substance is its amount of mass per unit volume.

- Density = $\frac{Mass}{Volume}$
- SI unit = $\frac{kg}{m^3}$ i.e. kg/m^3
- Density tells us how closely the particles in a substance are packed.

∴ Density ∝ Closeness of particles ∝ (intermolecular force of attraction)

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★ Temperature

→ Units - °C - (degree celsius / centigrade)

°F - (fahrenheit)

K - (kelvin) $\boxed{\text{SI unit}}$

Interconversion

① $°F = \left(\frac{9}{5}\right)°C + 32$

② $K = °C + 273.15$

★ In Kelvin scale, negative values aren't possible.

LAWS OF CHEMICAL COMBINATION

① Law of Conservation of Mass - Antoine Lavoisier, 1789

→ This law states that 'mass can neither be created nor destroyed'

→ In all reactions, physical and chemical changes, there is no net change of mass during the process

② Law of Definite Proportions - Joseph L. Proust

→ This law states that "a given compound always contains same elements in the exact, fixed proportion by mass

MOLE CONCEPT

→ Mole – One mole is the amount of a substance contains as many particles or entities as there are atoms in exactly 12g of the carbon-12 isotope.

1 mole ⟶ 6.023×10^{23} particles
Av. Const.

Substances ~~Gases/liquids~~ contain 22.4l at STP ⟵(volume) mole ⟶(particles) Avogadro constant

mole ↓ gram

23 g	17g	58.5g
Na	NH_3	NaCl
(atomic)	(~~molecular~~ covalent)	(ionic)

* $\boxed{\text{mole} = \dfrac{\text{weight}}{\text{molar weight}}}$

TRY!! (1) Calculate the volume occupied by 22 g of CO_2 at STP

~~Volume = $\frac{22}{22.4} \times 10$ = 0.98 l~~

0.982
112)1100
−1008
920
−896
240

→ Mole wt = 44

No. of moles = $\frac{22}{44}$ = $\boxed{0.5}$

⟹ Volume = $\frac{5}{10} \times \frac{224}{10}$

~~Volume~~ = $\frac{1120}{100}$ = $\boxed{11.2\ l}$

(2) Calculate the mass of

(1) an atom of silver ⟹ 108u

(2) a molecule of carbon dioxide ⟹ 12 + 2 × 16 = 44u

(1) Mass = $\frac{108}{N_A}$

~~$\frac{108 \times 100}{6.023 \times 10^{23}}$~~ = $\frac{108}{6.023 \times 10^{23}}$ = $\boxed{17.94 \times 10^{-23} g}$

(2) Mass = 44g

(3) How many atoms and molecules are present in 64g of sulphur?

~~1 mole = $\frac{64}{256}$ = $\frac{1}{4}$ = 0.25 molecules~~

~~No. of molecules = 0.25 × 6.023 × 10^{23}~~

~~$\frac{25}{100} \times 6.023 \times 10^{23}$ = 150.575 × 10^{21} molecules~~

~~12.046 × 10^{23} atoms~~

No. of atoms = 25 × 6.023 × 10^{21}

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$\rightarrow$ Moles $= \frac{64}{256} = 0.25$ moles.

1 mole $= 6.022 \times 10^{23}$ molecules

$\Rightarrow 0.25$ mole $= 0.25 \times 6.022 \times 10^{23} = \boxed{150.5 \times 10^{21} \text{ molecules}}$

or

$\boxed{1.505 \times 10^{23} \text{ molecules}}$

Atoms $= 8 \times 150.5 \times 10^{21}$

$= \boxed{1204 \times 10^{21} \text{ atoms}}$

or

$\boxed{12.04 \times 10^{23} \text{ atoms}}$

(4) Calculate the number of atoms of constituent elements in 53g of Na_2CO_3. (106)

$\rightarrow$ Moles $= \frac{\text{Weight}}{\text{Mol. Wt.}}$

$= \frac{53}{106} = $ 0.5 moles

In 0.5 moles, no. of molecules $= \frac{1}{2} \times 6.022 \times 10^{23}$

$\boxed{3.01 \times 10^{23} \text{ molecules}}$

No. of sodium atoms $= 2 \times 3.01 \times 10^{23} = 6.02 \times 10^{23}$ atoms.

No. of carbon atoms $= 1 \times 3.01 \times 10^{23} = 3.01 \times 10^{23}$ atoms

No. of oxygen atoms $= 3 \times 3.01 \times 10^{23} = 9.03 \times 10^{23}$ atoms

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(5) Calculate the number of moles in:

(1) 1 metric ton of Fe

(2) 7.9 mg of Ca

(3) 65 μg of C

$\hookrightarrow$ (1) Mole $= \frac{56}{10^{-6}} = 56 \times 10^{-5}$ moles $\frac{10^6}{56} = \boxed{17857.14 \text{ moles}}$

(2) Mole $= \frac{7.9}{10^{-3}} \quad \frac{7.9 \times 10^{-3}}{40} = 0.1975 \times 10^{-3}$

$= \boxed{19.75 \times 10^{-5}}$ moles

(3) Mole $= \frac{65 \times 10^{-6}}{12} = \boxed{5.41 \times 10^{-6} \text{ moles}}$

(6) Calculate the no. of moles present in 1L of water assuming that the density of water is 1 g/cm³.

$\rightarrow$ Density $= \frac{M}{V}$

$1 g/cm^3 = \frac{1000 g}{1000 cm^3}$

$\Rightarrow$ Moles $= \frac{1000}{18} = $ 55.56 moles

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(7) Calculate mass of:

(1) 0.1 mole of KNO_3 (K = 39, N = 14, O = 16)

(2) 1×10^{23} molecules of methane

(3) 112 liters of hydrogen at STP.

1) No. of Moles = 0.1 Mol wt. = 101u

Mole = $\frac{\text{Given Wt.}}{\text{Mol. Wt.}}$

$\Rightarrow$ Given wt. = $\frac{1}{10} \times 101$

= $\boxed{10.1g}$

2) ~~1×10^{23} molecules of~~
~~No. of molecules = 1×10^{23} molecules~~
~~1 mole = 6.02×10^{23}~~
~~Moles = 1×10^{23} molecules $\times N_A$~~
~~6.02×10^{23}~~
~~$\Rightarrow$ 6.02~~

C = 12 H 1
Mol. Mass = 12 + 4×1
= 16u

2) No. of molecules = 1×10^{23} molecules — ①

Mol. Wt = 16u

1 mole = 6.02×10^{23} molecules
Mass of 1 mole = 16g.

Mass of mole containing ① molecules,

$\Rightarrow$ Mass = $\frac{\cancel{16}^{8}\times1\times\cancel{10^{23}}\times100}{\cancel{602}_{301}\times\cancel{10^{25}}} = \boxed{\frac{8}{3.01}g} = \boxed{2.66g}$

3) 1 mole of H_2 gas = 22.4 litres.
Mass in 1 mole = 2g.

$\Rightarrow$ Mass: $\frac{2}{22.4} \times 112 \times 10 = \boxed{10g}$

Q → Calculate the volume at STP occupied by :-

① 14g of nitrogen
② 1.5 moles of CO_2
③ 10^{21} molecules of O_2

① → Mole = $\frac{14}{28}$

= 0.5 moles

1 mole = 22.4
0.5 mole = $22.4\times\frac{1}{2}$

= $\boxed{11.2l}$

② → 1 mole of CO_2 ~~contains~~ volume = 22.4 l
1.5 mole of CO_2 volume = $\frac{\cancel{224}^{112}}{10}\times\frac{\cancel{15}^{3}}{\cancel{10}_{2}} = \boxed{33.6l}$

③ 1 mole of O_2 contains 6.02×10^{23} molecules.

1 mole of O_2 volume = 22.4l

10^{21} molecules $= \frac{1}{6.02\times10^{23}} \times 10^{21}$ mole

$= \frac{1}{6.02\times10^{2}}$ moles

Volume of 10^{21} molecules $= \frac{1}{6.02\times10^{2}} \times 22.4$

$\Rightarrow$ $\boxed{Vol = \frac{11.2}{3.01} \times 10^{-2}}$

$\Rightarrow Vol = \frac{112\times10}{301} \times 10^{-2}$

$\Rightarrow \boxed{Vol = \frac{11.2\times10^{-1}}{301}\ L} = \boxed{0.0372}$

Q. Calculate the no. of electrons present in 1.4 g of N_2.

A→ No. of moles $= \frac{\text{Given Wt.}}{\text{Mol. Wt.}}$

$= \frac{1.4}{28} \times \frac{1}{10} = \boxed{0.05\ moles}$

1 mole contains N_A electrons

0.05 moles have $N_A \times 0.05$ electrons

$\Rightarrow$ No. of electrons $= 6.02\times10^{23} \times \frac{5}{100} = \boxed{0.301\times10^{23}}$

Molarity

↳ It is defined as moles of solute dissolved per litre of solution.

$$M = \frac{\text{No. of moles of solute}}{\text{Vol. of solution in litres}}$$

$$= \frac{\text{Weight of solute} \times 1000}{\text{Molar Mass} \times \text{Vol. of solution in (ml)}}$$

Q. Calculate molarity of a solution containing 4g NaOH in 250 cm^3 of solution.

$M = \frac{\text{no. of solute} \times 1000}{\text{mol. mass} \times \text{vol. of sol}^n}$

↳ $M = \frac{4\times1000}{40\times250} = \boxed{0.4\ mol/L}$

Mass Percent

↳ Mass percent of an element is given by:

$$\frac{\text{Mass of that element in compound} \times 100}{\text{Molar Mass of Compound}}$$

Molality

↳ It is defined as ~~weight~~ no. of moles of solute dissolved per gm of ~~solution~~ solvent.

$$'m' = \frac{\text{Weight of solute} \times 1000}{\text{Mol. Wt} \times \text{Weight of solvent (gm)}} \quad \text{(molal)}$$

Mole Fraction

→ Represented by 'x'

→ $X_A = \frac{n_A}{n_A + n_B}$, $X_B = \frac{n_B}{n_A + n_B}$

→ $X_A + X_B = 1$

Q. Calculate the mass of canesugar ($C_{12}H_{22}O_{11}$) and water required to prepare 250g of 25% solution of canesugar.

→ ~~$M = \frac{\text{Weight of solute} \times 1000}{\text{Mol. wt} \times \text{Weight of solution}}$~~

→ ~~$\% w/w = \frac{25}{250} \times 100 = \boxed{10g}$~~

~~Weight of water = $\boxed{240g}$~~

→ $\% w/w = \frac{\text{Wt. of cane sugar}}{\text{Total wt.}} \times 100$

⇒ Wt. of cane sugar $= \frac{250 \times 25}{100} = \boxed{62.5g}$

Wt. of water $= 250 - 62.5$
$= \boxed{187.5g}$

Q. A solution prepared by dissolving 4g of NaOH to give 500 ml of it. Calculate molarity.

→ ~~$M = \frac{\text{No. of moles}}{\text{Wt. of solute}}$~~

→ $M = \frac{\text{Wt of solute} \times 1000}{\text{Mol. wt} \times 500\text{ml}}$

$= \frac{4 \times 1000}{40 \times 500} = \boxed{0.2 \text{ mol/l}}$

Q. 2.5M 500ml H_2SO_4 diluted to 1500ml. What will be the molarity?

→ $M_1 \times V_1 = M_2 \times V_2$

⇒ $2.5 \times 500 = M_2 \times 1500$

⇒ $\frac{2.5}{3} = M_2$

⇒ $\boxed{M_2 = 0.8}$

Q. Calculate the molarity of the soln obtained by mixing 100ml of 0.2M H_2SO_4 with 50ml of 0.1M HCl.

→ $M_1 = 0.2$ M, $V_1 = 100$ ml

$M_2 = 0.1$ M, $V_2 = 50$ ml

$M_3 = ?$, $V_3 = 150$ ml

→ $M_1V_1 + M_2V_2 = M_3V_3$

$\Rightarrow \frac{0.2\times100+0.1\times50}{150} = M_3$

$\Rightarrow \cancel{\frac{10+10}{150} = M_3}$ $\Rightarrow \frac{20+5}{150} = M_3$

$\Rightarrow \cancel{\frac{20}{150} = \boxed{0.1\bar{3}}}$ $\Rightarrow \frac{25}{150} = M_3$

$\Rightarrow \frac{1}{6} = M_3$

$\Rightarrow \boxed{0.16 = M_3}$

$\therefore$, Molarity $= 0.16$ mol/l

* Limiting Reagent

→ In a chemical reaction, the reactant which gets consumed first, and limits the amount of product formed, is called the limiting reagent.

Q- Calculate molality of H_2SO_4 sol'n in which the mole fraction of water is 0.85.

→ Mole fraction of H_2SO_4 $= 1-0.85$
$= 0.15$

$n_2 = \frac{1000}{18}$
$= 55.55$

$\chi_{H_2SO_4} = \frac{n_1}{n_1+n_2}$ — (1)

$\chi_{H_2O} = \frac{n_2}{n_1+n_2}$ — (2)

Dividing (1) by (2), we get $\Rightarrow \frac{n_1}{n_2} = \frac{0.15}{0.85}$

$\Rightarrow n_1 = \frac{0.15}{0.85}\times 55.55 = 9.8$ moles

$\therefore$, molality is 9.8m.

Stoichiometric Calculations

- Types of Calculations:

1) moles - moles
2) mass - mass
3) mass - volume
4) volume - volume

Q- How many moles of CO_2 will be obtained if 0.274 moles of C_2H_5OH is burnt?

→ $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O +$ heat and light

1 mole   3 moles   2 moles   3 moles

We have, 1 mole C_2H_5OH = 2 moles CO_2

$\Rightarrow$ 0.274 moles C_2H_5OH = 2×0.274 moles CO_2

$= \boxed{0.548 \text{ moles of } CO_2}$

Q- If 2.4 moles of O_2 is needed, how many gm of $KClO_3$ must be decomposed?

$2KClO_3 \longrightarrow 2KCl + 3O_2$

2 mol   2 mol   3 mol

We get, 2 mol $KClO_3$ → 3 mol O_2

$\Rightarrow \frac{2}{3}$ mol $KClO_3$ = 1 mol O_2

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$\Rightarrow \frac{2}{3} \times \frac{24}{10}$ mol $KClO_3$ = 2.4 mol O_2

= $\boxed{1.6 \text{ mol } KClO_3}$

$n = \frac{G.wt}{M.mass}$

$\Rightarrow G.wt = n \times M.Mass$
$= 1.6 \times 122$
$= \boxed{195.2g}$

Q- Calculate amount of water produced by the combustion of 16g of methane.

$\rightarrow$ $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$ + heat & light

1mol 2mol 1mol 2mol

2 moles of H_2O = $\frac{mass}{18}$

$\therefore$ $\boxed{mass^{(H_2O)} = 36g}$

Q- How many moles of ethanol are required to produce 22g CO_2 after combustion?

$\rightarrow$ $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ + heat & light
1 mole 2 moles

1 mole $C_2H_5OH \rightarrow$ 2 mol CO_2

$\frac{1}{2}$ mole $C_2H_5OH \rightarrow$ 1 mol CO_2

$\frac{1}{2}$ mol CO_2 = $\frac{1}{2} \times \frac{1}{2}$

= $\boxed{\frac{1}{4} \text{ mol } C_2H_5OH}$

Q- Calculate the amount of $KClO_3$ needed to supply sufficient O_2 for burning 112 L of CO gas at STP.

$\rightarrow$ $CO + \frac{1}{2}O_2 \longrightarrow CO_2$

$2KClO_3 \longrightarrow 2KCl + 3O_2$

Moles of CO = $\frac{112}{22.4}$

$\Rightarrow$ Moles of CO = 5

$\therefore$, 112 L of CO will require $\boxed{2.5 \text{ moles of } O_2}$

2 mol $KClO_3 \longrightarrow$ 3 mol O_2

$\frac{2}{3}$ mol $KClO_3 \longrightarrow$ 1 mol O_2

~~$\frac{2}{3} \times \frac{5}{2}$ mol $KClO_3 \rightarrow$ 2.5 mol O_2~~

~~$\therefore$, We require 1.67 moles of $KClO_3$ to be burnt.~~

~~$\frac{1 \times 6}{10} \times 245g$ = 392g of $KClO_3$ is reqd.~~

$\frac{245}{3} \times \frac{5}{2}$ = $\boxed{204.16g}$

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Q- What volume of oxygen at STP is required to effect complete ~~complete~~ combustion of $200cm^3$ of C_2H_2 and what would be volume of CO_2 formed?

$\rightarrow$ $2C_2H_2 + 5O_2 \longrightarrow 4CO_2 + 2H_2O$

$2 \times 22400\, cm^3$ $\quad 5 \times 22400\, cm^3$ $\quad 4 \times 22400$

$44800 cm^3 \longrightarrow 5 \times 22400$

$200 \longrightarrow \dfrac{200 \times 5 \times 22400}{44800} = \boxed{500 cm^3}\ O_2$

$200 \longrightarrow \dfrac{200 \times 4 \times 22400}{44800} = \boxed{400 cm^3\ CO_2}$

* To determine Empirical & Molecular Formula

- Empirical Formula - represents simplest whole no. ratio of various atoms present in a compound.

  Eg Benzene - CH, Hydrogen peroxide - HO

- Molecular Formula - represents the exact no. of different types of atoms present in a molecule or compound.

  Eg Glucose - $\boxed{C_6H_{12}O_6}$, Ethanol - C_2H_5OH

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↳ Steps to write empirical formula:

1. Conversion of mass % to grams.
2. Convert into no. of moles of each element.
3. Divide each of the mole values obtained above by the smallest no. among them.
4. Write down empirical formula by mentioning the numbers after writing the symbols of respective elements.

↳ Steps to write molecular formula:

1. Determine empirical formula mass.
2. Divide molar mass by empirical formula mass.
3. Multiply empirical formula by n to get molecular formula

$$\boxed{n = \frac{\text{Molar mass}}{\text{Emp Form Mass}}}$$

Q- An organic substance contains 40.687% carbon, 5.085% hydrogen & 54.228% oxygen. Determine molecular formula of compound if its molar mass is 118g/mol.

→ C	40.687%	40.68g	40.68/12	3.39
H	5.085%	5.08 g	5.08 / 1	5.08
O	54.228%	54.22 g	54.22/16	3.389

E.F →

M.F →

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Q- Na - 14.31%
S - 9.97%
H - 6.22%
O - 69.50%

Determine m.f. of compound if its molar mass is 322 gm/mol. assuming that all the hydrogen in the compound are present as water of crystallization.

Na_1 - 0.622 → 2
S_1 - 0.312 → 1
H_{20} - 6.22 → 20
O_{14} - 4.34 → 14

E.F → $N_2SH_{20}O_{14}$
M.F → $Na_2SO_4 \cdot 10H_2O$

Q. Which one of the following will have largest no. of atoms.

(1) 1g Au (197u)
(2) 1g Na (23u)
(3) 1g Li (7)
(4) 1g Cl_2 (71u)

Q- The empirical formula of a compound is CH_2. One mole has a mass of 42g. Its molecular formula is:

a) C_3H_6
b) C_3H_8
c) CH_2
d) C_2H_2

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Q- In 3 moles of C_2H_6, calculate the following:

(1) No. of moles of carbon atoms.

(2) No. of moles of hydrogen atoms.

(3) No. of molecules of ethane. → 18.06×10^{23} molecules

↳ (1) 6 moles of carbon atoms
(2) 18 moles of hydrogen atoms.
(3) 18.06×10^{23} molecules.

Doubt
Q- How many Al^{3+} are present in 0.051 g of Al_2O_3? → $2Al^{3+} + 3O^{2-}$

→ Moles = $\frac{0.051}{75 \times 1000}$ = 0.68×10^{-3}

No. of Al^{3+} ions = $0.68 \times 6.022 \times 10^{20}$
= $\boxed{4.095 \times 10^{20} \text{ ions}}$

Q- How would you prepare 2M 2000ml from 18M H_2SO_4?

→ $M_1V_1 = M_2V_2$

⇒ $2 \times 2000 = 18 \times x$
⇒ $x = \frac{2 \times 2000}{18}$ = $\boxed{222.22\,ml}$

Q- What volume of 10 M HCl and 3 M HCl should be mixed to get 1 L of 6 M HCl solution.

$\Rightarrow M_1V_1 + M_2V_2 = M_3V_3$

$\Rightarrow 10V_1 + 3V_2 = 6000$

$\Rightarrow 13 \times V = 6000$

$\Rightarrow V = \frac{6000}{13}$

$V_1 = \frac{6000}{10} = 600$ ml

$V_2 = \frac{6000}{3} = 2000$ ml

Let V_1 be x & V_2 be $1-x$

$10x + 3 - 3x = 6$

$7x = 3$

$x = \frac{3}{7}$

$\boxed{V_1 = \frac{3}{7} l \ \& \ V_2 = \frac{4}{7} l}$

Q- If the concentration of glucose ($C_6H_{12}O_6$) in blood is $0.9 g l^{-1}$. What will be the molarity of glucose in blood?

$\hookrightarrow M = \frac{0.9}{180} \times \frac{1000}{1000}$

$= \boxed{0.005 M}$

Q- $CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

What mass of $CaCO_3$ is reqd. to react completely with 25 ml of 0.75 M HCl. Doubt calculation mistake

Q- $MnO_2 + 4HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

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How many g of HCl reacts with 5 g of MnO_2. (8.3)

★ NORMALITY

$\rightarrow N = \frac{Wt}{Eq.\ Wt.} \times \frac{1000}{\text{Vol of solution (ml)}}$

$Eq.\ Wt = \frac{\text{Molar Mass}}{n}$

① n for acids $\rightarrow$ Basicity

$Eq.\ Wt.$ of $HCl = \frac{36.5}{1}$

$Eq.\ Wt$ of $H_2SO_4 = \frac{98}{2} = 49$

② n for bases $\rightarrow$ Acidity

• No. of OH^- ions that are replaceable.

③ n for salts $\rightarrow$ Total Cationic Charge

④ n for oxidising / reducing agent $\rightarrow$ no. of electrons reqd. for transfer of charge in oxidation / reduction.

Ch-2 → ATOMIC STRUCTURE

★ QUANTUM NUMBERS

(1) Principal → (n) – shell

→ n = 1, 2, 3 . . . 7

As, no. of shells is 7

(2) Angular → (l) – subshell [l = (n-1) . . . (n-7)]

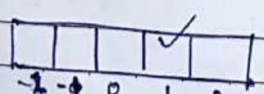
→ l = 0 → s
l = 1 → p
l = 2 → d
l = 3 → f
l = 4 → g
l = 5 → h

(3) Magnetic → (m) – orbitals

m → −l to l

n = 1, l = 0, m = 0.

n = 3, l = 2, m = +1



★ No. of electrons in a given subshell

→ $2(2l+1)$

l	subshell	electrons
0	s	$2e^-$
1	p	$6e^-$
2	d	$10e^-$
3	f	$14e^-$
4	g	$18e^-$
5	h	$22e^-$

★ Electronic Configuration of 21 – 30

21	Sc →	$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$	$4s^2\ 3d^1$	⇒ [Ar]	$3d^1 4s^2$
22	Ti →	[Ar]	$4s^2\ 3d^2$	⇒ [Ar]	$3d^2 4s^2$
23	V →	[Ar]	$4s^2\ 3d^3$	⇒ [Ar]	$3d^3 4s^2$
24	Cr →	[Ar]	$4s^2\ 3d^4$	→ [Ar]	$3d^5 4s^1$
25	Mn →	[Ar]	$4s^2\ 3d^5$	⇒ [Ar]	$3d^5 4s^2$
26	Fe →	[Ar]	$4s^2\ 3d^6$	⇒ [Ar]	$3d^6 4s^2$
27	Co →	[Ar]	$4s^2\ 3d^7$	⇒ [Ar]	$3d^7 4s^2$
28	Ni →	[Ar]	$4s^2\ 3d^8$	⇒ [Ar]	$3d^8 4s^2$
29	Cu →	[Ar]	$4s^2\ 3d^9$	⇒ [Ar]	$3d^{10} 4s^1$
30	Zn →	[Ar]	$4s^2\ 3d^{10}$	⇒ [Ar]	$3d^{10} 4s^2$

Exceptions★ Cr → [Ar] $3d^5 4s^1$ (attains extra stability in form of half-filled shell)
Cu → [Ar] $3d^{10} 4s^1$ (attains extra stability in form of full-filled shell)

Q – Why Cr has $3d^5 4s^1$ instead of $3d^4 4s^2$ & Cu has $3d^{10} 4s^1$ instead of $3d^9 4s^2$?

★ Number Of Unpaired Electrons

→

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1) $Cr^{+3} \rightarrow 3$
2) $Fe^{2+} \rightarrow 4$
3) $V^{+4} \rightarrow 1$
4) $Mn^{2+} \rightarrow 5$
5) $Ti^{+2} \rightarrow 2$
6) $S^{-2} \rightarrow 0$
7) $Ar \rightarrow 0$
8) $Ni^{+2} \rightarrow 2$

Q- (1) $n=3,\ l=0,\ m=0,\ s=-\frac{1}{2}$ 3s X

(2) $n=2,\ l=2,\ m=+2,\ s=+\frac{1}{2}$ X

(3) $n=4,\ l=1,\ m=0,\ s=+\frac{1}{2}$ 4p

(4) $n=3,\ l=1,\ m=0,\ s=0$ [3p] x

(5) $n=4,\ l=2,\ m=+1,\ s=-\frac{1}{2}$ 4d

X —— X —— X

Q- Atomic No. 52

(52 → [Kr] $5s^2\ 4d^{10}\ 5p^4$)

★ Electronic Configuration (1-20)

1. H - $1s^1$
2. He - $1s^2$
3. Li - $1s^2\ 2s^1$ → [He] $2s^1$
4. Be - $1s^2\ 2s^2$ → [He] $2s^2$
5. B - $1s^2\ 2s^2\ 2p^1$ → [He] $2s^2\ 2p^1$
6. C - $1s^2\ 2s^2\ 2p^2$ → [He] $2s^2\ 2p^2$
7. N - $1s^2\ 2s^2\ 2p^3$ → [He] $2s^2\ 2p^3$
8. O - $1s^2\ 2s^2\ 2p^4$ → [He] $2s^2\ 2p^4$
9. F - $1s^2\ 2s^2\ 2p^5$ → [He] $2s^2\ 2p^5$
10. Ne - $1s^2\ 2s^2\ 2p^6$
11. Na - $1s^2\ 2s^2\ 2p^6\ 3s^1$ → [Ne] $3s^1$
12. Mg - $1s^2\ 2s^2\ 2p^6\ 3s^2$ → [Ne] $3s^2$
13. Al - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$ → [Ne] $3s^2\ 3p^1$
14. Si - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$ → [Ne] $3s^2\ 3p^2$
15. P - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^3$ → [Ne] $3s^2\ 3p^3$
16. S - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$ → [Ne] $3s^2\ 3p^4$
17. Cl - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$ → [Ne] $3s^2\ 3p^5$
18. Ar - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
19. K - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ → [Ar] $4s^1$
20. Ca - $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$ → [Ar] $4s^2$

X —— X —— X —— X

★ Extra Q

6/5/24

1) What is the total no. of orbitals associated with principal quantum number $n=3$?

2) Among the following pairs of orbitals which orbital experience the larger effective nuclear charge?

(1) 2s & 3s (2) 4d & 4f (3) 3d & 3p

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3) How many electrons in an atom may have the following quantum number?

(1) $n=4$, $s=-\frac{1}{2}$ → 16

(2) $n=3$, $l=0$ → 2

4) The correct set of quantum numbers of the valence electrons of rubidium ($Z=37$) is:

(a) 5, 0, 0, $+\frac{1}{2}$

(b) 5, 1, 0, $+\frac{1}{2}$

(c) 5, 1, 1, $+\frac{1}{2}$

(d) 5, 0, 1, $+\frac{1}{2}$

5) Which of the following options does not represent ground state of an atom?

a) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^8\ 4s^2$

b) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^9\ 4s^2$

c) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^1$

d) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5\ 4s^1$

Q.6 Correct the following electronic configuration of the elements in ground state:

(1) $1s^2\ 2s^1\ 2p^6\ 3s^2\ 3p^1$ − $1s^2\ 2s^2\ 2p^6\ 3s^2$

(2) $1s^2\ 2s^1\ 2p^3$ − $1s^2\ 2s^2\ 2p^2$

(3) $1s^2\ 2s^1\ 2p^6\ 3s^2\ 3p^6\ 3d^5$ − $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^2$ $3d^5\ 4s^1$

(4) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$ − $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ ~~$4s^2\ 3d^4$~~

Q.7 The unpaired electrons in Al. & Si, are present in 3p orbital. Which electron will experience more effective nuclear charge from the nucleus? valence the electrons

Ans To Silicon will experience more effective nuclear charge as it have higher bonding than aluminium.

Q.8 Discuss the similarities and differences between 1s & 2s orbital?

→ Similarity − They have the same angular quantum number.

Difference − 2s is of larger size than 1s and 2s will experience ~~lesser nuclear charge than 1s~~

Q.9 An electron is in one of the 3d orbitals. Give the possible values of n, l, m.

→ n → 3, l → 2, m → −2, −1, 0, 1, 2

Q.10 A neutral atom of an element has 2K, 8L and 5M electrons. Find out the following.

(1) Atomic Number - 15
(2) Total s electrons - 6
(3) Total p electrons - 9
(4) No. of protons - 15
(5) Valency of the element - 3

x ——— x ——— x ——— x ——— x

* Electromagnetic Wave Theory

Imp

1 pm = 10^{-12} m
1 Å = 10^{-8} cm
= 10^{-10} m
1 nm = 10^{-9} m

→ When electrically charged particle moves under accelaration, alternating and magnetic fields are produced and transmitted. These are in the form of electromagnetic waves or radiations

(1) Wavelength - Distance between two consecutive crests or trough.

→ Represented by (λ) lambda. Units - Å, cm, m, nm, pm

(2) Frequency - It is defined as no. of waves passing through a point ~~per unit time~~ in 1 second.

→ Represented by nu (ν). Unit - Hertz.

1 Hertz = 1 cycle / 1 sec

(3) Velocity of a wave - It is defined as the linear distance travelled by a wave in 1 second.

→ Represented by (v) or (c) speed of light. Unit - m/s.

Relation b/w frequency, velocity and wavelength.

$$c = \lambda \nu$$

(4) Amplitude of a wave 'a' - It is the height of the crest or depth of trough.

→ Unit - metres. (length)

(5) Wave number ($\bar{\nu}$) - It is defined as the number of waves present in 1 cm length.

→ $$\bar{\nu} = \frac{1}{\lambda}$$

Q- Calculate wavenumber, frequency of yellow radiations having wavelength 5800 Å. Speed of light = 3×10^{8} m/s

→ $\cancel{\bar{\nu} = \frac{1}{5800} = 0.0152 \times 10^{-2} Å}$

$5800 Å = 5800 \times 10^{-10}$ m

$$\bar{\nu} = \frac{1}{5800\times10^{-10}} = \boxed{1.7\times10^{6}\ m^{-1}}$$

$$\nu = \frac{3\times10^{8}}{5800\times10^{-10}} = \frac{3\times10^{18}}{5800} = 0.0521\times10^{16} = \boxed{5.2\times10^{14}\ Hz}$$

Q- The Vividh Bharati Station

$\nu = 1368$ KHz
$= 1368 \times 10^3$ Hz

→ $\lambda = \frac{c}{\nu}$

$= \frac{8 \times 10^8}{1368 \times 10^3}$ $= 2.29 \times 10^2 = \boxed{229 \text{ m}}$

De-Broglie Equation

$\lambda = \frac{h}{mv}$ — (1)

$E = \frac{hc}{\lambda}$ — (2)

$E = mc^2$ — (3)

$E = h\nu$

$h = 6.626 \times 10^{-34}$ kgm²/s (Planck's Constant)

Heisenberg's Uncertainty Principle

→ $\Delta x \cdot p = \frac{h}{4\pi}$

$\boxed{\Delta x \cdot \Delta v = \frac{h}{4\pi m}}$

Q- Two particles A & B are in motion. If the wavelength associated with the particle is 5×10^{-8} m, Calculate wavelength of B if its momentum is half of A.

→ $\lambda_A = \frac{h}{P_A}$ $\lambda_B = \frac{h}{P_B}$

$\boxed{P_A = \frac{h}{\lambda_A}}$ — (1) $\boxed{P_B = \frac{h}{\lambda_B}}$ — (2)

ATQ, $P_B = \frac{1}{2} P_A$, So in (2),

∴ $\boxed{P_A = \frac{2h}{\lambda_B}}$ — (3)

⇒ $\frac{h}{\lambda_A} = \frac{2h}{\lambda_B}$

⇒ $\lambda_B = \frac{2h \times \lambda_A}{h}$

⇒ $\lambda_B = 2 \times 5 \times 10^{-8} = \boxed{10^{-7} \text{ m}}$

Q. Calculate wavelength of an electron with 1% of speed of light.

→ mass of $e^- = 9.1 \times 10^{-31}$ kg

$v = \frac{1}{100} \times 3 \times 10^8 = 3 \times 10^6$ m/s

$\lambda = \frac{h}{mv}$

$= \frac{6.626 \times 10^{-34}}{9.1 \times 10^{-31} \times 10^6 \times 3} = \boxed{0.24 \times 10^{-9} \text{ m}}$

or $\boxed{2.4 \times 10^{-10} \text{ m}}$

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Q- A golf ball has a mass 40g. At a speed of 45m/s. If the speed can be measured with an accuracy of 2%, calculate uncertainty in position.

$\Rightarrow \Delta x \cdot \Delta v = \frac{h}{4\pi m}$

Speed $= \frac{2}{100} \times 45 = \boxed{0.9}$

$\Rightarrow \Delta x \times 0.9 = \frac{6.626 \times 10^{-34} \times 10^{3}}{4 \times 3.14 \times 40}$

$\Rightarrow \Delta x = \frac{6.626 \times 10^{-31}}{0.9 \times 4 \times 3.14 \times 40} = 0.014 \times 10^{-31}$

$= \boxed{1.4 \times 10^{-33} m}$

Q. What must be velocity of beam electrons if they are to display 100 Å wavelength.

$\Rightarrow \lambda = \frac{h}{mv}$

$\Rightarrow E = \frac{hc}{\lambda}$ (1)

$\Rightarrow E = h\nu$ (2)

From (1) & (2),

★ The Periodic Table & Periodicity in Properties.

Modern Periodic Table - Henry Mosely & co.

- Characteristic of s-block elements (ns^{1-2})

→ Low ionization energy / enthalpy
→ Soft metals
→ monovalent and divalent elements
→ impart characteristic color to the flame
→ Molten or aqueous state
→ Act as strong reducing agent

- Characteristics of p-block elements (ns^2 & np^{1-6})

→ mainly non-metals
→ it forms covalent compounds
→ high ionization energy / enthalpy
→ p block elements smaller than s block
→ bad conductors.
→ Act as strong oxidising agent

- Characteristics of d-block element ($(n-1)d^{1-10}$ ns^{0-2})

→ their sizes are almost similar
→ they have low ionization energies
→ Act as catalysts
→ forms coloured compounds
→ tends to form alloys
→ They are paramagnetic in nature (having unpaired electrons)

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→ Group 15 → $ns^2 np^3$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow|\uparrow|\uparrow}$

Valency → -3

Covalency → $+3, +5$

Max covalency → ± 5

→ Group 16 → $ns^2 np^4$ $\boxed{\uparrow\downarrow}$ $\boxed{\uparrow\downarrow|\uparrow|\uparrow}$

Valency → -2

Covalency → $+2, +4, +6$

Max Covalency → $+6$

Q. ~~then~~ f-block elements $\left((n-2)f^{1-14}(n-1)d^{0-1} ns^2\right)$

→ most of the elements are radioactive
→ they tend to form complexes

X ——— X ——— X ——— X

- Atomic Radii

→ "The distance from the center of the nucleus of an atom to its outermost shell."

Factors → (1) Number of shells $\propto$ atomic radius

(2) Nuclear charge $\propto \dfrac{1}{\text{atomic radius}}$

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(a) Ionic radius

→ All cations have a smaller size (radius) than their atoms.
Eg. $Na^+ < Na$

→ All anions have larger size (radius) than their atoms.
Eg. $Cl < Cl^-$

→ Cationic charge $\propto \dfrac{1}{\text{radius}}$

→ Anionic charge $\propto$ radius

Q. Indicate which order of relative sizes is incorrect.

1) $Li < Na < K$ ✓

2) $Mg < Al < Na$ ✗

3) $C < Si < Al$ ✓

4) $P < As < Se$ ✗

5) $F < Cl < Br$ ✓

6) $Na^+ < Mg^{+2} < Al^{+3}$ ✗

Q. Arrange:

1) Ar , K^+, Cl^-, S^{2-}

→ ~~Ar > S^{2-} > Cl^- > K^+~~

→ K^+ < Ar < Cl^- < S^{2-}

b) Covalent radii : $\frac{1}{2}$(Internuclear distance of two covalently bonded atoms)

(2) Ionization Enthalpy

→ The energy required to remove an electron from the neutral gaseous atom to acquire positive charge.

$$M_{(s)} \xrightarrow{\text{Sublimation Enthalpy}} M_{(g)} \xrightarrow{I.E} M^+_{(g)}$$

- Factors affecting I.E :

a) Number of shells $\propto \frac{1}{I.E}$

b) Nuclear charge $\propto$ I.E

c) Shielding effect $\propto$ I.E (s > p > d > f) ← I.E. increase

d) Penetration effect $\propto$ I.E (s > p > d > f)

c) Electronic Configuration → Full filled & half filled subshell and noble gases have higher I.E than adjacent element.

Eg. Li Be B C N O F Ne

→ Li < B < Be < C < O < N < F < Ne

→ I.E increase

★ Electron Gain Enthalpy (ΔH_{eg})

→ $X_{(g)} + 1e^- \longrightarrow X^-_{(g)}$

- First ΔH_{eg} is always negative, as energy is released.

- $EA_1 > EA_2 > EA_3$ ...

→ This is because

Exception

O	F
S	Cl
Se	Br
Te	I
Po	At

→ ~~Sulphur & Oxygen & Chlorine are less negative~~

→ O & F are very small in size. Thus, when an elctn is added, electron density increases, thus electron-electron repulsion increases, so electron affinity decreases.

★ Electronegativity

→ Tendency of an element to pull the shared pair of electrons towards itself.

★ Metallic & Non-metallic character

→ Metallic Character – Tendency to lose electrons.
– Shows metallic properties.

→ Non Metallic Character – Tendency to gain electrons
– Shows non-metallic properties

Across period (L-R) → M.C ↓, N.M.C ↑

Down the group (U-D) → M.C ↑, N.M.C ↓

★ Valency → combining capacity of an element.

→ Across period (L-R) → Increases.
Down the group (T-B) → Remains same.

★ Nature of oxides :-

Metal + Oxygen → Metal Oxide

Non-metal + Oxygen → Non-metal oxide

$MO + H_2O \rightarrow MOH$ (Basic)

$NMO + H_2O \rightarrow NMOH$ (acidic)

★ Oxyacids – $HNO_3, H_2SO_4, HClO_4, H_3PO_4$

★ Mineral Acid – HCl

★ Eg. $Na + O_2 \rightarrow Na_2O \xrightarrow{+H_2O} NaOH$ (basic)

$SO_3 + H_2O \rightarrow H_2SO_4$ (~~Basic~~ Acidic)

$P_4 + O_2 \rightarrow P_2O_3 \xrightarrow{H_2O} H_3PO_3$ (Acidic)

★ Reducing & Oxidising ~~Agent~~ Nature

→ Down the group → Oxidising nature ↓ Reducing nature ↑
Across the period → Oxidising nature ↑ Reducing nature ↓

Q. Among the elements of second period, pick out element.

1) First highest I.E. → ~~Fluorine~~ Neon
2) Highest Electronegativity → Fluorine
3) Largest atomic radii → ~~Neon~~ Lithium
4) Most reactive non-metal → Fluorine
5) Highest electron gain enthalpy → Fluorine
6) Least reactive element → Neon

Q. Atomic number of three element A, B & C are Z-2, Z & Z+1 resp. B is an inert gas.

(1) Which one is most electronegative? → A
(2) Highest ionization enthalpy? → B
(3) Write down the formula of the compound obtained by A&C?

→ C → +1 A → -2

$\boxed{\text{Formula} \rightarrow AC_2}$

Q. The elements Na, Mg, Al, Si, P, S, Cl and Ar are arranged in the periodic table. Pick out :

① highest first IE ? → Ar
② highest EN ? → Cl
③ largest atomic radii ? → Na
④ most reactive non metal ? → Cl
⑤ Highest ΔH_{eg} ? → Cl
⑥ Gases at room temp → ? ~~S, Cl~~ Ar, Cl

Q → 2 elements A & B, atomic no. 16 & 19.

S K

① Write electronic configuration of A & B.

(A) S = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^4$
(B) K = $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$

② Which element belongs to p-block ? → A

③ Which element is more powerful reducing agent → B

④ Formula of compound between A & B → B_2A

Q. Name elements

① $1s^2\ 2s^2\ 2p^6\ 3s^2$ → Mg
② $1s^2\ 2s^2\ 2p^6$ → Ne
③ $1s^2\ 2s^2\ 2p^2$ → C
④ $1s^2\ 2s^2\ 2p^6\ 3s^1$ → Na
⑤ $1s^2\ 2s^2\ 2p^5$ → F

(1) Highest I.E → (IV) Na

(2) a halogen ? → (V) F
(3) valency of 1 ? → ~~None~~ (V) F, (IV) Na

Q. Arrange in increasing order of ΔH_{eg}.

F, O, S, Cl

O F
S Cl

→ ~~S, O, Cl, F~~ ~~O<S<F<Cl~~

→ S, O, F, Cl

Q. Which of the following compound is amphoteric

→ ① Cl_2O_7
② As_2O_3 ✓
③ Al_2O_3 ✓
④ Na_2O

$Al_2O_3 + HCl \rightarrow AlCl_3 + H_2O$

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Q Highest acidic character

① SO_3 ✓
② P_2O_5
③ ZnO
④ Na_2O

More covalency → Higher acidic character

Least valency → High basic character

5-7-24

* Ch-4 → Chemical Bonding & Molecular Structure

* Chemical Bond - Force of attraction between two or more atoms which keeps them bonded together.

Eg $MgCl_2$

→ Mg → $1s^2 2s^2 2p^6 3s^2$ → $Mg^{2+} + 2e^-$

~~$2Cl_{(g)} + 2e^- \rightarrow 2Cl^-_{(g)}$~~ $Cl_2^-{}_{(g)}$

$2Cl_{(g)} + 2e^- \longrightarrow 2Cl^-_{(g)}$

$Mg^{2+} + 2Cl^- = MgCl_2$

* Ionic Bond

→

* Covalent Bond → mutual sharing of electrons between two or more same or different atoms.

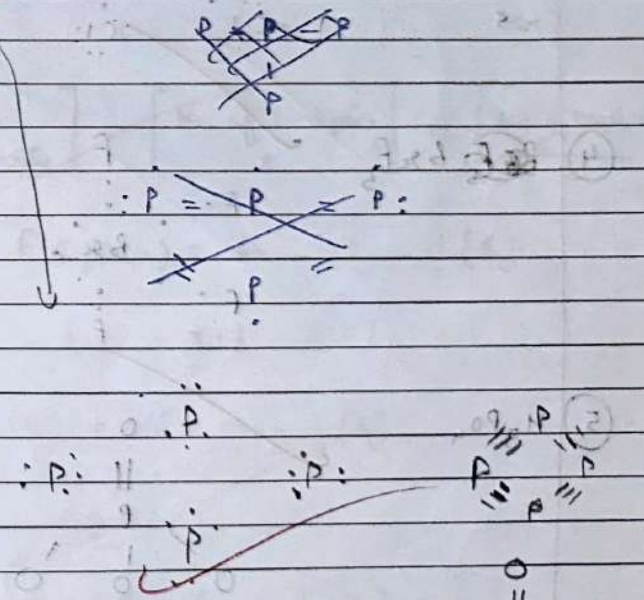
Lewis Dot Structure

→ Cl_2 → :Cl· ·Cl: → :Cl–Cl:

→ O_2 → :Ö: :Ö: → Ö=Ö

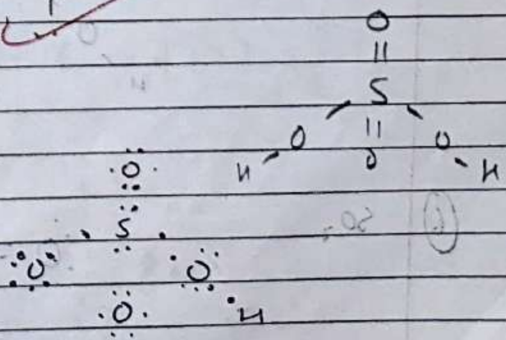
→ N_2 → :N: :N: → N≡N

→ P_4 →

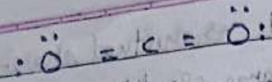


Heteroatomic Molecule

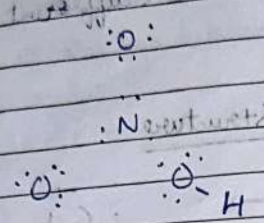
Eg. H_2SO_4 →



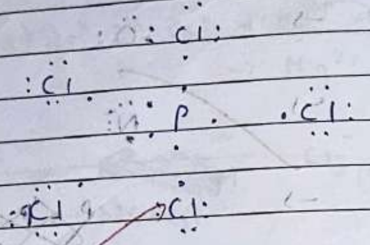
(1) CO_2 –



(2) HNO_3 –

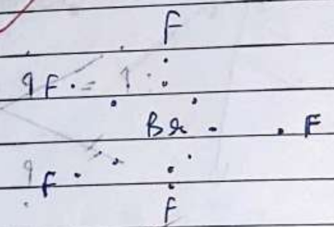


(3) PCl_5 –

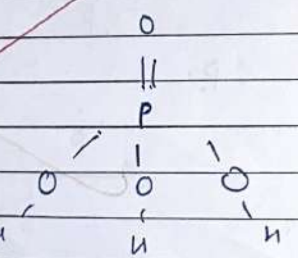


$\frac{2 \times n}{2}$ ... (5+5) = 5

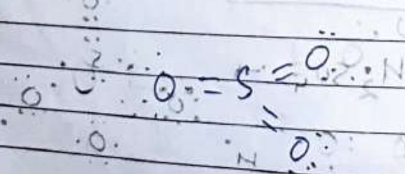
(4) BrF_5



(5) H_3PO_4



(6) SO_3

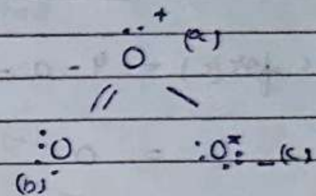


- Failure of octet rule

→ Sidgwick Powell Theory – Singlet & duplet linkage

- Ions

Eg O_3 →



Formal Charge

$$\left[\frac{\text{No. of valence}}{e^- \text{ in neutral state}}\right] - \left[\text{No. of lone pair } e^-\right] - \left[\frac{\text{No. of bond pair } e^-}{2}\right]$$

→ O_3 → F.C for (a) $= 6 - 2 - \frac{1}{2}[6]$

$= +1$

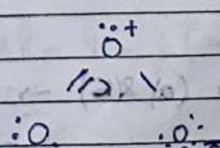
→ F.C for (b) $= 6 - 4 - \frac{1}{2}[4]$

$= 0$

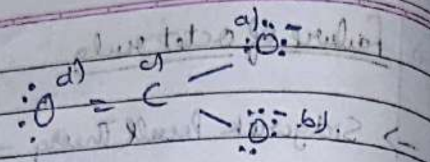
→ F.C for (c) $= 6 - 6 - \frac{1}{2}[2]$

$= -1$

∴, Structure ⇒



Eg → CO_3^{2-} →



→ FC for (a) & (b) = $6 - 6 - \frac{1}{2}(2)$

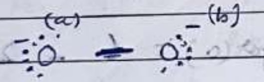
$= \boxed{-1}$

→ F.C for (c) = $4 - 0 - \frac{1}{2}(8)$

$= 0$

→ F.C for (d) = $6 - 4 - \frac{1}{2}(4)$

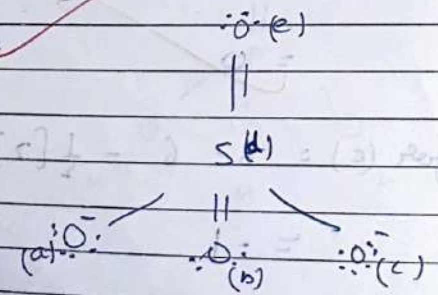
Eg O_2^{2-} →



F.C for (a) & (b) → $6 - 6 - \frac{1}{2}(2)$

→ $\boxed{-1}$

Eg SO_4^{-2}



→ F.C for (a) & (b) → $6 - 6 - \frac{1}{2}(2)$

→ $\boxed{-1}$

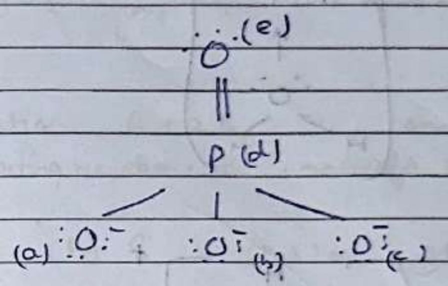
→ F.C for (b) & (c) = $6 - 4 - \frac{1}{2}(4)$

$= 0$

→ FC for (d) → $6 - 0 - \frac{1}{2}[12]$

→ 0

Eg PO_4^{-3}



→ F.C for (a),(b) & (c) → $6 - 6 - \frac{1}{2}(2)$

→ $\boxed{-1}$

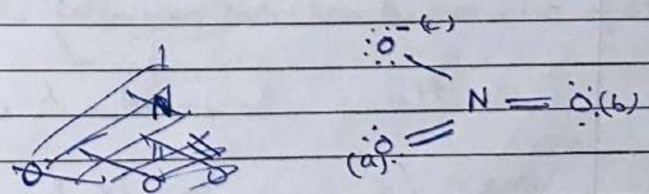
→ F.C for (d) → $5 - 0 - \frac{1}{2}(10)$

→ 0

→ F.C for (e) → $6 - 4 - \frac{1}{2}(2)$

→ 0

Eg → NO_3^{-1}



→ F.C for (a) & (b) → $6 - 4 - \frac{1}{2}[4]$

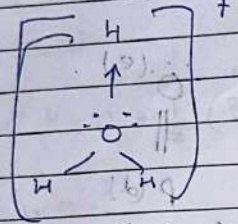
→ F.C for N = $5 - 0 - \frac{1}{2}(10) = 0$ → 0

→ F.C for (c) → $6 - 6 - \frac{1}{2}[2] = \boxed{-1}$

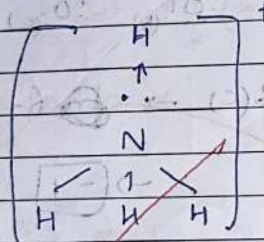
☆ Coordinate Bond (↑)

→ Bond formed by donating lonepair of electrons.

Eg. $H_2O + H^+ \rightleftharpoons H_3O^+$



Eg $NH_3 + H^+$



Revision

① Which has max no. of molecules ?

a) 44g CO_2 → $\frac{44}{44}$ 1   (c) 8g H_2 4

b) 44g O_2 $\frac{44}{32}$ = 1.3   (d) 64g SO_2 1

② For reaction $A + 2B \rightarrow C$, amount of C formed by starting reaction with 5 moles of A & 8 moles of B.

(a) 5   (b) 8   (c) 16   (d) 4

~~$A + 2B \rightarrow C$~~
~~5   8   →   ?~~
5   4   → ?

③ The no. of oxygen atoms in 4.4g of CO_2 is equal to :

a) 1.2×10^{23} b) 6×10^{22}

c) 6×10^{23} d) 12×10^{23}

④ Which of the following pairs have the same no. of atoms

① 16g O_2 & 4g H_2 a) I & II

② 16g O_2 & 44g CO_2 b) II & III

③ 28g N_2 & 32g O_2 c) III & IV

④ 12g C & 23g Na   d) I & IV

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(5) The volume of 34g of NH_3 at STP is (NH_3 = 17g/mol)

(a) 22.4 L ~~(b)~~ 44.8 L (c) 11.2 L (d) 67.2 L

(6) The amount of $C_{12}H_{22}O_{11}$ (342) required to prepare 2 L of $\frac{M}{10}$ soln is:

a) 342g b) 171g ~~c)~~ 68.4g d) 34.2g

$\Rightarrow \frac{1}{10} = \frac{m}{342 \times 2}$

$\Rightarrow m = \underline{68.4}$

(7) Which of the following set of quantum numbers represents the higher energy level in an atom?

a) $n = 3,\ l = 1,\ m = -1,\ s = +\frac{1}{2}$

~~b)~~ $n = 3,\ l = 2,\ m = -1,\ s = +\frac{1}{2}$

c) $n = 4,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

d) $n = 3,\ l = 0,\ m = 0,\ s = +\frac{1}{2}$

(8) If $n = 3, l = 0, m = 0$, for valence electrons of elements A & B, the atomic numbers of A & B respectively are:

~~a)~~ 11,12 b) 12,13 c) 13,14 d) 10,11

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(9) What is de Broglie wavelength of a man of 66 kg skiing down Kufri hill at a velocity of 1×10^3 m/s.

$$\lambda = \frac{h}{mv}$$

$$= \frac{6.6 \times 10^{-34}}{66 \times 10^3} \qquad (c) \boxed{1 \times 10^{-38} m}$$

(10) Which of the following elements contains maximum number of unpaired electrons.

a) Mn → [Ar] $3d^5 4s^2$

b) Fe → [Ar] $3d^6 4s^2$

~~c)~~ Cr → [Ar] $3d^5 4s^1$

d) Ni → [Ar] $3d^8 4s^2$

(12) The electronic configuration of Pd(46) is

→ ~~(a)~~ [Kr] $5s^2\ 4d^8$ $4s^2 4p^6$

~~(b)~~ [Kr] $5s^0\ 4d^{10}$

(c) [Kr] $5s^1\ 4d^{10}$

(d) [Kr] $5s^0 4d^8$

32

(13) Which of the following has max difference in 1st & 2nd ΔH_i?

a) $1s^2\ 2s^2\ 2p^4$

b) $1s^2 2s^2 2p^6 3s^2$

~~c)~~ $1s^2\ 2s^2\ 2p^6\ 3s^1$

d) $1s^2\ 2s^2\ 2p^6$

Q. ① 3, 33, 53, 87 ⇒

② 2, 10, 22, 36 ⇒

③ 7, 17, 25, 37, 48 ⇒

④ 9, 35, 51, 88 ⇒

a) I & II   b) II & III   (c) III & IV   (d) I & IV

Q. Increasing ionic size: $Al^{3+}, Mg^{2+}, Na^{+}, F^{-}$ ✓

First I.E → B, C, N, O ✗

I, Br, Cl, F → Electron gain enthalpy ✗

Li, Na, K, Rb → Metallic Character ✓

* Hybridisation

No. of bonds	Type of hybridisation
2	sp
3	sp^2
4	sp^3
5	sp^3d
6	sp^3d^2
7	sp^3d^3

⇒ Increasing s ratio → more acidic character

Eg. sp hybrid has more acidic character than sp^2 hybrid

Eg. *) $\underset{sp^3}{CH_3} - \underset{sp}{C} \equiv \overset{sp}{C} - \overset{sp^2}{C}(=O) - \overset{sp^3}{CH_2}OH$

*) $\overset{sp^3}{CH_3} - \overset{sp^2}{CH} = \overset{sp^2}{CH} - \overset{sp^3}{CH_2} - \overset{sp}{C} \equiv \overset{sp}{CH}$

*) $\overset{sp^3}{CH_3} - \overset{sp^3}{CH}(OH) - \overset{sp^2}{COOH}$

Q. Predict hybridization:

① BF_3 (sp^2), NH_3 (sp^3), H_2O (sp^3), SF_2 (sp^3), SF_4 (sp^3d), SF_6 (sp^3d^2), PCl_3 (sp^3), PCl_5 (sp^3d), SO_2 (sp^2), SO_3 (sp^2), H_2SO_4 (sp^3), HNO_3 (sp^2), ClF_3 (sp^3d), BrF_5 (sp^3d^2), IF_7 (sp^3d^3), $BeCl_2$ (sp), CO_2 (sp), XeF_2 (sp^3d), XeF_4 (sp^3d^2), XeF_6 (sp^3d^3), XeO_3 (sp^3), $XeOF_4$ (sp^3d^2)

Cl_2O_7 (sp^3), $HClO_4$ (sp^3), $HClO$ (sp^3), CO_3^{-2} (sp^2), NO_3^{-1} (sp^2), PO_4^{-3} (sp^3)

~~Cl — Be — Cl~~

→ H_2SO_5 (sp^3), $H_2S_2O_7$ (sp^3), H_2SO_3 (sp^3), $H_2S_2O_8$ (sp^3)

* Geometry of Molecules

→ Hybridisation	Geometry
sp	Linear
sp^2	Trigonal Planar
sp^3	Square Planar, Tetrahedral
sp^3d	Trigonal Bipyramidal
sp^3d^2	Octahedral
sp^3d^3	Pentagonal ~~Tetrahedral~~ Bipyramidal

Ilar
12.7.24

* RESONANCE

→ Resonating structure

NO_2, CO_2 & N_2O : $O = \overset{+}{C} - O^-$

$:N \equiv \overset{+}{N} - \ddot{O}:$

$O = N - O^-$

→ CO → $^-C \equiv \ddot{O}^+$ $^-C :\,: \ddot{O}^+$

☆ Bond Parameters

1) Bond length
2) Bond energy / enthalpy / dissociation enthalpy
3) Bond angle
4) Bond order

☆ Hydrogen Bonding

→ Bond formed between hydrogen and highly electronegative atom (F, O, N).

Req. → ① Highly electronegative atom
② Small atom.

→ Consequences: ① Extremely soluble
② Boiling point & melting point is higher.

◦ Types: 1) Intermolecular → between two molecules
2) Intramolecular → within a molecule.

◦ Intermolecular H-bonding: In alcohol group

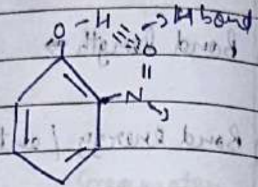
Eg. R − O - - - H − O - - - H − O (with H, R, R attached below the O atoms)

H-bond

Eg. R − O - - - H − O (with H below each O)

→ Intramolecular H bonding

Eg Orthonitrophenol



★ Molecular Orbital Theory (Linear Combination of Atomic Orbitals)
LCAO

→ Two types of atomic orbitals : ① BMO → Bonding Molecular Orbital
② ABMO → Antibonding Molecular Orbital

→ Represented by σ, π and

BMO ABMO

Eg $\sigma 1s$, $\sigma^* 1s$
$\sigma 2s$, $\sigma^* 2s$
$(\pi 2p_x = \pi 2p_y)$, $(\pi^* 2p_x = \pi^* 2p_y)$

→ Follow all the given laws for arrangement. (Pauli, Aufbau, Hund's)

→ Arrangement : for molecules having <14e⁻.
→ $\sigma 1s, \sigma^* 1s, \sigma 2s, \sigma^* 2s, (\pi 2p_x = \pi 2p_y), \sigma 2p_z, (\pi^* 2p_x = \pi^* 2p_y)$

Eg N_2 → $\sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, (\pi 2p_x^2 = \pi 2p_y^2),$
$\sigma 2p_z^2$.

→ Bond order = $\frac{1}{2}$(No. of bonding − No of antibonding)

$= \frac{1}{2}(10 - 4) = \underline{\underline{3}}$

→ It has diamagnetic behaviour.

★ Bond order ∝ Stability
∝ B.D.E
∝ $\frac{1}{\text{Bond length}}$

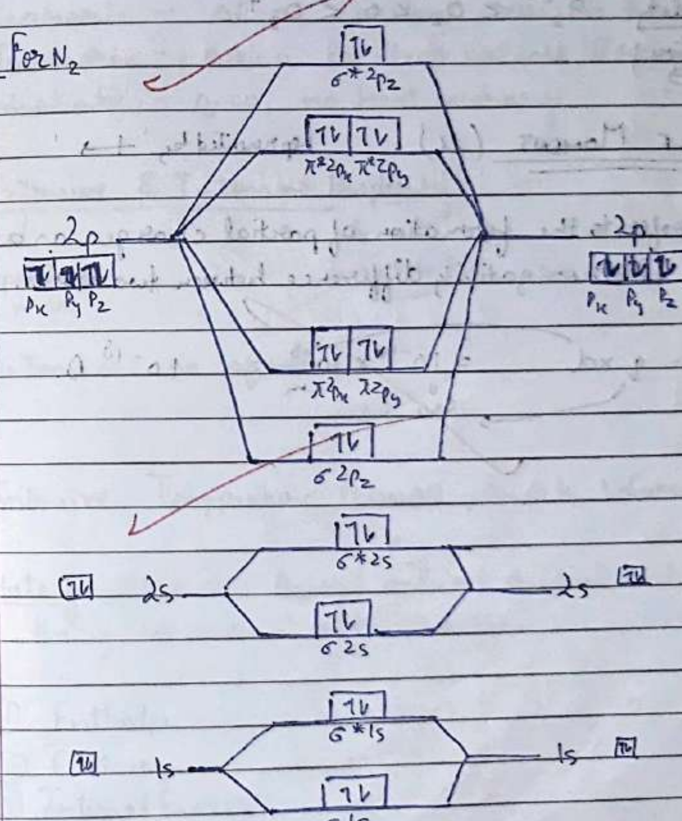
Eg N_2^+ → $B.O = \frac{1}{2}(9-4) = 2.5$
→ Paramagnetic

N_2^- → $B.O = \frac{1}{2}(10-5) = 2.5$
→ Paramagnetic

N_2^{2-} → $B.O = \frac{1}{2}(10-6) = 2$
→ Paramagnetic

Stability → $N_2^{2-} < N_2^- < N_2^+ < N_2$
(increasing order)

Diagram For N_2



magnetic moment $\mu = \sqrt{n(n+2)}$

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Eg $O_2 = \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2 (\pi 2p_x^2 = \pi 2p_y^2), (\pi^* 2p_x^1 = \pi^* 2p_y^1)$

→ Bond order = $\frac{10 - 6}{2} = \underline{\underline{2}}$

→ Paramagnetic

$O_2^- \Rightarrow B.O = 1.5$ (Paramagnetic)
$O_2^+ \rightarrow B.O = 2.5$ (Paramagnetic)
$O_2^{2-} \rightarrow B.O = 1$ (Dimagnetic)

Stability: $O_2^{2-} < O_2^- < O_2 < O_2^+$
(increasing) →

* **DIPOLE MOMENT (μ)** Represented by '$\leftarrow\!\!\!+$'

→ It refers to the formation of partial charges as a result of electronegativity difference between two atoms.

→ $\mu = q \times d = 10^{-10} \times 10^{-8} = 10^{-18}$ D.
esu, cm

Zeroth Law → Heat flow from high temp to low temp.

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* **THERMODYNAMICS**

↳ System + Surrounding = Universe
↳ Open system – Mass & energy exchange
↳ Closed system – Only energy exchange
↳ Isolated system – No exchange.

- Types of thermodynamic processes:

1. Isothermal – $\Delta T = 0$, constant temperature throughout.
2. Isobaric – $\Delta P = 0$, constant pressure throughout.
3. Isochoric – $\Delta V = 0$, constant volume throughout.
4. Adiabatic – $q = 0$, no heat exchange.

☆ Extensive & Intensive Property
Extensive ↓ Dependent on mass
Intensive ↓ ~~Independent of mass~~

Eg Extensive: no. of moles,

Intensive: Temperature, Pressure, Density, Volume

- State functions → Depend only on initial and final state of the system and not on the process.

1. Enthalpy
2. Entropy
3. Internal Energy
4. Gibb's Free Energy
5.

★ **Internal Energy (U)** → The total energy stored in the system.

$$\boxed{U_1} \xrightarrow{+q} \boxed{U_1 + q} \xrightarrow{+w} \boxed{U_1 + q + w}$$

U_1 $\qquad$ U_2

$\therefore \boxed{\Delta U = q + w}$ — imp

Sign Convention

Exothermic → $-q$

Endothermic → $+q$

Work done by system → $-w$

Work done on system → $+w$

★ **Enthalpy (H)** → The heat content present with a system.

$$\boxed{H = U + PV}$$

→ $H_1 = U_1 + PV$

→ $H_2 = U_2 + PV$

→ $H_2 - H_1 = U_2 - U_1 + P\Delta V$

⇒ $\Delta H = \Delta U + P\Delta V$

Also ; $W = -P_{ext}\Delta V$

⇒ $\Delta H = q + w - \cancel{w}$

⇒ $\boxed{\Delta H = q}$

★ **Boyle's Law**

→ $P \propto \frac{1}{V}$

⇒ $P = \frac{k}{V}$ $\qquad$ Also by $\boxed{P_1V_1 = P_2V_2}$

⇒ $PV = k$ —(1)

→ **Charles Law**

→ $V \propto T$

→ $V = kT$

→ $\frac{V}{T} = K$ —(2)

From (1) & (2), $PV = KT$

$\therefore PV = nRT$ (imp)

$\therefore P\Delta V = \Delta n_{(g)} RT$

$R = 0.0821$ L atm/mol K
$= 0.083$ bar dm^3/mol K
$= 8.314$ J/K mol
$= 1.987$ cal/K mol

Q. The reaction of cyanamide $NH_2CN_{(g)}$ was carried out with oxygen and ΔU was found to be 742 kJ/mol. Calculate ΔH for reaction at 298K.

$$NH_2CN_{(s)} + \frac{3}{2}O_{2(g)} \rightarrow N_{2(g)} + CO_{2(g)} + H_2O_{(l)}$$

→ $\Delta H = \Delta U + n_{(g)}RT$

⇒ $\Delta H = 742 + \left(\frac{1}{2}\right) \times 8.314 \times \overset{149}{\cancel{298}} \times 10^{-3}$

~~⇒ $\Delta H = 742 + 870$~~

~~⇒ $\Delta H = -128$ kJ/mol~~ $\qquad$ ~~$\Delta H = 0$~~

~~⇒ $\Delta H = 1612$ kJ/mol~~

~~$\Delta H = 1.612$ kJ/mol~~

$\Delta H = 742 + 8.7$

$\boxed{\Delta H = 750.7}$ kJ/mol

$\Rightarrow \Delta H = 742 + 1.2 = \boxed{1743.2 \text{ kJ/mol}}$

* Types of Enthalpies

$\boxed{\Delta H = \Delta H^\circ_p - \Delta H^\circ_r}$ → Sum of ΔH° of product — Sum of ΔH° of reactants

Eg. $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$

$C_4H_{10} + \frac{13}{2} O_2 \rightarrow 4CO_2 + 5H_2O$

$\rightarrow \Delta H = [4\Delta H^\circ_{f\,CO_2} + 5\Delta H^\circ_{f\,H_2O}] - [\Delta H^\circ_{f\,C_4H_{10}}]$

Q- Calculate the enthalpy change for formation of C_2H_5OH:

(1) $C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$ $\quad \Delta H = x = -1368$ kJ

(2) $C + O_2 \rightarrow CO_2$ $\quad \Delta H = y = -393$ kJ

(3) $H_2 + \frac{1}{2}O_2 \rightarrow H_2O$ $\quad \Delta H = z = -286$

$\rightarrow x = (2y + 3z) - \Delta H^\circ_{f\,C_2H_5OH}$

$\Rightarrow \boxed{\Delta H^\circ_{f\,C_2H_5OH} = 2y + 3z - x}$

$\Rightarrow \Delta H^\circ_{f\,C_2H_5OH} = 2(-393) + 3(-286) + 1368$

$= -786 - 858 + 1368$

$= -1644 + 1368$

$= -276$ kJ

286
× 3
858
+786
1644

1644
−1368
276

Q. Calculate the enthalpy of combustion of glucose ($C_6H_{12}O_6$) from the following data:

ΔH°_f glucose $= -435$ kJ

$\Delta H^\circ_f\, CO_2 = -380$ kJ

$\Delta H^\circ_f\, H_2O = -275$ kJ

$\rightarrow 6C + 12H + 3O_2 \longrightarrow C_6H_{12}O_6$

$C + O_2 \rightarrow CO_2$

$H_2 + \frac{1}{2}O_2 \rightarrow H_2O$

275
×12
550
275
3300

$\rightarrow \Delta H^\circ_c$ glucose $= 6(-380) + 12(-275) + 435$

$= -2280 - 3300 + 435$

$= -5580 + 435 = \underline{-5145 \text{ kJ}}$

5580
− 435
5145

Q. Calculate ΔH_f of anhydrous Al_2Cl_6:

$2Al + 3Cl_2 = Al_2Cl_6$

(1) $2Al_{(s)} + 6HCl_{(aq)} \rightarrow Al_2Cl_{6(aq)} + 3H_{2(g)}$ $\quad \Delta H = -1004$ kJ

(2) $H_2 + Cl_2 \rightarrow 2HCl$ $\quad \Delta H = -184$ kJ

(3) $HCl_{(g)} + aq \rightarrow HCl_{(aq)}$ $\quad \Delta H = -73$ kJ

(4) $Al_2Cl_{6(s)} + aq \rightarrow Al_2Cl_{6(aq)}$, $\Delta H = -642$ kJ

$\Rightarrow$ ~~$\Delta H^\circ_f\, Al_2Cl_6 = \Delta H^\circ_f\, 2Al = -1004 + 3(-184) + 6(73)$~~

~~$= -1004 - (-552 + 438 - 642)$~~

~~$= -1004 - (-1194 + 438)$~~

$= -1004 + 756 = -248$ kJ

$\Rightarrow$ $\cancel{-248}$ $\Delta H_f^\circ \; Al_2Cl_6 = -248\ kJ$

① → $2Al + 6HCl \rightarrow Al_2Cl_{6(aq)} + 3H_2$ $\quad -1004\ kJ$
② → $3H_2 + 3Cl_2 \rightarrow 6HCl$ $\quad 3(-184)$
③ → $6HCl + aq. \rightarrow 6HCl_{(aq)}$ $\quad 6(-73)$
④ → $Al_2Cl_{6(aq)} \rightarrow Al_2Cl_{6(s)} + aq.$ $\quad -642$

→ $2Al + 3Cl_2 \rightarrow Al_2Cl_{6(s)}$

→ ~~-1004 - 552~~

$\Rightarrow \Delta H = -1004 - 552 + 6(-73) + 642$
$= -1352\ kJ$

* Bond Enthalpy

→ $\boxed{\Delta H = BE_R - BE_P}$

Q. Calculate enthalpy change for the following reaⁿ:

→ $CH_2 = CH_2 + 3O_2 \rightarrow 2CO_2 + 2H_2O$

C−H = 413
C=C = 619
O=O = 494
C=O = 787
O−H = 463

$\Delta H = [4(413) + 619 + 3(494)] - [4(787) + 4(463)]$

$= [1652 + 619 + 1482] - [3148 + 1852]$

$= 3753 - 5000 = -1247\ kJ/mol$

3850 − 2753 = 927	1652 + 1482 = 3134 + 619 = 3753
5000 − 2753 = 2247	3148 + 1852 = 5000
2828 + 1852 = 3680	

Q. Calculate ΔH,

$CH_3 - CH_3 + Cl_2 \rightarrow CH_3CH_2Cl + HCl$

C−C = 347 $\qquad$ H−Cl = 431
C−H = 413 $\qquad$ C−Cl = 328
Cl−Cl = 242

$\rightarrow \Delta H = [6(413) + 347 + 242] - [3(413) + 347 + 2(413) + 328 + 431]$

$\Rightarrow = [2478 + 589] - [1239 + 347 + 826 + 328 + 431]$

$\Rightarrow = 3067 - 3171 = -104\ kJ$

2478 + 589 = 3067
1239 + 347 = 1586 + 826 = 2412 + 328 = 2740 + 431 = 3171
3171 − 3067 = 104

× —— × —— × —— × —— ×

* Spontaneous & Non Spontaneous Processes

↳ Processes which take place on their own, without any help from external agents, are called a spontaneous reaction / process. (under given set of conditions)

↳ Processes which don't take place on their own, without any help from external agents, are called non-spontaneous processes. (Under given set of conditions)

• Enthalpy change of a Spontaneous reaction (Spontaneity)

$NH_{3(g)} + HCl_{(g)} \rightarrow NH_4Cl_{(s)} \Rightarrow \Delta H = -ve$

$NaOH + HCl \rightarrow NaCl + H_2O \Rightarrow \Delta H = -ve$

Exothermic − Spontaneous →
Some Endothermic − Spontaneous } ΔH not enough to determine spontaneity

* ENTROPY → Degree of randomness / disorder. 'S'

Q. To predict sign of entropy change: Entropy ∝ Spontaneity

* Factors Affecting Randomness

(1) Physical State → Gas > Liquid > Solid
← Increasing randomness

(2) Temperature → Temp. ∝ Randomness

(3) Pressure → Pressure ∝ $\frac{1}{\text{Randomness}}$

(4) Dissolution → Increases randomness.

Q. Predict the sign of ΔS :

(1) Burning of rocket fuel → ΔS = +ve

(2) Crystallization of solid from aq. soln → ΔS = -ve

(3) $NH_4Cl_{(s)} \longrightarrow NH_4Cl_{(aq)}$ → ΔS = +ve

(4) Melting of ice → ΔS = +ve

Math Repres → $\Delta S = \frac{\text{heat gained}}{\text{rise in temp}} = \frac{q}{\Delta T}$

→

- Heat Capacity → Amount of heat required to raise the temperature of a system by 1K.

- Sp. Heat Capacity → Amount of heat required to raise the temperature of 1g substance by 1K.

- Mol. Sp. Heat Capacity → Amount of heat required to raise the temperature of 1 mole substance by 1K.

* Entropy Change & Spontaneity

For isothermal → $\Delta S = \frac{q}{T}$

Q A heated copper block at 130°C (403K) loses 340 J of heat to the surroundings which are at 32°C (305K). Calculate: ① ΔS of system
② ΔS surrounding
③ ΔS universe

① $\Delta S_{sys} = \frac{-340}{403} = -0.84$ J/K

② $\Delta S_{surrounding} = \frac{+340}{305} = 1.11$ J/K

③ $\Delta S_{universe} = \frac{-340}{403} + \frac{340}{305}$

$= 340\left(\frac{-305+403}{403\times305}\right)$

$= 340\left(\frac{98}{403\times305}\right) = +0.27$ J/K

$403 - 305 = 98$

$1.11 - 0.84 = .27$

Adsorption →

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* **Second Law of Thermodynamics**

(1) "All spontaneous processes are thermodynamically irreversible."

(2) "Without help of external agency, a spontaneous process cannot be reversed."

(3) "All spontaneous processes are accompanied by a net increase of entropy."

(4) "The entropy of the universe is constantly increasing."

★ **Gibb's Free Energy (ΔG)**

→ $\boxed{\underbrace{\Delta G}_{\text{Gibbs Free Energy}} = \underbrace{\Delta H}_{\text{Enthalpy}} - \underbrace{T}_{\text{Temp}}\underbrace{\Delta S}_{\text{Entropy}}}$ — Mathematical expression
Gibb's Helmholtz's Eqn

↳ $\Delta G \to -ve$ ⇒ Spontaneous
$\Delta G \to +ve$ ⇒ Non-spontaneous
$\Delta G \to 0$ ⇒ Equilibrium

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★ **Conditions for spontaneity**

	ΔH	ΔT	Temp	Spontaneity
(1)	−	+	Any temp	$\Delta G \to -ve$. Spontaneous
(2)	+	+	High Temp	$\Delta G \to -ve$. Spont.
(3)	+	−	Any temp	Non spontaneous
(4)	−	−	Low temp.	Spontaneous

Q. $\Delta S = 108$ J/K/mol & $\Delta H = 40$ kJ/mol. Predict the feasability of the reaction at 27°C (300K)

⇒ $\Delta G = \Delta H - T\Delta S$

$\Delta G = 40000 - 108 \times 300$
$= 40000 - 32400 = \underline{7600}$ J/mol

→ Non spontaneous reaction. It is not feasible.

Q. $A + B \to C + D$.

$\Delta H = -10000$ J/mol, $\Delta S = -33$ J K mol

1) At what temperature the reaction will occur spontaneously (L→K)?
< 303K

2) At what temp. non spontaneous?
> 303K

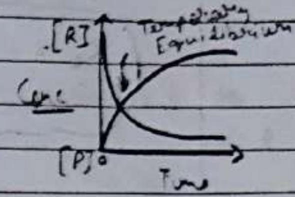
* Standard Gibb's Free Energy & Equilibrium Constant

→ $\boxed{\Delta G^\circ = -2.303\, RT \log K_c}$

Ch-6 → EQUILIBRIUM

→ It is a state of any system, where conditions like pressure, volume, concentration doesn't change over a period of time.

→ Reaction will not go 100% completion for equilibrium.



∘ Types : (1) Physical Equilibrium

(2) Chemical Equilibrium

$$A + B \rightleftharpoons C + D$$

$R_f \propto [A][B]$, $R_b \propto [C][D]$

$R_f = K_f[A][B]$ — (1) $R_b = K_b[C][D]$ — (2)

As reaction is at equilibrium,

$R_f = R_b$

⇒ $K_f[A][B] = K_b[C][D]$

⇒ $\dfrac{K_f}{K_b} = \dfrac{[C][D]}{[A][D]}$

$$K_{eq} = \frac{[C][D]}{[A][B]}$$

$\rightarrow$ $aA + bB \rightleftharpoons cC + dD$

$R_f = k_f [A]^a [B]^b$

$R_b = K_b [C]^c + [D]^d$

~~$K_c = \frac{R_f}{R_b}$~~

$$K_c = \frac{[A]^a [B]^b}{[C]^c [D]^d} = \frac{K_f}{K_b}$$

$\rightarrow$ Equilibrium Pressure (K_p)

$$K_p = \frac{(P_c)^c (P_D)^d}{(P_A)^a (P_B)^b}$$

$\rightarrow$ Relation for partial pressure

Partial Pressure = Mole fraction of substance $\times$ Total pressure

Eg $N_2 + 3H_2 \rightleftharpoons 2NH_3$

	N_2	$3H_2$	$2NH_3$
Initial moles	a	b	0
Mole at equilib.	$a-x$	$b-3x$	$2x$

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$= \frac{\left[\frac{2x}{V}\right]^2}{\left[\frac{a-x}{V}\right]\left[\frac{b-3x}{V}\right]^3}$$

Eg $N_2 + 3H_2 \rightleftharpoons 2NH_3$ (60%) $V = 2\,l$

	N_2	$3H_2$	$2NH_3$
	2	3	0
Left moles	$2-0.6$	$3-1.8$	2×0.6
	1.4	2.2	1.2

$$\therefore K_c = \frac{\left[\frac{1.2}{2}\right]^2}{\left[\frac{1.4}{2}\right]\left[\frac{2.2}{2}\right]^3}$$

P atm

$$K_p = \frac{(P_{NH_3})^2}{(P_{N_2})(P_{H_2})^3}$$

Total moles at eq. $= a - x + b - 3x + 2x$

$= a + b - 2x$

$x_{NH_3} = \left(\frac{2x}{a+b-2x}\right)$ $\quad P_{NH_3} = \left(\frac{2x}{a+b-2x}\right)(P)$

$x_{N_2} = \left(\frac{a-x}{a+b-2x}\right)$ $\quad P_{N_2} = \left(\frac{a-x}{a+b-2x}\right)P$

$x_{H_2} = \left(\frac{b-3x}{a+b-2x}\right)$ $\quad P_{H_2} = \left(\frac{b-3x}{a+b-2x}\right)P$

$$\Rightarrow K_p = \frac{(P_{NH_3})^2}{(P_{N_2})(P_{H_2})^3}$$

$$= \frac{\left(\frac{2x}{a+b-2x}P\right)^2}{\left(\frac{a-x}{a+b-2x}P\right)\left(\frac{b-3x}{a+b-2x}P\right)^3}$$

* Relⁿ between K_p & K_c

$\hookrightarrow K_c = \frac{[C]^c[D]^d}{[A]^a[B]^b}$; $K_p = \frac{(P_c)^c(P_d)^d}{(P_a)^a(P_b)^b}$

$\rightarrow PV = nRT$ (ideal gas eqn)

$\Rightarrow P = \frac{n}{V}RT$

$\Rightarrow P = [conc]RT$

$\therefore P_A = \frac{n_A}{V}(RT)^a$; $P_B = \frac{n_B}{V}(RT)^b$

$P_C = \frac{n_C}{V}(RT)^c$ $\quad P_D = \frac{n_D}{V}(RT)^d$

$\therefore K_p = \frac{[C]^c[D]^d}{[A]^a[B]^b}(RT)^{(c+d)-(a+b)}$

$$\boxed{K_p = K_c(RT)^{\Delta n(g)}}$$

imp!!

Eg (i) $N_2 + 3H_2 \rightleftharpoons 2NH_3 \rightarrow \Delta n = -2$ $\Rightarrow K_p = \frac{K_c}{(RT)^2}$ $\Rightarrow \boxed{K_p > K_c}$

(ii) $PCl_5 \rightleftharpoons PCl_3 + Cl_2 \rightarrow \Delta n = 1$ $\therefore K_p = K_c RT$ $\boxed{\Rightarrow K_c > K_p}$

(iii) $H_2 + I_2 \rightleftharpoons 2HI \rightarrow \Delta n = 0$ $\therefore K_p = K_c$

* Le - Chatelier's Principle

$\hookrightarrow$ "A reaction which is at equilibrium under the set conditions of temperature, pressure and concentration If any of these conditions is altered then the reaction shifts in either direction to minimise the change."

① Effect of Pressure $\rightarrow$ Low pressure = High Volume & vice versa

$$N_2O_4 \underset{\text{high pres.}}{\overset{\text{low pr.}}{\rightleftharpoons}} 2NO_2$$

② Effect of Temperature ~~→ All endothermic reactions~~

→ All endothermic reactions with increase in temperature favors product formation.

→ All exothermic reactions with decrease in temperature favors product formation.

$$N_2 + 3H_2 \underset{\text{high temp}}{\overset{\text{low temp}}{\rightleftharpoons}} 2NH_3 \quad , \Delta H = -ve$$

→

③ Effect of concentration

→ Increase in conc. of reactant = Forward direction
" in conc. of product = Backward direction
Decrease in conc. of reactant = Backward direction
" in conc. of product = Forward direction

④ Effect of catalyst ⇒ Catalyst has no effect on direction of reaction.

* Theories of Acids & bases

① Arrehnius concept

↳ Acids are H^+ donor, Bases are OH^- donor

② Lowry - Bronsted Concept

→ Acids are proton donor, bases are proton acceptor.

Eg: $\underset{A\ I}{H_2S} + \underset{B\ II}{H_2O} \rightleftharpoons \underset{A\ II}{H_3O^+} + \underset{B\ I}{HS^-}$

$\underset{B\ II}{NH_3} + \underset{A\ I}{H_2O} \rightleftharpoons \cancel{H_3O^+ + NH_2^-}$
$\underset{B\ I}{NH_4^+} + \underset{A\ II}{OH^-}$

HCO_3^- → C.A: H_2CO_3 ; C.B: CO_3^{2-}

HPO_4^{-2} → $H_2PO_4^-$ (Conjugated Acid) ; PO_4^{-3} (Conjugated Base)

* Ionisation Constant of Acid (K_A)

↳ $\underset{A\ I}{CH_3COOH} + \underset{B\ II}{H_2O} \rightleftharpoons \underset{B\ I}{CH_3COO^-} + \underset{A\ II}{H_3O^+}$

Initial Conc	C	Excess	0	0
Conc at equib.	$C(1-\alpha)$		$C\alpha$	$C\alpha$

$$K_{eq} = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH][H_2O]}$$

$$K_A = \frac{[C\alpha]^2}{[C(1-\alpha)]} = \frac{[C\alpha]^2}{\ }$$

* Ionisation constant of Base (K_B)

⇒ $NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$

$$K_{eq} = \frac{[NH_4^+][OH^-]}{[NH_3][H_2O]}$$

$$K_B = \frac{[NH_4^+][OH^-]}{[NH_3]}$$

$$= \frac{C\alpha \times C\alpha}{C(1-\alpha)} = C\alpha^2$$

$$\boxed{\alpha = \sqrt{\frac{K_B}{C}}}$$

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* Ionisation constant in water (K_w)

$$H_2O + H_2O \rightleftharpoons H_3O^+ + OH^-$$

$$K_{eq} = \frac{[H_3O^+][OH^-]}{[H_2O][H_2O]}$$

$$K_w = [H_3O^+][OH^-]$$

$$\therefore \boxed{K_w = 1\times10^{-14}}$$

* Lewis acid & Lewis Base

Lewis acid : electron pair donor
Eg H_3N

Lewis Base : electron pair acceptor
Eg BF_3

pH :- power of hydrogen / potential of hydrogen

$$pH = -\log[H_3O^+]$$

Q. Determine pH of 0.02 N HCl.

$\Rightarrow pH = -\log(0.02)$
$= -\log(2\times10^{-2})$
$= -[\log(2) + \log 10^{-2}]$
$= -[0.3010 - 2] = 1.6990$

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Q. pH of 0.05 M NaOH. ($K_w = 1\times10^{-14}$)

$\Rightarrow K_w = [H_3O^+][OH^-]$

$\Rightarrow [H_3O^+] = \frac{K_w}{[OH^-]} = \frac{1\times10^{-14}}{5\times10^{-2}} = \boxed{0.2\times10^{-12}}$

$pH = -\log(0.2\times10^{-12})$
$= -[0.3010 - 13] = 12.69$

$pH = -\log(H_3O^+)$

* Buffer Solution

→ The solution which resists the change in pH, even after keeping it for a long time or on adding a little amount of acid or base to it.

→ Types of ~~soln~~ buffer soln :

(1) Acidic Buffer : Weak Acid + Salt of weak acid

(2) Basic Buffer : Weak Base + Salt of weak base

∘ pH of acidic buffer

$HA + H_2O \rightleftharpoons H_3O^+ + A^-$

HA → acid; A^- → acetate ion

$$K_{eq} = \frac{[H_3O^+][A^-]}{[HA][H_2O]}$$

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

$$[H_3O^+] = \frac{K_a[HA]}{[A^-]}$$

$$-\log[H_3O^+] = -\log\left(\frac{K_a[HA]}{[A^-]}\right)$$

$$\Rightarrow pH = -\log(K_a) + (-\log[HA]) - (-\log[A^-])$$

$$\Rightarrow \left\{ pH = pK_a + \log\left(\frac{[salt]}{[acid]}\right) \right\} \to \text{imp}$$

Q Determine the pH of a solution obtained by mixing 0.3M CH_3COONa & 0.2M CH_3COOH.
$K_a = 1.8 \times 10^{-5}$

$$\Rightarrow pH = pK_a + \log\left(\frac{[salt]}{[acid]}\right)$$

$$\Rightarrow pH = -\log(1.8\times10^{-5}) + \log\left(\frac{0.3}{0.2}\right)$$

$$\Rightarrow pH = -\log(1.8\times10^{-5}) + \log(3) - \log(2)$$

$$= -(\log 1.8 + \log 10^{-5})$$

$$= -[0.2553 + (-5\times1)] + \log(3) - \log(2)$$

$$= 4.7447 + 0.1761$$

$$= \boxed{4.9208}.$$

$$\begin{array}{r} 5.0000 \\ -\ 0.2553 \\ \hline 4.7447 \end{array}$$

∘ ~~pH of basic buffer~~ Salt Hydrolysis

→ Salts → WA + S.B

$CH_3COONa + H_2O \rightleftharpoons CH_3COOH + NaOH$

→ Salt of WA, SB → CH_3COONa

→ Salt of SA, WB → NH_4Cl

→ Salt of WA, WB → CH_3COONH_4

→

(1) Hydrolysis Constant (K_h)

$$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$$

$$K_{eq} = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-][H_2O]}$$

$$K_h = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]}$$

$$K_a = \frac{[CH_3COO^-][H_3O^+]}{[CH_3COOH]}$$

$$K_w = [H_3O^+][OH^-]$$

$$\frac{K_w}{K_a} = \frac{[H_3O^+][OH^-][CH_3COOH]}{[CH_3COO^-][H_3O^+]}$$

$$= \frac{[OH^-][CH_3COOH]}{[CH_3COO^-]} = K_h$$

$$\therefore K_h = \frac{K_w}{K_a}$$

* Degree of Hydrolysis

$$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$$

$$K_h = \frac{ch \times ch}{c(1-h)} = \frac{ch^2}{c(1-h)}$$

$$h = \sqrt{\frac{K_h}{c}} = \frac{K_w}{K_a \cdot c}$$

(III) pH of salt solution

$\Rightarrow [OH^-] = ch$

$$K_w = [H_3O^+][OH^-]$$

$$[H_3O^+] = \frac{K_w}{[OH^-]} = \frac{K_w}{ch}$$

$$= \frac{K_w}{c\sqrt{\frac{K_w}{K_a \cdot c}}} = \frac{\sqrt{K_w}\sqrt{K_w}}{\frac{\sqrt{c}\sqrt{c}\cdot\sqrt{K_w}}{\sqrt{K_a}\cdot\sqrt{c}}} = \frac{K_w}{\sqrt{\frac{c \cdot K_w}{K_a}}}$$

$$= \frac{K_w \cdot \sqrt{K_a}}{\sqrt{c} \cdot \sqrt{K_w}} = \frac{\sqrt{K_w} \cdot \sqrt{K_w} \cdot \sqrt{K_a}}{\sqrt{c} \cdot \sqrt{K_w}} = \frac{\sqrt{K_w \cdot K_a}}{\sqrt{c}}$$

$$\therefore \boxed{[H_3O^+] = \sqrt{\frac{K_w \cdot K_a}{c}}}$$

$$-\log[H_3O^+] = -\log\left(\frac{K_w K_a}{c}\right)^{1/2}$$

$$\Rightarrow \boxed{pH = -\frac{1}{2}\log(K_w) - \frac{1}{2}\log(K_a) + \frac{1}{2}\log(c)}$$

* Common Ion Effect

↳ When a solution of weak electrolyte is added to the solution of strong electrolyte, the disassociation of weak electrolyte is suppressed having a common ion.

$HCl \rightleftharpoons H^+ + Cl^-$
$H_2S \rightleftharpoons 2H^+ + S^{2-}$
$NH_4Cl \rightleftharpoons NH_4^+ + Cl^-$
$NH_4OH \rightleftharpoons NH_4^+ + OH^-$

* Indicators

→ WA + SB → Methyl Orange
SA + WB → Phenolphthalein

* Solubility product (K_{sp})

$AgCl \rightleftharpoons \underset{s}{Ag^+} + \underset{s}{Cl^-}$

$K_{sp} = s^2$

$Ag_2CrO_4 \rightleftharpoons \underset{2s}{2Ag^{-1}} + \underset{s}{CrO_4^{2-}}$

$K_{sp} = (2s)^2(s) = 4s^3$

* Revision

Q.1 Write the molecular orbital configuration of:

N_2^+, N_2^{-2}

(a) Determine bond order.

(b) Predict magnetic behaviour.

→ N_2^+ (13) $= \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2$, ~~$\sigma 2p_z^2$~~, $(\pi 2p_x^2 = \pi 2p_y^2), \sigma 2p_z^1$

→ Bond Order $= \frac{9-4}{2} = 2.5$

→ It will show paramagnetic behaviour.

N_2^{-2} (16) $=$ ~~$\sigma 1s^2, \sigma^*$~~ $kk, kk', \sigma 2p_z^2, (\pi 2p_x^2 = \pi 2p_y^2)$ $(\pi^* 2p_x^1 = \pi^* 2p_y^1)$

→ Bond order $= \frac{10-6}{2} = 2$

→ It will show paramagnetic behaviour.

Q.2 Among H_2O & H_2S, which has stronger H-bonding?

Q.3 Draw resonance structure of N_2O & CO_2

Q.4 Predict hybridization:

$HClO_2$, XeF_4, SO_3, $BeCl_2$, ClF_3

Q.5 Among O_2, O_2^{-1}, O_2^{+1} & O_2^{-2} highest bond length?

Ans 2 H_2O will have higher hydrogen bonding as the electronegativity difference is higher than H_2S.

~~Ans 3 $N_2O \rightarrow [N = \ddot{O} = N]$~~

Ans 4 $HClO_2 \rightarrow sp^3$ hybridization

$XeF_4 \rightarrow sp^3d^2$ hybridization

$SO_3 \rightarrow sp^2$ hydridization

$BeCl_2 \rightarrow sp$ hybridization

$ClF_3 \rightarrow sp^3d$ hybridization

Ans 3 $N_2O \rightarrow \left[N \equiv \overset{+}{N} - O^- , \ {}^-N = \overset{+}{N} = O \right]$

$CO_2 \rightarrow \left[O = C = O , \ {}^-O \equiv \overset{+}{C} - O^- , \ O - C^+ \equiv O^- \right]$

Ans 5 $O_2^{2-} < O_2^- < O_2 < O_2^+$

$\xrightarrow{\text{Increasing stability}}$
Decreasing bond length

$\therefore$ O_2^{2-} will have highest bond length.

Q. $(CH_3)_3C-CO-C(CH_3)_3$

$\Rightarrow$ ~~$CH_3 - CH_3 - CH_3 - C - CO - C - CH_3 - CH_3 - CH_3$~~

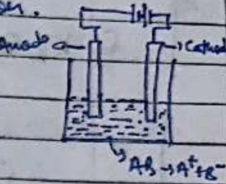
Sigma $\rightarrow$ 27 Pi $\Rightarrow$ 1

Term 2

Ch-7 : Redox Reactions

→ A chemical reaction in which both reduction & oxidation occur simultaneously is called a redox reaction.

→ Anode – Oxidation
Cathode – Reduction



Cation → Cathode
Anion → Anode

Eg. $\overset{0}{Fe} + \overset{+1}{H}\overset{-1}{Cl} \longrightarrow \overset{+2}{Fe}\overset{-1}{Cl_2} + \overset{0}{H_2}$

Oxidation: Fe → $FeCl_2$; Reduction: HCl → H_2

• Oxidation State →

Eg. $K\overset{+7}{Mn}O_4 + FeSO_4 + H_2SO_4 \longrightarrow K_2SO_4 + \overset{+2}{Mn}SO_4 + Fe_2(SO_4)_3 + H_2O$

Oxidation: $FeSO_4$ → $Fe_2(SO_4)_3$; Reduction: $KMnO_4$ → $MnSO_4$

→ $C_{12}H_{22}O_{11}$
$12x + 22 - 22 = 0$
$12x = 0$
$x = 0$

$Cr_2O_7^{-2}$
→ $2x - 14 = -2$
$2x = 12$
$x = +6$

→ $NaBrO_3$ → $x + 1 - 6 = 0$
$x = +5$

Na_3AsO_3
→ $3 + x - 6 = 0$
→ $x = +3$

→ $H_2C_2O_4$ → $2x + 2 - 8 = 0$
$x = +3$

→ $NaClO_3$ → $x + 1 - 6 = 0$
$x = +5$

- Elements in diatomic state → 0

Eg $\overset{0}{Cl_2} + \overset{+1}{Na}\overset{-1}{OH} \rightarrow Na\overset{-1}{Cl} + NaClO_3 + H_2O$

~~Reduced~~ Oxidation

~~Oxidation~~ Reduction

Eg $K_2Cr_2O_7 + SnCl_2 + H_2SO_4 \rightarrow K_2SO_4 + Cr_2(SO_4)_3 + SnCl_4 + H_2O$

Oxidation

Reduction

$\overset{0}{Cl_2} + NaOH \rightarrow NaCl + NaClO_3 + H_2O$

Oxidation

Reduction

↳ Disproportionation Reaction

Eg $HNO_3 \rightarrow 1 + x - 6 = +5$

- Oxidising Agent → Gets reduced, oxidises others.
- Reducing Agents → Gets oxidised, reduces others.

Balancing Redox Reactions

1. ~~Ox~~ Oxidation number method

↳ $\overset{+4}{Mn}O_2 + 2H\overset{-1}{Cl} \rightarrow \overset{+2}{Mn}Cl_2 + H_2O + \overset{0}{Cl_2}$

Reduction → 2×1

Oxidation → 1×2

→ $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

↳ $\overset{+7}{KMnO_4} + 2\overset{+2}{Fe}SO_4 + H_2SO_4 \rightarrow K_2SO_4 + \overset{+2}{Mn}SO_4 + \overset{+3}{Fe_2}(SO_4)_3 + H_2O$

Oxy → ~~3~~×2 = 2

Red → 5×1 = 5

→ $2KMnO_4 + 10FeSO_4 + \overset{+8}{H_2SO_4} \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O$

→ $2KMnO_4 + 10FeSO_4 + 8H_2SO_4 \rightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 8H_2O$

Q → $\overset{0}{P_4} + H\overset{+5}{N}O_3 \rightarrow 4H_3\overset{+5}{P}O_4 + \overset{+4}{N}O_2 + H_2O$

Red → 1×1 = 1

Oxy → 4×5 = 20

→ $P_4 + 20HNO_3 \rightarrow 4H_3PO_4 + 20NO_2 + 4H_2O$

Q → $\overset{0}{C_{12}}H_{22}O_{11} + HNO_3 \rightarrow 6H_2\overset{+3}{C_2}O_4 + NO_2 + H_2O$

Red → 1×1 = 1

12×3 = 36

→ $C_{12}H_{22}O_{11} + 36HNO_3 \rightarrow 6H_2C_2O_4 + 36NO_2 + 23H_2O$

Q → $K_2\overset{+6}{Cr_2}O_7 + 2HCl \rightarrow KCl + 2\overset{+3}{Cr}Cl_3 + H_2O + Cl_2$

Reduc = 3×2 = 6 3

Oxidation → 2×1 = 2 1

→ $K_2Cr_2O_7 + 14HCl \rightarrow 2KCl + 2CrCl_3 + 3Cl_2 + 7H_2O$

② Ion-electron Method (Half-Reaction Method)

Eg $MnO_4^- + S_2O_3^{2-} \rightarrow Mn^{+2} + SO_4^{-2}$

Acidic Medium
→ For Oxygen add H_2O
→ for H_2 add H^+.

Reduc Half → $(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{+2} + 4H_2O)_8$

Oxy half → $(S_2O_3^{2-} + 5H_2O \rightarrow 2SO_4^{-2} + 10H^+ + 8e^-)_5$

→ $\cancel{2MnO_4^- + 16H^+ + S_2O_3^{2-} + 5H_2O \rightarrow 2Mn^{+2} + 2SO_4^{-2} + 10H^+ + 8H_2O}$

→ $2MnO_4^- + 6H^+ + S_2O_3^{2-} + \cancel{H_2O} \rightarrow 2Mn^{+2} + 2SO_4^{-2} + 3H_2O$

→ $8MnO_4^- + 64H^+ + 5S_2O_3^{2-} + 25H_2O \rightarrow 8Mn^{+2} + 32H_2O + 10SO_4^{2-} + 50H^+$

→ $8MnO_4^- + 14H^+ + 5S_2O_3^{2-} \rightarrow 8Mn^{+2} + 10SO_4^{2-} + 7H_2O$

Eg $\overset{+5}{Cl}O_3^{-1} + \overset{+4}{S}O_2 \rightarrow \overset{+3}{Cl}O_2^- + H\overset{+6}{S}O_4^-$

Reduc → $(ClO_3^{-1} + 2H^+ + 2e^- \rightarrow ClO_2^{-1} + H_2O)$

Oxy → $(SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-)$

→ $ClO_3^{-1} + 2H^+ + SO_2 + 2H_2O \rightarrow ClO_2^{-1} + H_2O + HSO_4^- + 3H^+$

→ $ClO_3^{-1} + SO_2 + H_2O \rightarrow ClO_2^{-1} + HSO_4^{-1} + H^+$

Eg $\overset{+3}{As_2}S_3 + \overset{+5}{N}O_3^- \rightarrow \overset{+7}{As}O_4^- + \overset{+2}{N}O + S$

Oxy → $As_2S_3 + 8H_2O \rightarrow 2AsO_4^- + 16H^+$

Red → $(NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O)_2$

→ $As_2S_3 + \cancel{8H_2O} + 2NO_3^- + 8H^+ \rightarrow 2AsO_4^- + 8H^+ + 2NO + 4H_2O$

→ $As_2S_3 + 2NO_3^- + \cancel{4H_2O} \rightarrow 2AsO_4^- + 2NO + 3S$

Oxy → $(As_2S_3 + 8H_2O \rightarrow 2AsO_4^- + 16H^+ + 14e^-)_3$

Red → $(NO_3^- + 4H^+ + 3e^- \rightarrow NO + 2H_2O)_{14}$

→ $3As_2S_3 + 8H^+ + 14NO_3^- \rightarrow 6AsO_4^- + 14NO + 4H_2O + 9S$

Eg → $\overset{+6}{Cr_2}O_7^{2-} + \overset{+3}{N}O_2^- \rightarrow Cr^{+3} + \overset{+5}{N}O_3^-$

Oxy → $(NO_2^- + H_2O \rightarrow NO_3^- + 2H^+ + 2e^-)_3$

Reduc → $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

→ $3NO_2^- + 3H_2O + Cr_2O_7^{2-} + 14H^+ \rightarrow 3NO_3^- + 6H^+ + 2Cr^{3+} + 7H_2O$

→ $3NO_2^- + Cr_2O_7^{-2} + 8H^+ \rightarrow 3NO_3^- + 2Cr^{3+} + 4H_2O$

Eg $\overset{-2}{N_2}H_4 + ClO_3^- \rightarrow \overset{+2}{N}O + Cl^-$

Oxy → $(N_2H_4 + 2H_2O \rightarrow 2NO + 8H^+ + 8e^-)_3$

Reduc → $(ClO_3^- + 6H^+ + 6e^- \rightarrow Cl^- + 3H_2O)_4$

→ $3N_2H_4 + 6H_2O + 4ClO_3^- + 24H^+ \rightarrow 4Cl^- + 12H_2O + 6NO + 24H^+$

→ $3N_2H_4 + 4ClO_3^- \rightarrow 4Cl^- + 6H_2O + 6NO$

Q. Balance the following:

(1) $\overset{3+}{Cr}(OH)_3 + \overset{+5}{I}O_3^- \rightarrow I^- + \overset{+6}{Cr}O_4^{-2}$ (basic)

(2) $\overset{0}{Br_2} + NaOH \rightarrow 2Na\overset{+5}{Br}O_3 + 2Na\overset{-1}{Br} + H_2O$ (Oxy 2×5, Reduc 2×1)

(3) $\overset{+7}{Cl_2}O_7 + H_2\overset{-1}{O_2} \rightarrow \overset{+3}{Cl}O_2^- + \overset{0}{O_2}$ (basic)

① → Oxy: $Cr(OH)_3 \rightarrow CrO_4^{-2}$

→ $(Cr(OH)_3 + H_2O \rightarrow CrO_4^{-2} + 5H^+ + 3e^-)_2$

Reduc: $IO_3^- + 6H^+ \xrightarrow{+6e^-} I^{-1} + 3H_2O$

→ $2Cr(OH)_3 + 2H_2O + IO_3^- + 6H^+ \rightarrow 2CrO_4^{2-} + 10H^+ + I^- + 3H_2O$

→ $2Cr(OH)_3 + IO_3^- \rightarrow 2CrO_4^{2-} + 4H^+ + H_2O + I^-$

→ $2Cr(OH)_3 + IO_3^- + 4OH^- \rightarrow 2CrO_4^{2-} + 5H_2O + I^-$

② $12Br_2 + 24NaOH \rightarrow 4NaBrO_3 + 20NaBr + 12H_2O$

→ $12Br_2 + 24NaOH \rightarrow 4NaBrO_3 + 20NaBr + 12H_2O$

→ $3Br_2 + 6NaOH \rightarrow NaBrO_3 + 5NaBr + 3H_2O$

old

Oxy: ~~$Br_2 + 6H_2O \rightarrow 2NaBrO_3 + 12H^+ + 12e^-$~~

$Br_2 + OH^- \rightarrow \overset{+5}{Br}O_3^- + Br^{-1} + H_2O$

Oxy: $Br_2 + 6H_2O \rightarrow 2BrO_3^- + 12H^+ + 10e^-$

Reduc: $(Br_2 + 2e^- \rightarrow 2Br^{-1})_5$

→ $6Br_2 + 6H_2O \rightarrow 2BrO_3^- + 10Br^{-1} + 12H^+$

→ ~~$6Br_2 \rightarrow$~~

→ $6Br_2 + 12OH^- \rightarrow 2BrO_3^- + 10Br^{-1} + 6H_2O$

→ $3Br_2 + 6NaOH \rightarrow NaBrO_3 + 5NaBr + 3H_2O$

③ → $(Cl_2O_7 + 6H^+ + 8e^- \rightarrow 2ClO_2^- + 3H_2O)_2$

→ $(H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-)_4$

→ $2Cl_2O_7 + 12H^+ + 7H_2O_2 \rightarrow 4ClO_2^- + 6H_2O + 7O_2 + 14H^+$

→ $2Cl_2O_7 + 7H_2O_2 \rightarrow 4ClO_2^- + 6H_2O + 7O_2 + 2H^+$

→ $2Cl_2O_7 + 7H_2O_2 + 2OH^- \rightarrow 4ClO_2^- + 8H_2O + 7O_2$

$\rightarrow Cl_2O_7 + 6H^+ + 4H_2O_2 \rightarrow 2ClO_2^- + 3H_2O + 4O_2 + 8H^+$

$\rightarrow Cl_2O_7 + 4H_2O_2 \rightarrow 2ClO_2^- + 3H_2O + 4O_2 + 2H^+$

$\rightarrow Cl_2O_7 + 4H_2O_2 + 2OH^- \rightarrow 2ClO_2^- + 5H_2O + 4O_2$

Q. $\overset{+7}{Mn}O_4^- + \overset{+2}{Sn}O_2^{-2} + H_2O \rightarrow \overset{+4}{Mn}O_2 + \overset{+4}{Sn}O_3^{-2} + OH^-$

Oxy $\rightarrow (MnO_4^- + 4H^+ + 3e^- \rightarrow MnO_2 + 2H_2O)_2$

Reduc $\rightarrow (SnO_2^{-2} + H_2O \rightarrow SnO_3^{-2} + 2H^+ + 2e^-)_3$

$\rightarrow 2MnO_4^- + 8H^+ + 3SnO_2^{-2} + 3H_2O \rightarrow 2MnO_2 + 4H_2O + 3SnO_3^{-2} + 6H^+$

$\rightarrow 2MnO_4^- + 2H^+ + 3SnO_2^{-2} \rightarrow 2MnO_2 + H_2O + 3SnO_3^{-2}$

$+2H_2O$

$\rightarrow 2MnO_4^- + 3SnO_2^{-2} \rightarrow 2MnO_2 + 2OH^- + 3SnO_3^{-2}$

1×1

Q. $\overset{0}{Sb} + H\overset{+5}{N}O_3 \rightarrow H_3\overset{+5}{Sb}O_4 + \overset{+4}{N}O_2 + H_2O$

1×5

$\rightarrow Sb + 5HNO_3 \rightarrow H_3SbO_4 + 5NO_2 + H_2O$

Q. $P_4 + OH^- \rightarrow PH_3 + H_2PO_2^-$

Oxy Reduc $\rightarrow P_4 + \cancel{6H_2O}\ 12H^+ \xrightarrow{+12e^-} 4PH_3$

Oxy $\rightarrow (P_4 + 8H_2O \rightarrow 4H_2PO_2^- + 8H^+ + 4e^-)_3$

$\rightarrow 2P_4 + 12H^+ + 8H_2O \rightarrow 4PH_3 + 4H_2PO_2 + 16H^+$

$\rightarrow P_4 + 8H_2O \rightarrow 2PH_3 + 2H_2PO_2 + 2H^+$

$\rightarrow P_4 + 6H_2O + 2OH^- \rightarrow 2PH_3 + 4H_2PO_2$

$\rightarrow P_4$

$\rightarrow 4P_4 + 12H_2O + 12OH^- \rightarrow 12H_2PO_2^- + 4PH_3$

$\rightarrow P_4 + 3H_2O + 3OH^- \rightarrow 3H_2PO_2^- + PH_3$

X ——— X ——— X ——— X

Electrochemical Cell

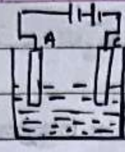
$\rightarrow$ Standard Electrode Potential

- $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$E^\circ_{cell}\ Cu^{2+}/Cu \rightarrow +0.34V$ (Standard Reduction Potential)

$E^\circ_{cell}\ Cu/Cu^{2+}$ (Standard Oxidation Potential)

* Electrochemical Cell



↳ Anode: $Cu_{(s)} \rightarrow Cu^{2+} + 2e^-$

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu(s)$

(1) $E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$

$E^\circ_{Cu/Cu^{2+}} = -0.34V$

$E^\circ_{Cu^{2+}/Cu} = +0.34V$ } SRP

$E^\circ_{Zn^{+2}/Zn} = -0.76V$ } SOP

$E^\circ_{Zn/Zn^{+2}} = +0.76V$

* Higher negative reduction potential → more oxidation

Lesser " → more reduction.

* Predicting the products of electrolysis:

↳ molten state (NaCl molten)

↳ Aqueous solution

↳ Higher positive SRP → cathode & reduction

Higher negative SRP → anode & oxidation

Cu, Ag, Au, Hg — Pt → Below H^+ ← Preferential Discharge Towards Cathode in place of H^+

SO_4^{-2}, NO_3^{-1}, OH^-, Cl^-, Br^-, I^- — Increasing Oxidation Preference

H^+, Cu, Ag, Au, Hg, Pt — Increasing Reduction Preference

Q. $CuSO_4 \rightleftharpoons Cu^{+2} + SO_4^{-2}$

$H_2O \rightleftharpoons H^+ + OH^-$

→ Anode: $-(4OH^- \rightarrow O_2 + 2H_2O + 4e^-)_{1/2}$

Cathode: $-(Cu^{2+} + 2e^- \rightarrow Cu)$

→ $Cu^{2+} + 2OH^- \rightarrow \frac{1}{2}O_2 + Cu + H_2O$

Q. Electrolysis of $AgNO_3$ soln.

$AgNO_3 \rightleftharpoons Ag^+ + NO_3^-$

$H_2O \rightleftharpoons H^+ + OH^-$

Anode: → $(4OH^- \rightarrow O_2 + 2H_2O + 4e^-)_{1/4}$

Cathode: → $Ag^+ + e^- \rightarrow Ag$

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$\rightarrow Ag^+ + OH^- \rightarrow \frac{1}{4}O_2 + \frac{1}{2}H_2O$

$\rightarrow 2Ag^+ + 2OH^- \rightarrow \frac{1}{2}O_2 + H_2O$

Q. 1. Electrolysis of $CuSO_4$ soln. with platinum electrodes.
↓
No effect (inert metal)

2. Electrolysis of $CuSO_4$ soln with copper electrodes.
↓
Only metal will get oxidised and reduced

(1) → Anode: $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

$\rightarrow Cu^{2+} + 2OH^- \rightarrow \frac{1}{2}O_2 + H_2O + Cu$

(2) Anode: $Cu \rightarrow Cu^{2+} + 2e^-$

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

Q → $E^\circ_{K^+/K} = -2.93V$

$E^\circ_{Ag^+/Ag} = +0.80V$

$E^\circ_{Hg^{2+}/Hg} = +0.79V$

$E^\circ_{Mg^{2+}/Mg} = -2.37V$

$E^\circ_{Cr^{+3}/Cr} = -0.74V$

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Arrange them in reducing power.

→ Ag < Hg < Cr < Mg < K

$\xrightarrow{\text{Reactivity} \uparrow}$

$\xrightarrow{\text{Oxidising Tendency} \uparrow}$

$\rightarrow CaCO_3 \xrightarrow{\Delta} CaO + CO_2$ → Not redox

$KClO_3 \xrightarrow{\Delta} KCl + O_2$

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★ Ch-8 → Organic Chemistry

- **Alkane** → Single bond b/w carbon.

→ G.F → C_nH_{2n+2}

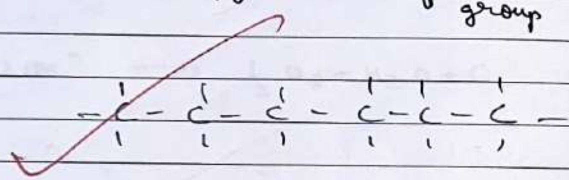
Eg n = 5 → C_5H_{12} (Pentane)

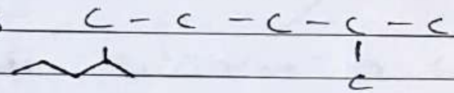
→ IUPAC NOMENCLATURE

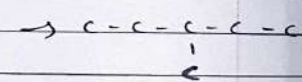
→ Word Root + Suffix (Primary) + Secondary Suffix

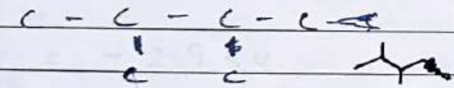
- Alk + ane/ene/yne + functional group

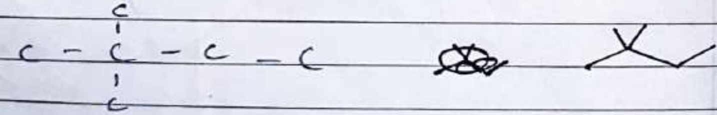
Eg C_6H_{14}











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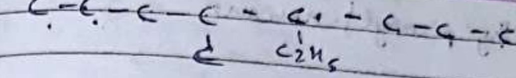
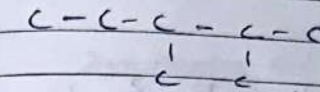
Eg →



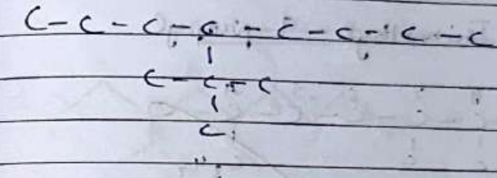
4 - ethyl - 5 - methyl - octane

Eg →



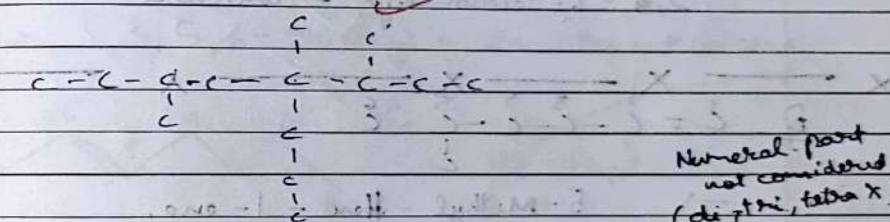
2, 3 - dimethyl - pentane

Eg →



4-ethyl-(1,1 - dimethyl) - ~~hexane~~ octane

Eg →



Numeral part not considered (di, tri, tetra ✗)

~~3,6 dimethyl - 4 - propyl - 4 - methyl 6 -~~

✓ 3, 4, 6 - trimethyl - 4 - propyl - octane

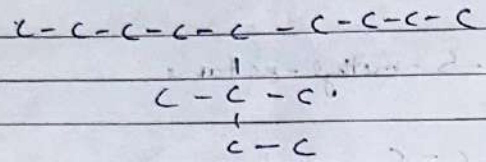
or

~~3,7 - dimethyl - 4 (1 - methyl propyl) octane~~

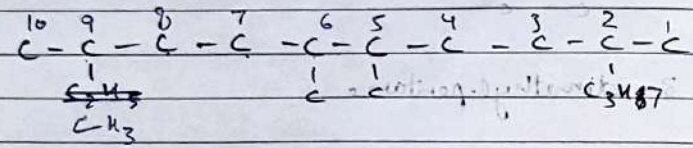
Select chain which have more of subst.

4 - (1 - methyl - propyl) - 4,6 - dimethyl octane

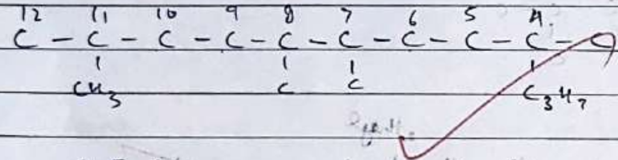
→ 5-(1,1-dimethyl propyl)-nonane



Q.

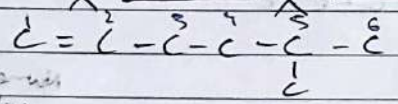


→ ~~2,5,6-Trimethyl-9-propyl~~

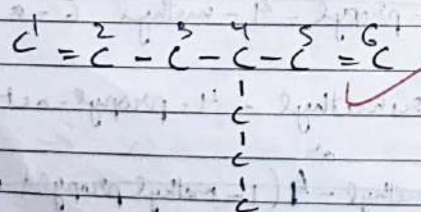


~~2,5,6~~,9
2,~~4~~,5,6,9 - Tetramethyl - dodecane

X ——— X ——— X ——— X ←——— X

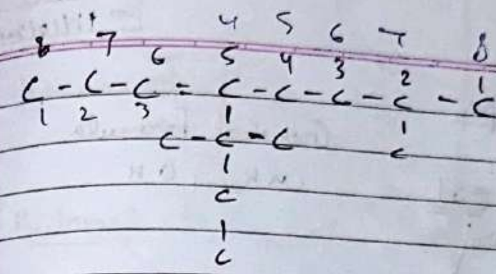


→ 5-Methyl - Hex - 1 - ene.



→ 3~~4~~ - propyl - Hex - 1,5 - diene

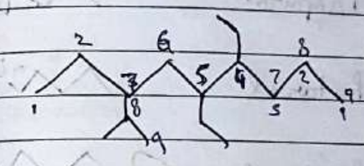
Q.



→ ~~2-methyl - 5(1,1-dimethyl-propyl) - Oct - 6-ene~~

7-methyl - 4(1,1-dimethyl-propyl) - oct - 3-ene

Q

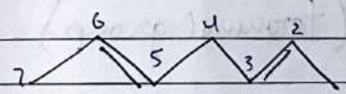


→ ~~3-(1-methyl ethyl)-5,6-diethyl - nonane~~

3,5,6
↳ ~~4,5,7-triethyl-1 methyl nonane~~

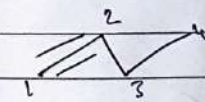
↳ 3,5,6-triethyl - 2-methyl-nonane

Q



→ Hept - 2,5 - diene

Q.



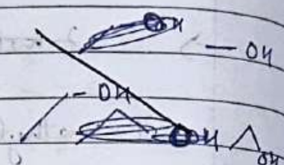
→ But - 1 - yne → Butyne

→

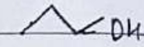
★ Functional Groups

General Formula

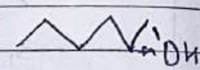
① Alcohol — -ol — $C_nH_{2n+1}OH$
(attached to primary carbon)

① CH_3-OH — Methanol


② C_2H_5-OH — Ethanol

③ C_3H_7-OH — Propanol


④ C_4H_9-OH — Butanol

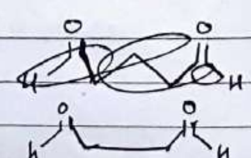

⑤ $C_5H_{11}-OH$ — Pentanol


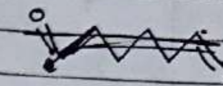
② Aldehyde — = al — (terminal group)
(-CHO) $-\overset{O}{\overset{\|}{C}}-H$
(carbon included in long chain)

① $H-\overset{O}{\overset{\|}{C}}-H$ → Methanal

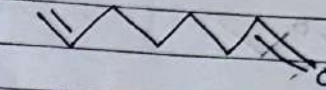
② $CH_3-\overset{O}{\overset{\|}{C}}-H$ → Ethanal

③ $C_2H_5-\overset{O}{\overset{\|}{C}}-H$ → Propanal

④ $C_3H_8-\overset{O}{\overset{\|}{C}}-H$ → Butanal


★ Hexane dial — $OHC-(CH_2)_4-CHO$


Butanal →


→


③ Ketone (non-terminal)
(carbon of ketone also included)

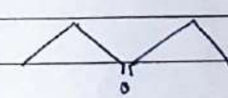
— one

$R-\overset{O}{\overset{\|}{C}}-R$

↳ $CH_3-CO-CH_3$ → Propanone

↳ $CH_3-\overset{O}{\overset{\|}{C}}-CH_2-CH_2-CH_3$ → Pentan-2-one

↳ $CH_3-CH_2-\underset{O}{\underset{\|}{C}}-CH_2-CH_3$ → Pentan-3-one



④ Ether — R-O-R — Alkoxy Alkane

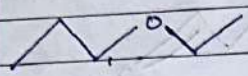
Smaller alkyl → Alkoxy
Larger alkyl → Alkane

↳ CH_3-O-CH_3 → Methoxy Methane

↳ $CH_3-O-C_2H_5$ → Methoxy Ethane

→ $C_2H_5-O-CH_3$ → ~~Methox Ethoxy Metho~~ Methoxy Ethane

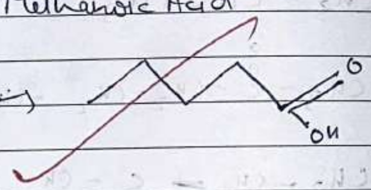
→ $C_3H_7-O-C_2H_5$ → Ethoxy Propane



★ Carboxylic Acid — -oic acid

$-COOH$
(Terminal Group)

↳ $HCOOH$ → Methanoic Acid

Pentanoic Acid → 

18-10-24

★

Eg Draw structure of 2-Pentanoic acid.

↳ <u>Not possible</u>

★ <u>Ester</u> $R-\overset{O}{\overset{\|}{C}}-O-R'$ → <u>Alkyl Alkanoate</u>

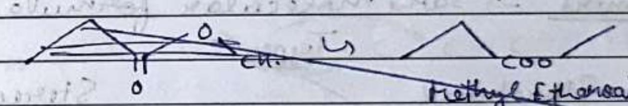
Alkanoate ↙ ↘ Alkyl

(Carboxylic Acid Derivative)

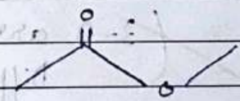
↳ $CH_3-\overset{O}{\overset{\|}{C}}-OCH_3$ → Methyl Ethanoate

↳ $CH_3-\overset{O}{\overset{\|}{C}}-OC_2H_5$ → Ethyl Ethanoate

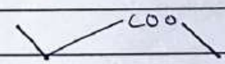
↳ $C_2H_5-\overset{O}{\overset{\|}{C}}-OCH_3$ → Methyl Propanoate



~~Methyl Ethanoate~~



→ Methyl Ethanoate



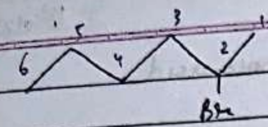
→ Methyl propanoate

X —— X —— X —— X —— X

★ <u>Halide</u> $R-X$ ($X = Cl, Br, I$)

↳ CH_3Cl → Chloromethane

↳ CH_3Br → Bromomethane

Eg  → 2-Bromo-hexane

- Acid halide → $R-\overset{O}{\overset{\|}{C}}-Cl$
- Acid Anhydride → $(RCO_2)O$ $R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R$
- Nitro → $R-NO_2$
- Amide → $R-CONH_2$
- Cyanide → $R-CN$
- Amine → $R-NH_2$

× ——— × ——— × ——— ×

★ **Isomers** → Same molecular formula, different structural formula

Types:

Structural (Structural Arrangement Different) | Stereo (3-D arrangement Different)

↳ Chain
↳ Positional
↳ Functional
↳ Metamerism
↳ Tautomerism
↳ Ring-chain

① **Chain isomerism**

Eg C–C–C–C–C–C n-hexane

C–C–C–C–C (with C branch) iso-hexane

C–C(C)(C)–C–C neo-hexane

② **Positional isomerism**

↳ Compounds having same molecular formula but different positions of multiple bonds or functional groups.

Eg C_5H_{10} C=C–C=C–C → 2 only

C=C–C(C)–C → 3

C–C(C)(C)–C

↳ C–C–C–C=C (a)
C–C–C=C–C (b)
C–C–C(C)=C (c)
C–C–C=C (d)
C–C=C(C)–C (e)
C–C(C)=C–C (6)

↳ (a & b) → positional isomers

(c & e) → positional isomers

(c & d) → chain isomers

(3) Functional isomers

↳ Same molecular formula different functional group

Single Oxygen ↳ Alchol } Ether }
Aldehyde } Ketone }

Eg C_2H_6O

→ CH_3CH_2OH → Ethanol

CH_3-O-CH_3 → Methoxy Methane

~~C_2H_5-CHO~~

$C-\overset{O}{\overset{||}{C}}-H$ → Not possible

★ Alcohol & Ether are functional isomers of each other.

Eg C_3H_6O → $CH_3CH_2CH_2-OH$

↳ $-\overset{|}{C}-\overset{|}{C}-\overset{O}{\overset{||}{C}}-H$ → Propanal ✓

↳ $-\overset{|}{C}-\overset{O}{\overset{||}{C}}-\overset{|}{C}-$ → Propanone ✓

★ Ketone & Aldehyde are functional isomers of each other

o $C_3H_6O_2$ → CH_3CH_2COOH → Propanoic Acid

→ CH_3COOCH_3 → Methyl Ethanoate

★ Carbonylic Acids & Esters are functional isomers of each other

18-10-24

(4) Metamers

↳ Same molecular formula, unequal distribution of alkyl groups around oxygen and nitrogen.

Eg Metamers {
$CH_3-O-C_3H_7$ → Methoxy Propane
$C_2H_5-O-C_2H_5$ → Ethoxy Ethane

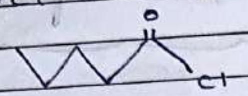
★ Acid Chloride $R-\overset{O}{\overset{||}{C}}-Cl$ - oyl chloride
(derived f.g of COOH)

Eg ~~$H-\overset{O}{\overset{||}{C}}-Cl$ → Methanoyl Chloride~~

$CH_3-\overset{O}{\overset{||}{C}}-Cl$ → Ethanoyl Chloride

$CH_3-CH_2-\overset{O}{\overset{||}{C}}-Cl$ → Propanoyl Chloride

→ $CH_3(CH_2)_3 \cdot COCl$ → ~~Butanoic~~ Pentanoyl Chloride



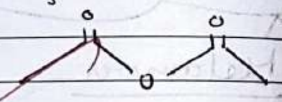
★ **Acid Anhydride** $R-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-R$

↳ Removal of H_2O

Alkanoic Anhydride

same only

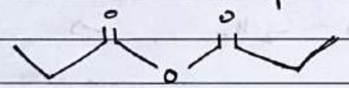
$$\left.\begin{matrix} CH_3-\overset{O}{\overset{\|}{C}}-OH \\ CH_3-\underset{O}{\underset{\|}{C}}-OH \end{matrix}\right\} \xrightarrow{-H_2O} CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3$$



General formula → $(RCO)_2O$

Eg ↳ $(CH_3CO)_2O$ → Ethanoic Anhydride

$(C_2H_5CO)_2O$ → Propanoic Anhydride



★ **Amines** $R-NH_2$ (alkanamine) (amino alkane)

Eg → CH_3NH_2 → Methanamine

$C_2H_5NH_2$ → Ethanamine

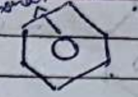
$C_3H_7NH_2$ → Propanamine

$CH_3-CH_2-\underset{NH_2}{\underset{|}{CH}}-CH_3$ → 2-Amino butane

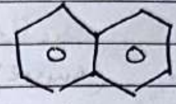
:: Homologous differ by CH_2

★ **Aromatic Compounds**

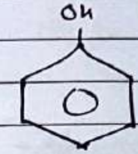
cycling of pi-bonds



→ Benzene C_6H_6

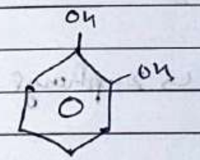
↳  → Homologous series of benzene (add another ring)

↳ Napthalene

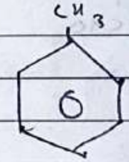
↳ 

→ Phenol (1-hydroxy benzene)

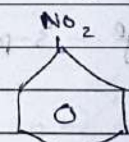
C_6H_6 → Benzene
– 1 Hydrogen for substitution
↳ C_6H_5 → Phenyl

↳ 

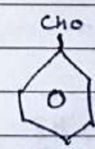
→ 1, 2 - dihydroxy - benzene

↳ 

→ Methyl Benzene (Toluene - Industrial Name)

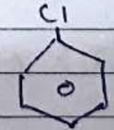
↳ 

→ Nitrobenzene

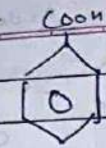
↳ 

→ Benzaldehyde / Benzene carbaldehyde

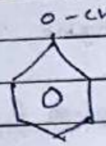
→ 1 - phenyl methanal

↳ 

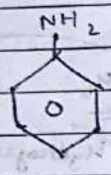
→ Chlorobenzene



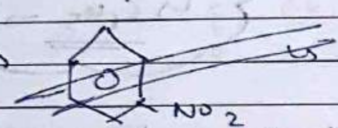
→ Benzene carboxylic acid
~~Benzenoic acid~~ Benzoic Acid
1-phenyl-methanoic acid

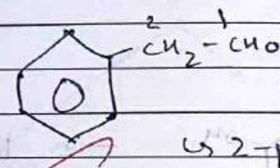


→ Methoxy benzene (Anisole)



→ Amino benzene





→ 2-phenyl ethanal

Eg (1) $\overset{6}{C}H_3 - \overset{5}{C}H(CH_3) - \overset{4}{C}H(OH) - \overset{3}{C}H(C_6H_5) - \overset{2}{C}H_2 - \overset{1}{C}HO$

→ 4-hydroxy ~~3-phenyl~~ - 5-methyl - 3-phenyl hexanal

(2) $\overset{4}{C}H_3 - \overset{3}{C}H_2 - \overset{2}{C}H = \overset{1}{C}H - C_6H_5$

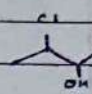
→ 1-phenyl-but-1-ene

(3) $\overset{6}{C}H_3 - \overset{5}{C}H(Cl) - \overset{4}{C}H(OH) - \overset{3}{C}(CH_3) - \overset{2}{C}H_2 - \overset{1}{C}HO$ (with C=O)

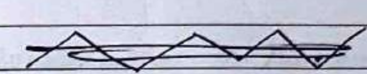
→ 5-Chloro-4-hydroxy-4-methyl-3-oxo-hexanal

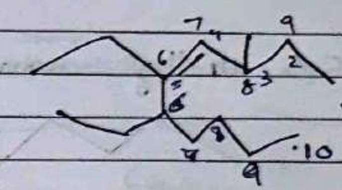
(4) Which represents correct names?

(1) 2-Chloro-Butan-3-ol
3-Chloro-2-Butanol



(2)



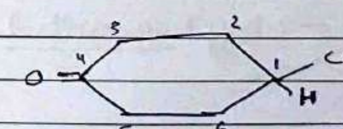


→ 5,6-diethyl-3-methyl-dec-4-ene

(3) $\overset{6}{H} - \overset{}{C}(=O) - \overset{5}{C}H_2 - \overset{4}{C}H_2 - \overset{3}{C}H(CHO) - \overset{2}{C}H_2 - \overset{1}{C}HO$

→ 3-~~formyl hexan-1,6-dial~~
Butan-1,2,4-tricarbaldehyde

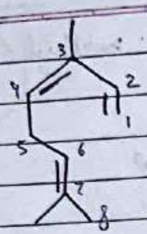
(4)

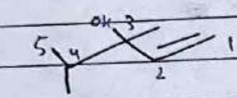


→ 1-(4-oxo-cyclohexyl) ~~carboxylic~~ acid
methanoic

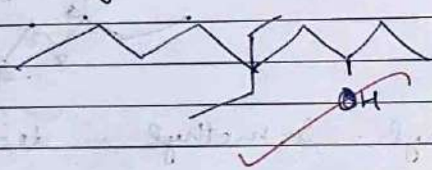
(5) $\overset{6}{C}H_3 - \overset{5}{C}(=O) - \overset{4}{C}H_2 - \overset{3}{C}(=O) - \overset{2}{C}H_2 - \overset{1}{C}(=O) - OH$

→ 3,5-dioxo-hexanoic acid

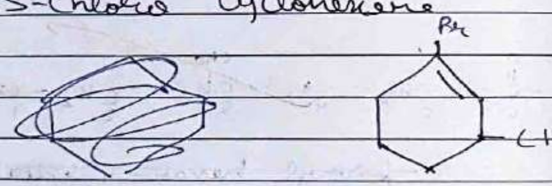
(6)  ↳ 3,7-dimethyl-octa-1,3,6-triene.

(7)  → 3,4-dimethyl-pent-1-en-3-ol

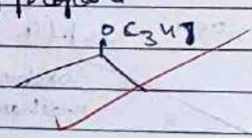
(8) 5,5-diethyl-nonane-3-ol



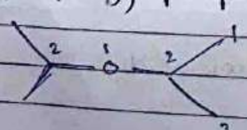
(9) 1-Bromo-3-Chloro Cyclohexene



(10) 2-propoxy propane



(11) 2-(2-propoxy) propane



* Delocalization of σ-bond is permanent.
" of π-bond is temporary

* Reaction Mechanism.

↳ Reactant + Reagent
catalyst, pressure, temp ↓ medium agent
Product

Type of Reagents:
Electrophile: -ve charge seeker
Nucleophile: +ve charge seeker

↳ Delocalization of σ-bond breaks up the compound into ions.

↳ Delocalization of π-bond ~~breaks~~ doesn't leads to splitting of compound.

Eg. Inductive: $CH_3-Cl \rightarrow CH_3^+ + Cl^-$ Electromeric

$>C=O \leftrightarrow >C^+-O^-$

+I: Electron donating
-I: Electron withdrawing

↳ Inductive Effect :→ +I & -I
EN more than carbon; EN less than carbon

+I → Electron donating (ERG)
C is bonded to less EN. atom

-I → Electron withdrawing (EWG)
C is bonded with more EN atom.

↳ Electromeric Effect :→

Q→ (i) $CH_3-Cl + KOH_{(aq)} \rightarrow KCl + CH_3OH$

σ-bond undergoes substitution
π-bond undergoes addition

Eg $CH_3 - \overset{CH_3}{\underset{CH_3}{C}} - H$ & $CH_3 - \overset{CH_3}{\underset{CH_3}{C}} - Cl$

+I ~~Carbon has more EN~~

−I Cl has more EN

Eg $CH_3COOH + H_2O \rightleftharpoons CH_3COO^- + H_3O^+$

$ClCH_2COOH + H_2O \rightleftharpoons ClCH_2COO^- + H_3O^+$

$K_{a_1} =$

$K_{a_2} =$

~~$Cl - C(=O) - O - H$~~

Eg 1. $CH_3 - C(=O) - O - H$

+I ↳ This causes carbon will have lesser tendency to pull.

$ClCH_2 - C(=O) - O - H$

−I ↳ This leads to pulling of shared pair more.

∴ Tendency of releasing H^+ is more.

* Electromeric Effect

① $>\overset{\oplus}{C} = \overset{\ominus}{O} + \overset{\oplus}{H}\overset{\ominus}{CN}$ (CN) (C=O) Nucleophilic Addition Reaction

↳ $>C(CN)(OH)$

② $CH_3 - \underset{O}{\underset{\|}{C}} - CH_3 + HCN$

↳ $CH_3 - \overset{CN}{\underset{OH}{C}} - CH_3$

③ ~~$>\overset{\oplus}{C} = \overset{\ominus}{C}<$~~ $+ HBr$

~~$>\overset{Br}{C} - CH<$~~ $\rightarrow H - \overset{H}{\underset{H}{C}} - \overset{Br}{\underset{H}{C}} - H$ same

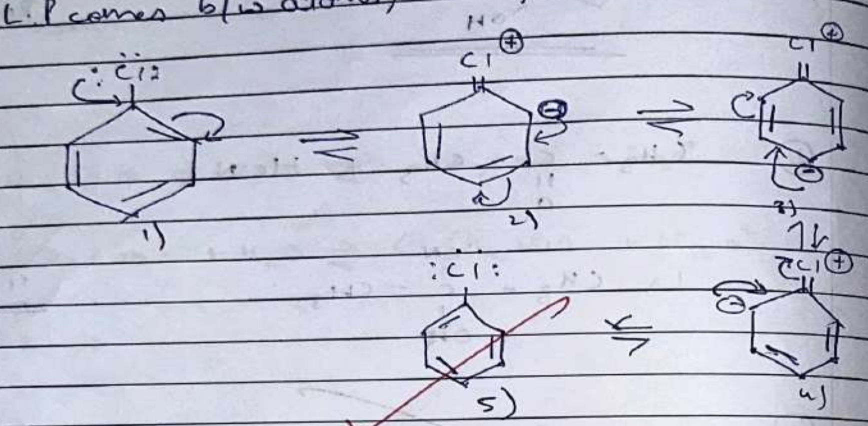
④ $CH_3 - \overset{\oplus}{CH} = \overset{\ominus}{CH_2} + HBr$

$CH_3 - \overset{Br}{\underset{H}{C}} - \overset{H}{\underset{H}{C}} - H$ or $CH_3 - \overset{H}{\underset{H}{C}} - CH_2Br$

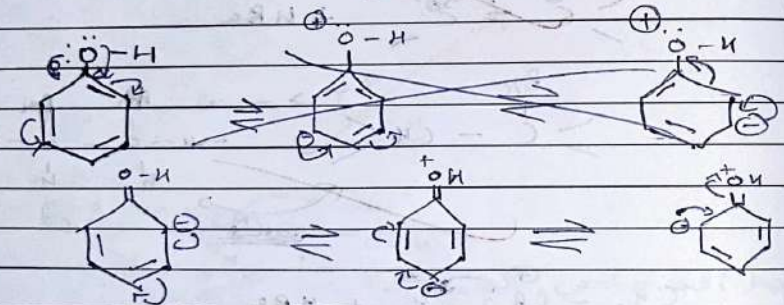
* Resonance effect

↳ L.P → B.P & B.P → L.P

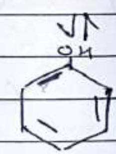
↳ L.P comes b/w atoms, B.P goes on the atom

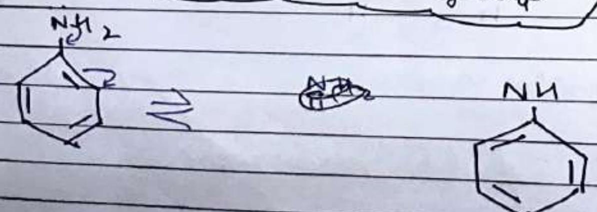


Eg

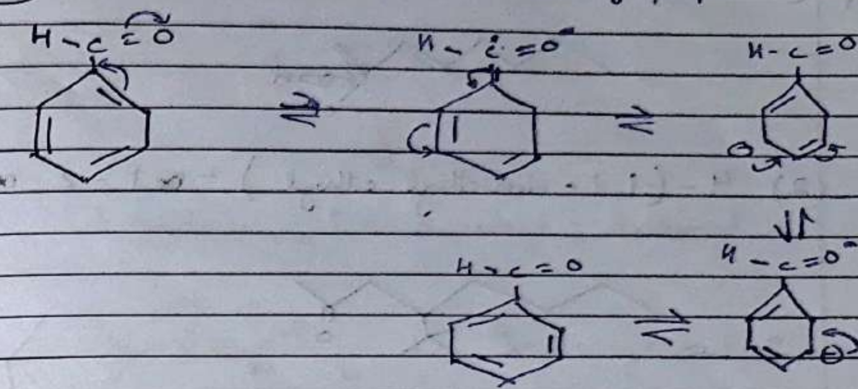


* L.P generated at 2, 4, 6
(+R) ortho - para group





→ (−R) → e^- taken away → meta groups



• COOR, SO_3H, Br^-, OH, −OR, CN

−R, −R, +R, +R, +R, −R

☆ Types of Reagents

1. Electrophile < Positive / Negative — Deficient of e^-
2. Nucleophile < Negative / Neutral — Rich in e^-
3. Free Radicle

NH_3, NO_2^+, Cl_2, BF_3, OH^-

NH_3 — Neutral Nucleophile; NO_2^+ — Positive Electrophile; Cl_2 — F.R; BF_3 — Neutral Electrophile; OH^- — Negative Nucleophile

↳ $CH_4 + Cl_2 \xrightarrow{\text{sunlight}} CH_3Cl + HCl$

Cleavage - Breakage

CH_3 H

↳ Cl — Cl

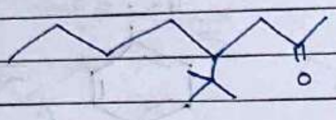
Cl· ·Cl → Cleavage

Free radicle Substitution

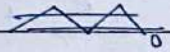
Date: 28/10/24

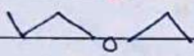
Q. (1) Hept-2-ynoic acid

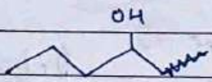
(2) 4-(1,1-dimethyl ethyl)-~~oct~~-2-one

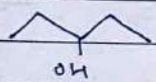


(3) $C_5H_{12}O$ (All possible structures)

→ 1)   } Functional isomers

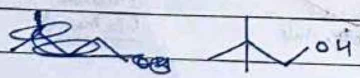
→ 2) 

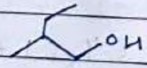
3) 

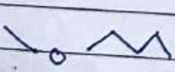
4)  } Positional

Metamers ←

5) 

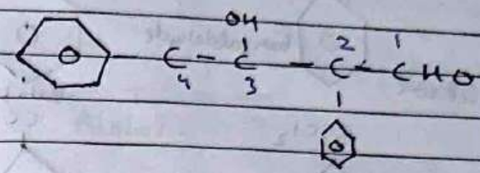
6) 

7)  } Chain

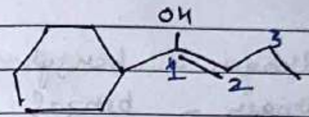
→ 8) 

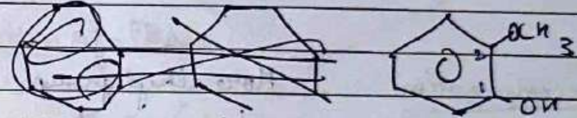
9)  } Chain

---

Q. 

↳ 3-hydroxy-2,4-diphenyl-butanal

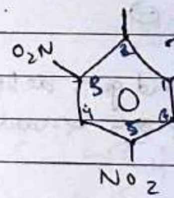
Q.  ↳ 1-phenyl but-3-en-1-ol

Q. 

→ ~~1-methoxy 2-hydroxy benzene~~

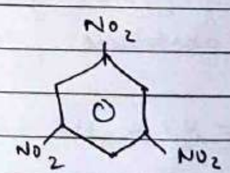
2-methoxy phenol

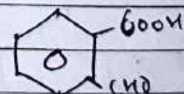
→ ~~Methoxy~~

Q.  → Trinitrotoluene (TNT)

→ ~~1,3,5-trinitro~~

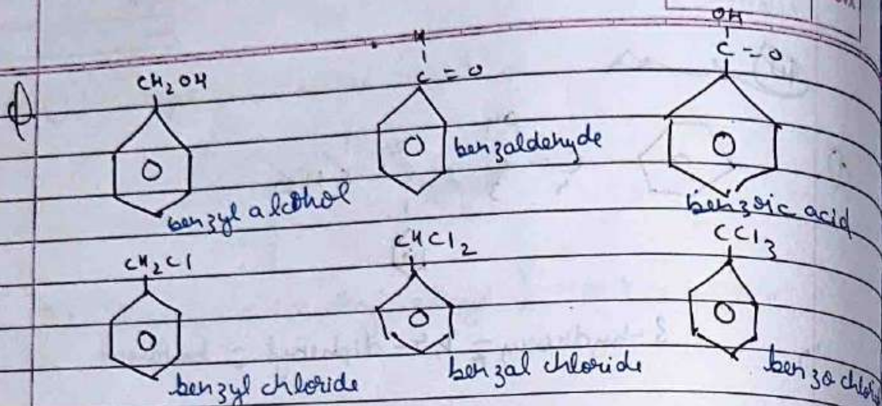
↳ 2-methyl-1,3,5-trinitro-benzene

Q.  → 1,3,5-trinitro-benzene

Q.  → 2-formyl benzene carboxylic acid

or

1-(2-formyl phenyl) methanoic acid



Single carbon → 2 hydrogen : benzyl
1 hydrogen - benzal
0 hydrogen - benzo

★ Hyperconjugation — More alkyl groups attached
↳ more hyper conjugation

$H-\overset{H}{\underset{H}{C}}-C=C^{\ominus}$ — α carbon (the carbon next to carbon having pi bond)

↳ $H-\overset{H}{\underset{H}{C}}=C-C^{\ominus}$

↳ σ bond gets delocalized from α-carbon.

22-11-24

Date: 12/11/24

★ Ch-9 : Hydrocarbons

$\underbrace{\text{Saturated, Cyclic}}_{\text{Aliphatic}}$, $\underbrace{\text{Aromatic, Unsaturated}}_{\text{Aromatic}}$

★ Alkanes

- Isomers
  - → Normal (n-)
  - → Iso (iso-)
  - → neo (neo-)

- Preparation of alkane:

① Alkene method (Hydrogenation) — Adsorption of H_2 occurs.

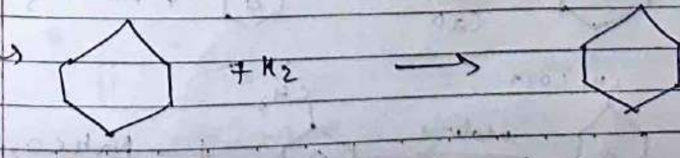
$$CH_2=CH_2 + H_2 \xrightarrow[Pd]{Ni/Pt} CH_3-CH_3$$

Ni/Pt → catalyst — Increases rate

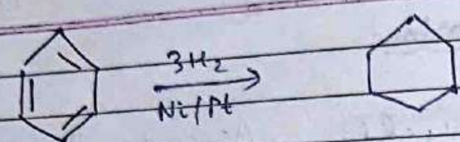
Addition reaction → called hydrogenation

- $C_1 - C_4$ → Gas
  $C_5 - C_{10}$ → Liquid
  C_{11} onwards → Solid

Eg $CH_3-CH=CH_2 \xrightarrow[Ni/Pt]{H_2} CH_3-CH_2-CH_3$

↳ 

R – alkyl group



(2) By alkyl halide R–X

R–X + Na → R–R + NaX

Through lower member alkyl halide, higher member alkane

→ $CH_3Cl + Na \rightarrow C_2H_6 + NaCl$

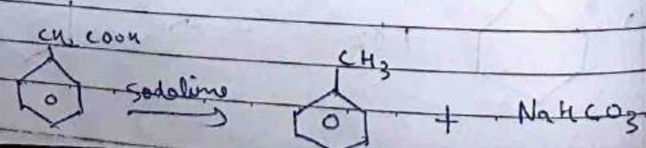
(3) From carboxylic acid (~~Lower~~ Higher member chain → Lower member chain)

R–COOH → R–H .

$-COO^-$ → Carboxyl group

$$R\text{-}COOH \xrightarrow[CaO]{NaOH} R\text{-}H + NaHCO_3$$

soda lime

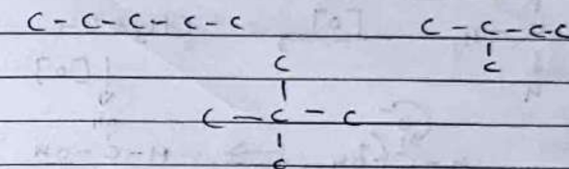


* Physical Property

→ Solubility → Decreases as carbon increase.

→ Boiling Point → Increases as carbon increase

Eg



→ Increase in branching → Increase in solubility, Decrease in B. P.
(Decrease in Surface Area)
(Decrease in Force of Attraction)

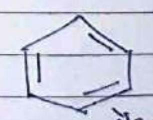
* Chemical Properties

CH_4, CH_3-CH_3

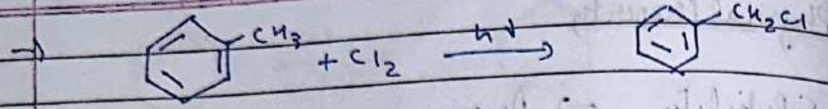
→ $CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl$
→ CH_2Cl_2
→ $CHCl_3$
→ CCl_4

→ $CH_3-CH_3 + Cl_2 \xrightarrow{h\nu} CH_3-CH_2Cl$

→ $\overset{1^\circ}{C}H_3 - \overset{2^\circ}{C}H_2 - \overset{1^\circ}{C}H_3 + Cl_2 \xrightarrow{h\nu} CH_3-CHCl-CH_3$
(Higher degree carbon will have substitution)

→  $+ Cl_2 \xrightarrow{h\nu}$ No reaction

→ sp^2 hybridized free radicle doesn't undergo substitution



*** Oxidation** → Adding of oxygen!

symbol

$H-\underset{H}{\overset{H}{C}}-H \xrightarrow{[O]} CH_3-OH$ (Alcohol)

$\downarrow [O]$

$H-\underset{}{\overset{OH}{C}}-OH$

$H-\overset{O^-}{C}(\overset{+}{O}H_2) \rightleftharpoons$

cleavage

(Two OH on single carbon is unstable. One H will get attracted to O because of lone pair and detaches as H_2O. L.p → B.p on remaining oxygen to form pi bond)

$H-\underset{H}{\overset{O}{\overset{\|}{C}}}$ → Aldehyde

$H-\underset{H}{\overset{O}{\overset{\|}{C}}}$ $\xrightarrow{[O]}$ $H-\overset{O}{\overset{\|}{C}}-OH$ → $HO-\overset{O}{\overset{\|}{C}}-OH$

Aldehyde Carboxylic

↓

→ $H_2O^+ \overset{O}{\overset{\|}{C}}-O^-$

↓

$\overset{O}{\overset{\|}{C}}=O$

$\boxed{CO_2}$

$\xrightarrow{[O]}$ Alcohol

* Alkane $\xrightarrow{[O]}$ Aldehyde $\xrightarrow{[O]}$ Carboxylic

Nascent oxygen

↳ $CH_3CH_2OH \xrightarrow{[O]}$

*** Combustion** (Burning of hydrocarbons)

↳ $C_xH_y + O_2 \longrightarrow xCO_2 + yH_2O$

*** Controlled Oxidation** or **Catalytic Oxidation**

↳ Use of specific catalyst only!

Used where direct conversion is needed!

Alkane → Alcohol

Alkane → Carboxylic

Alkane
- $\xrightarrow[523K,\ 120\ atm]{Cu\ tube}$ Alcohol
- $\xrightarrow{Mo_2O_3}$ Aldehyde
- $\xrightarrow{(CH_3COO)_2Mn}$ Acid

*** Cracking / Pyrolysis** (Higher alkane breaks into smaller alkene & alkane)

↳ $C_5H_{12} \xrightarrow{\Delta} C_2H_4 + C_3H_8$

X ——— X ——— X ——— X

*** Alkenes**

- Preparation

① Alcohol $CH_3CH_2OH \xrightarrow[H_2SO_4]{conc.} CH_2=CH_2 + H_2O$

$CH_3CH_2OH \overset{-H^+}{\rightleftharpoons} CH_3CH_2\overset{+}{O}H_2 \overset{-H_2O}{\rightleftharpoons} CH_3\overset{\oplus}{C}H_2 \overset{-H^+}{\rightleftharpoons} CH_2=CH_2$

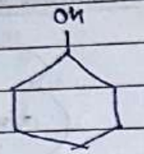
22-11-24

β → carbon donating H

↳ $CH_3-\underset{OH}{CH}-CH_3 \xrightarrow{conc\ H_2SO_4} CH_3CH=CH_2$

↳ $CH_3-\overset{\beta}{CH_2}-\underset{OH}{CH}-\overset{\beta}{CH_3} \xrightarrow[H_2SO_4]{conc} H_3C-CH=CH-CH_3$

↳



cyclohex-1-ene

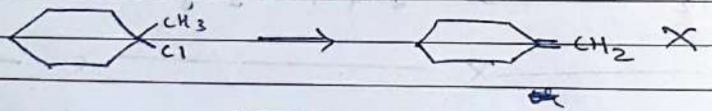
(2) By alkyl halide (Dehydrohalogenation) β-elimination
nucleophilic elimination — Saytzeff's Rule

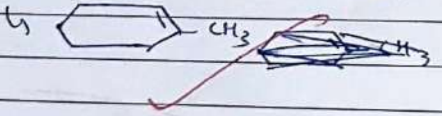
↳ $CH_3CH_2Cl + KOH_{(alc)} \longrightarrow CH_2=CH_2 + KCl + H_2O$

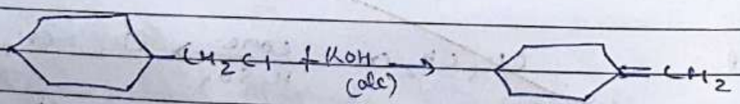
$CH_3\underset{Cl}{CH}CH_3 \longrightarrow CH_2=CH-CH_3 + HCl$ "

→ look for symmetry

$CH_3CH_2\underset{Cl}{CH}CH_3 \longrightarrow CH_3CH=CHCH_3$ "







* Alkene having more alkyl groups is more stable

Addition will take place on carbon having less H. (in alkene) assymetrical

(3) By vicinal dihalides

↳ Dihalides which have halogen atoms on adjacent ~~at carbon~~ ~~or same carbon~~

$\underset{}{\overset{Cl}{CH_2}} - \overset{Cl}{CH_2} \xrightarrow{+Zn} CH_2=CH_2 + ZnCl_2$

(4) By alkyne

↳ $CH=CH + H_2 \xrightarrow[Pd]{Ni/Pt} CH_2=CH_2$

★ Chemical Properties

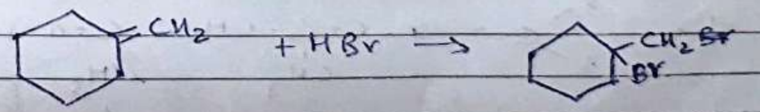
↳ (1) $CH_2=CH_2 \xrightarrow{Ni} CH_3-CH_3$

(2) $CH_2=CH_2 + Cl_2 \longrightarrow \underset{Cl}{CH_2}-\underset{Cl}{CH_2}$

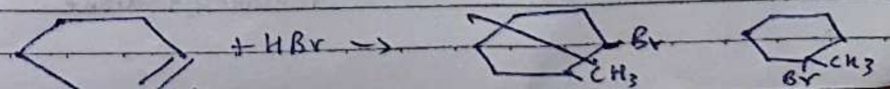
(3) $CH_2=CH_2 + HBr \longrightarrow CH_3-CH_2Br$

(4) $CH_3-\underset{CH_3}{C}=CH_2 + HBr \longrightarrow CH_3-\underset{CH_3}{\overset{Br}{C}}-CH_3$

(5)



(6)

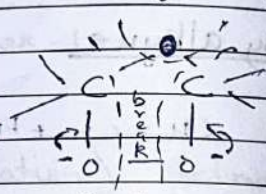


* Hydration of Alkene

↳ $CH_2=CH_2 + H_2O \xrightarrow[H_2SO_4]{conc} CH_3-CH_2OH$

H_2SO_4 ↓ to ionise water

* ozonolysis of Alkene

↳ $>C=C< + O_3 \rightarrow$ 

↓ O gets cleavaged by zinc

↳ House structure common for all

$>C=O + O=C< + ZnO$ ($Zn-H_2O$)

Eg $(CH_3)_2C=C(CH_3)_2 \xrightarrow[Zn-H_2O]{O_3} CH_3-\underset{\|}{\overset{}{C}}(O)-CH_3 + CH_3-\underset{\|}{C}(O)-CH_3 + ZnO$

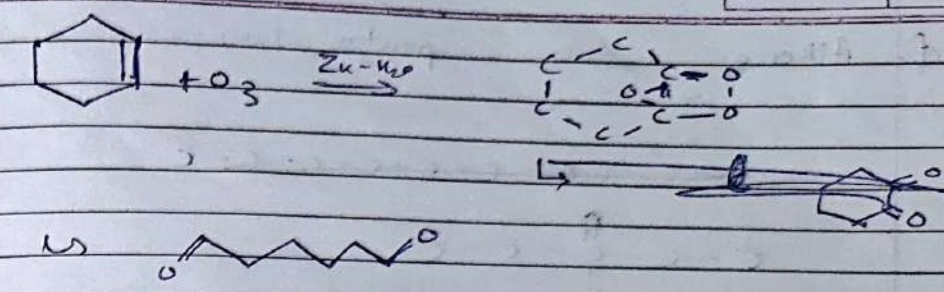
Eg $CH_2=C(CH_3)-CH_2-C(CH_3)=CH_2$

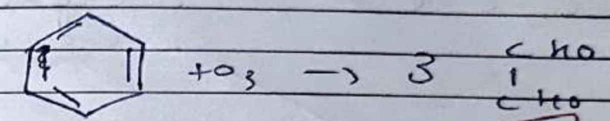
$\downarrow O_3$, $Zn-H_2O$

↳ $H_2C=O + O=C(CH_3)-CH_2-C(CH_3)=O + O=CH_2$

Methanal

Pentan-2,4-dione

Eg 



Q. Find alkene whose ozonolysis as ethanal & propanal as only product

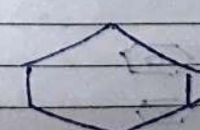
$C-C=C-C-C + O_3$

↓ Pent-2-ene

↳ $C-C=O + O=C-C-C$

Q. Alkene whose O_3 gives hexane-di-al as only product

$\underset{\|}{C}(O)-C-C-C-C-\underset{\|}{C}(O)$

 → cyclohexene

pentan - 3 one

Q. Alkene

C – C – C – C – C – C – C – C – C – C

$C - C - \overset{}{\underset{\|}{C}} - C - C$

O

$C - C - \overset{O}{\overset{\|}{C}} - C - C$

$C - C - C - C - C$

$C - C - \overset{\|}{C} - C - C$

Q. Ethanal + Pentan - 2, 4 - dione + Ethanal

$C_2H_5O + C - \overset{O}{\overset{\|}{C}} - C - \overset{O}{\overset{\|}{C}} - C + OC_2H_5$

⇒ ~~$C_2H_5 = O$~~

⇒ $CH_3 - CH = \underset{CH_3}{\underset{|}{C}} - \overset{C}{C} - \underset{CH_3}{\underset{|}{C}} = CH - CH_3$

Q. 3,5- dimethyl - hept - 2,5- diene

Q. Methyl Phenyl ketone

$CH_3 - \overset{O}{\overset{\|}{C}} -$ ⌬

↳ $CH_3 - \underset{\|}{C} -$ ⌬

$CH_3 - C -$ ⌬

2,3 - diphenyl - but - 2 - ene

★ $CH_2 = CH_2 + H_2O_2 \longrightarrow \underset{OH}{\underset{|}{CH_2}} - \underset{OH}{\underset{|}{CH_2}}$

glycol

ethan - 1,2 - diol

★ CH_2OH
$|$
$CHOH$
$|$
CH_2OH ⟶ glycerol

★ Polymerisation

This is not ethane

↳ $n\, CH_2 = CH_2 \longrightarrow \left(- \underset{|}{\overset{|}{C}} - \underset{|}{\overset{|}{C}} - \right)_n$

moles Ethene

Poly - ethene → no. of linkages

$\overset{\frown}{CH_2 = CH_2}$ (one e^- each distributed)

→ It will remain as ethene but is free to form monomer

× ——— × ——— × ——— × ——— ×

★ Alkynes C_nH_{2n-2}

• Preparation

(1) $\underset{Br}{\underset{|}{CH_2}} - \underset{Br}{\underset{|}{CH_2}} \xrightarrow[(alc)]{2KOH} CH \equiv CH$ ~~$+ 2KBr + 2H_2O$~~

$CH_3 - \underset{Br}{\underset{|}{CH}} - \underset{Br}{\underset{|}{CH}} - CH_3 \xrightarrow{2KOH} CH_3 - C \equiv C - CH_3 + 2KBr + 2H_2O$

(2) $CH_3CH_2^{\oplus}-Br^{\ominus} + Na^{\oplus}\ C^{\ominus}\equiv CH$ (sodium Acetylide)

↳ $CH_3CH_2-C\equiv CH$

* Chemical Properties

① $CH\equiv CH + 2HBr \Rightarrow CH_2(Br)-CH_2(Br)$

↳ $CHBr=CH_2$

$H-C(Br)=CH_2 + HBr \longrightarrow CHBr_2=CH_2$

Addition at H ~~containing~~ less hydrogen

② $CH_3-C\equiv CH + 2HBr \longrightarrow CH_3-CBr_2-CH_3$

③ Hydration of Alkyne

↳ $CH\equiv CH + H_2O \xrightarrow[Hg^{+2}]{H_2SO_4} CH_2=CH(OH)$ enol

⇅ tautomerism

$CH_3-C(=O)-H$ keto

Only ethyne makes aldehyde
Rest all alkynes make ketone

Eg. $CH_3-C\equiv CH + H_2O \xrightarrow[HgSO_4]{H^+} CH_3-C(OH)=CH_2$

⇅

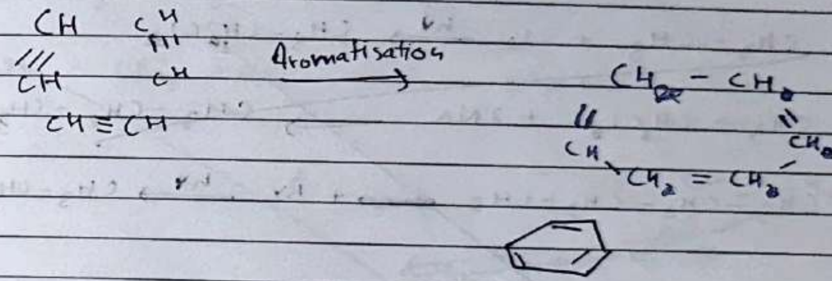
$CH_3-C(=O)-CH_3$

③ $CH\equiv CH + 2H_2 \xrightarrow[Pt]{Ni} CH_2=CH_2 \rightarrow CH_3-CH_3$

④ $CH\equiv CH + 2Cl_2 \rightarrow CHCl_2-CHCl_2$

↳ 1,1,2,2-tetrachloro ethane

⑤ $3\ CH\equiv CH \xrightarrow{\text{Aromatisation}}$ benzene



⑥ Polymerisation

$CH\equiv CH + HC\equiv CH$

↳ ~~$CH=CH-CH=CH$~~

↳ $\sim CH=CH-HC=CH\sim$

1) Convert : Butane → Ethanal

$C-C\equiv C-C \xrightarrow{[O]} C-C(OH)-C$

$\longrightarrow$

$CH_3-CH_2-CH_2-CH_3 \xrightarrow[Cl_2]{h\nu} CH_3-CHCl-CH_2-CH_3$

Alchotic KOH

$CH_3-CH=CH-CH_3$

$2\,CH_3-\overset{O}{\overset{\|}{C}}H \xleftarrow{+O_3} CH_3-CH=CH-CH_3$

Q. Ethane to 2-Bromo-Butane.

CH_3-CH_3 to $CH_3-CHBr-CH_2-CH_3$

$CH_3-CH_3+Cl_2 \xrightarrow{h\nu} CH_3-CH_2Cl$

$CH_3-CH_2Cl+2Na \longrightarrow CH_3-CH_2-CH_3$

$CH_3-CH_2-CH_2-CH_3+Br \xrightarrow{h\nu} CH_3-CHBr-CH_2CH_3$

$CH_3-CH_3+Cl_2 \xrightarrow{h\nu} CH_3-CH_2Cl + HCl$

$CH_3-CH_2Cl+Na \longrightarrow CH_3-CH_2-CH_3$

$Cl_2\ h\nu$

$CH_3-CHCl-CH_3$

$CH_3-CHBr-CH_2CH_3 \xleftarrow[h\nu]{Br} CH_3-CH_2-CH_2-CH_3$ $\xleftarrow{+Na}$

$CH_3-CH_3+Cl_2 \xrightarrow{h\nu} CH_3-CH_2Cl$

$CH_3-CH_2Cl+Na \longrightarrow CH_3-CH_2-CH_2-CH_3$

$CH_3-CHBr-CH_2-CH_3 \xleftarrow[Br]{h\nu}$

Q. Ethanoic Acid $\longrightarrow$ Bromomethane.

CH_3-COOH to CH_3Br

$CH_3-COOH \xrightarrow[CaO]{NaOH} CH_4+NaHCO_3$

$CH_4+Br_2 \xrightarrow{h\nu} CH_3Br$

Q. Ethane $\longrightarrow$ Bromoethene

$CH_3-CH_3 \longrightarrow CH_2=CHBr$

$CH_3-CH_3+Cl_2 \xrightarrow{h\nu} CH_3-CH_2Cl$

$+KOH$

$CH_2=CH_2$

$CH_2=CHBr \xleftarrow[Br]{h\nu}$

$CH_2=CH_2+Br_2 \xrightarrow{KOH} \underset{Br}{CH_2}-\underset{Br}{CH_2}$

$+2KOH$

$CH\equiv CH$

$CHBr=CH_2 \xleftarrow[Br]{h\nu}$

Ans

$CH_3-CH_3 \xrightarrow[h\nu]{+Br_2} CH_3-CH_2Cl \xrightarrow{+KOH} CH_2=CH_2$

$+Br_2$

$CH_2=CHBr \xleftarrow{+HBr} CH\equiv CH \xleftarrow{+2KOH} \underset{Br}{CH_2}-\underset{Br}{CH_2}$

Q. Propane $\longrightarrow$ Propanone.

$CH_3-CH_2-CH_3 \longrightarrow CH_3-\overset{O}{\overset{\|}{C}}-CH_3$

$CH_3-CH_2-CH_3 + Br_2 \xrightarrow{h\nu} CH_3-CHBr-CH_3$

$\downarrow KOH$

$CH_3-CH=CH_2$

$\downarrow + Br_2$

$CH_3-C\equiv CH \xleftarrow{+2KOH} CH_3-CHBr-CH_2Br$

$CH_3-C\equiv CH + H_2O \xrightarrow[Hg^{+2}]{+H_2SO_4}$

$CH_3-C=CH$ (OH)

$CH_3-\overset{\oplus}{C}=CH_2 \longrightarrow CH_3-\underset{O}{\underset{\|}{C}}-CH_3$

Q. 1-Bromopropane $\longrightarrow$ 2-bromopropane

$CH_3-CH_2-CHBr \longrightarrow CH_3-CHBr-CH_3$

↳ $CH_3-CH_2-CHBr + KOH_{(alc)} \longrightarrow CH_3-CH=CH_2$

$CH_3-CH=CH_2 + HBr \longrightarrow CH_3-CHBr-CH_3$ $\downarrow Br_2\ h\nu$

~~$CH_3-CHBr-CH_3$~~

Q. 2-Bromobutane $\longrightarrow$ Ethanal.

↳ $CH_3-CHBr-CH_2-CH_3 \longrightarrow CH_3-CHO$

↳ $CH_3-CHBr-CH_2-CH_3 + KOH \longrightarrow CH_3-CH=CH-CH_3$

$\downarrow O_3$

$CH_3-CHO + CH_3-CHO$

Q. Organic compound A (M.F $\rightarrow$ C_5H_{10} pentene) on ozonolysis gives 2 products B & C. Both are functional isomers of each other.

↳ ~~$C-C=C-C-C + O_3 \rightarrow HCHO + \ldots$~~

↳ ~~$C-C=C-C-C + O_3 \xrightarrow{Zn-H_2O} CH_3-CHO + CH_3-CH_2CHO$~~

~~$CH_3-\overset{H}{\underset{H}{C}}-\overset{O}{\overset{\|}{C}}-H + CH_3-\overset{O}{\overset{\|}{C}}-CH_3$~~

↳ $C-C=\underset{C}{C}-C + O_3 \xrightarrow{Zn-H_2O} CH_3CHO + CH_3COCH_3$

A $\rightarrow$ 2-methyl-but-2-ene ... 2-methyl-but-1-ene

B $\rightarrow$ Ethanal (Acetaldehyde) or Methanal

C $\rightarrow$ Propan-2-one ... Butan-2-one

Q. $C_5H_{11}Br$ ('A') $\xrightarrow{KOH\,(alc)}$ B $\xrightarrow{HBr}$ C

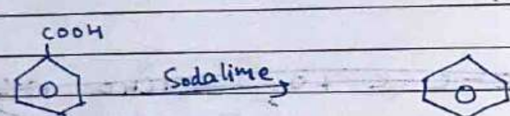
A → $CH_3-CH_2-CH_2-CH_2-CHBr$

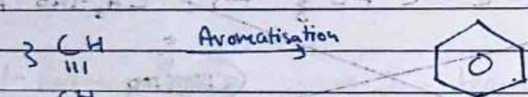
B → $CH_3-CH_2-CH_2-CH=CH_2$

C → $CH_3-CH_2-CH_2-CHBr-CH_3$

* Aromatic hydrocarbon

• Preparation of benzene

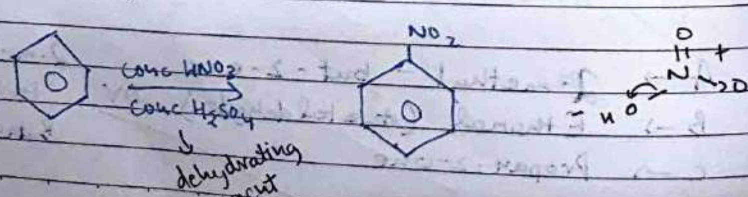
① 

② 

* Chemical Properties

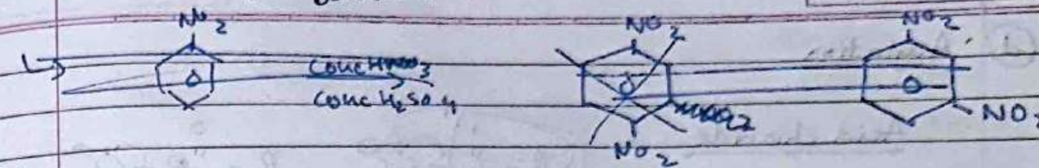
1) Electrophilic substitution reaction of benzene

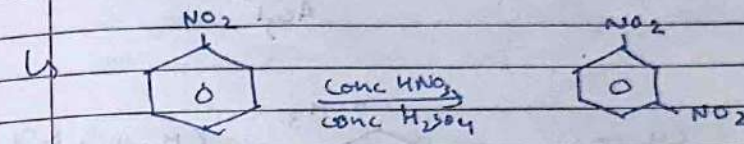
(a) Nitration



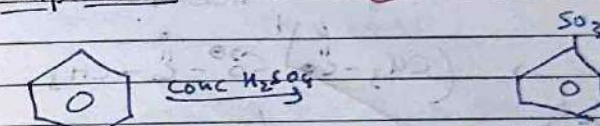
pi - bond = -R

σ - bond = +R

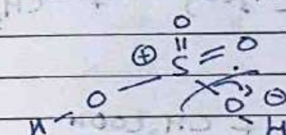




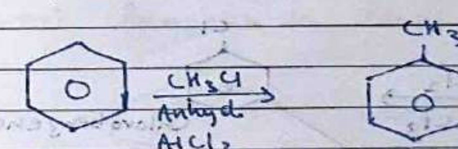
(b) Sulphonation



→ Benzene Sulphonic Acid



(c) Alkylation



(Toluene)

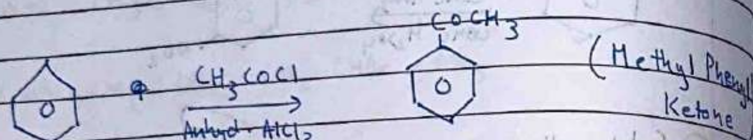
Only R-X &  -X can undergo.

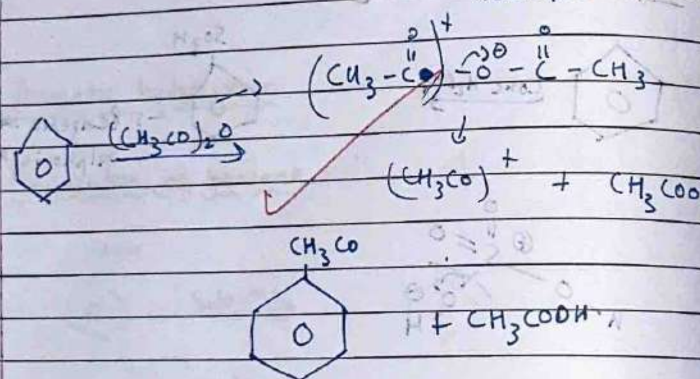
Ar - X will not undergo.
(Aromatic)

(d) Acylation

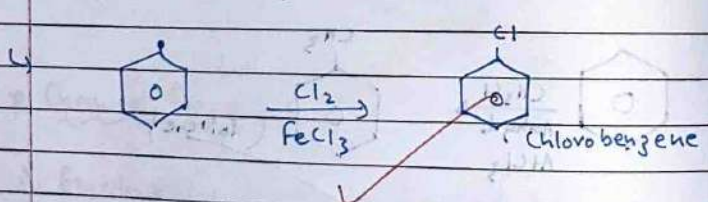
Acid chloride $R-\overset{O}{\overset{\|}{C}}-Cl \rightarrow R-\overset{O}{\overset{\|}{C}}{}^{\oplus} + Cl^{\ominus}$

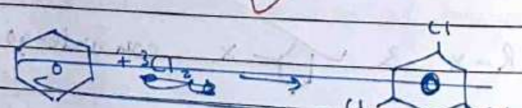
Acyl

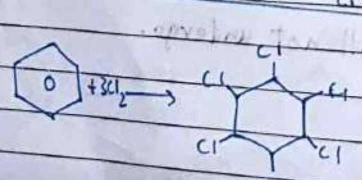




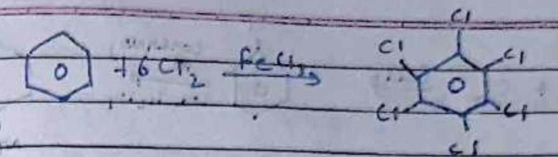
(e) ~~Benzoylation~~ Halogenation







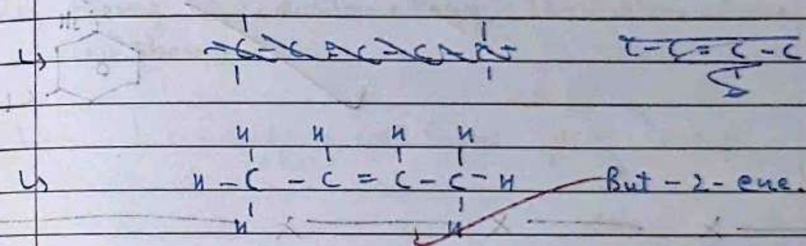
Way



- In presence of $h\nu$ or $FeCl_3$, ~~addition~~ substitution takes place. else, addition takes place.

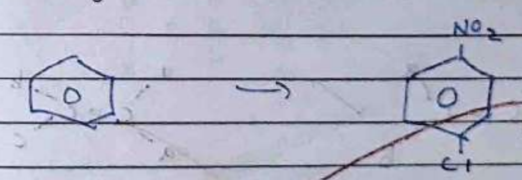
Q. An alkene 'A' contains 3 C-C, 8 C-H, 1 C-C π bond

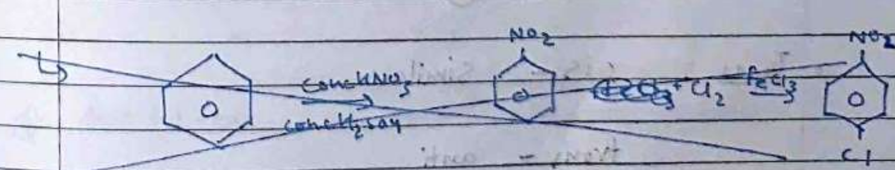
$A \xrightarrow[Zn-H_2O]{O_3}$ 2 Aldehydes (4H each)

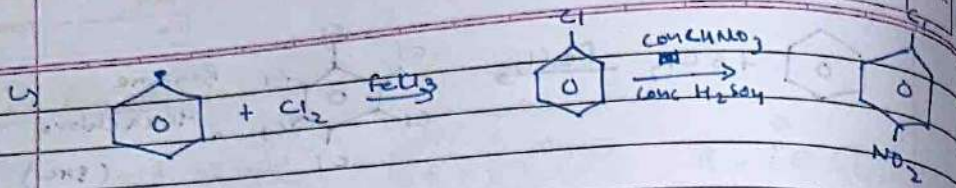


$\therefore$ ~~2 CH_3-CHO~~ $C_4H_8 \xrightarrow[Zn-H_2O]{O_3} 2\ CH_3-CHO$

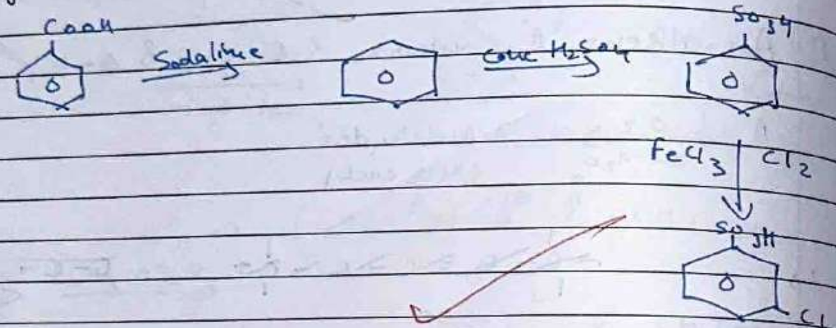
Q. Convert Benzene to Para chloronitrobenzene







Q. Benzoic Acid → Metachlorobenzene sulphonic acid

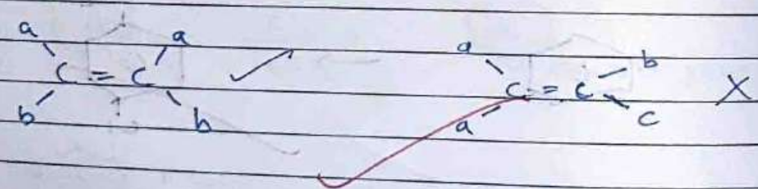


#

x ———— x ———— x ———— x ————

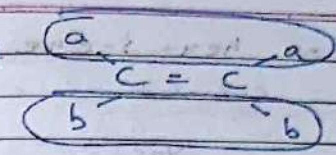
- Geometrical Isomers

↳ For a compound to show GI, it should have atleast 1 C–C π bond & each carbon should have different substituents bonded to it.

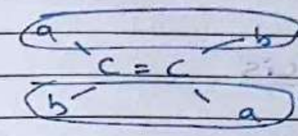


- Types : cis – Similar

  trans – anti

Eg  Same molecules on same side.

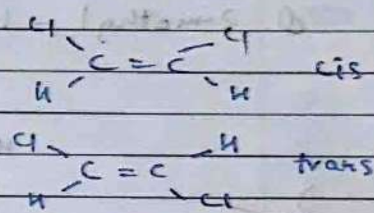
∴ Cis-isomer

 opposite groups on same side.

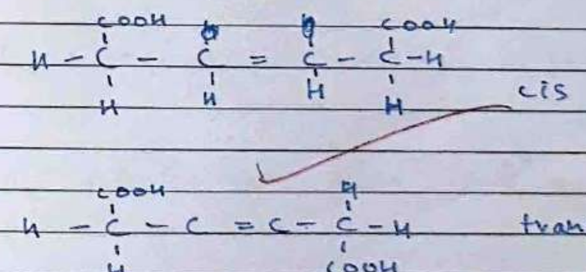
∴ Trans-isomer

Q ↳ Among 1,1-dichloroethene, 1,2-dichloro ethene, which will show GI.

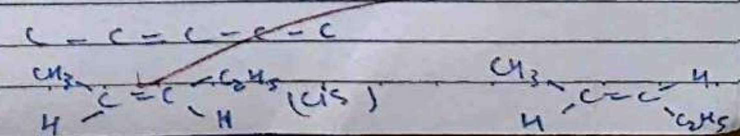
↳ 1,2 - dichloro ethene will show.



Q. But-2-ene-1,4-dioic acid.

↳ 

Q. Pent-2-ene → ~~No, because of~~ ~~No, because of symmetry~~



Q. 2,3-dimethyl but-2-ene or hex-3-ene

$CH_3-\overset{CH_3}{\overset{|}{C}}=\overset{CH_3}{\overset{|}{C}}-CH_3$ No

$C-C-C=C-C-C$ Yes

→ $\overset{C_2H_5}{\underset{H}{>}}C=C\overset{C_2H_5}{\underset{H}{<}}$ cis

→ $\overset{H}{\underset{C_2H_5}{>}}C=C\overset{C_2H_5}{\underset{H}{<}}$ ~~trans~~

Q. 2-methyl-1phenyl-prop-1-ene.

$\overset{C_6H_5}{\underset{H}{>}}C=\overset{CH_3}{\overset{|}{C}}-CH_3$ → No as 2 methyl group on same carbon

17-12-24

* Redox Revision

Oxy → 6×3 = 18

Q. $C_{12}H_{22}O_{11} + HNO_3 \longrightarrow 6H_2C_2O_4 + NO_2 + H_2O$

Reduct → 1×1 = 1

→ $C_{12}H_{22}O_{11} + 18HNO_3 \rightarrow 6H_2C_2O_4 + 18NO_2 + 4H_2O$

→ ~~$2C_{12}H_{22}O_{11} + 36HNO_3 \rightarrow 12H_2C_2O_4 + 36NO_2 +$~~

→ $C_{12}H_{22}O_{11} + 36HNO_3 \rightarrow 6H_2C_2O_4 + 36NO_2 + 23H_2O$

Reduc → 1

Q. $I_2 + HNO_3 \longrightarrow 2HIO_3 + NO_2 + H_2O$

Oxy → 10

→ $I_2 + 10HNO_3 \longrightarrow 2HIO_3 + 10NO_2 + 4H_2O$

Q. $\overset{(+7)}{Mn}O_4^- + \overset{(-1)}{Br^-} \longrightarrow \overset{(+4)}{Mn}O_2 + \overset{+5}{Br}O_3^-$ (Basic)

Oxy → $Br^- + 3H_2O \longrightarrow BrO_3^- + 6H^+ + 6e^-$

Reduc → $(MnO_4^- + 4H^+ + 3e^- \longrightarrow MnO_2 + 2H_2O)_2$

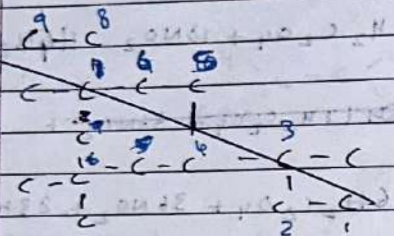
$2MnO_4^- + 8H^+ + Br^- + 3H_2O \rightarrow BrO_3^- + 6H^+ + 2MnO_2 + 4H_2O$

$2MnO_4^- + Br^- + 2H^+ \rightarrow BrO_3^- + 2MnO_2 + H_2O$

$2MnO_4^- + Br^- + H_2O \rightarrow BrO_3^- + 2MnO_2 + 2OH^-$

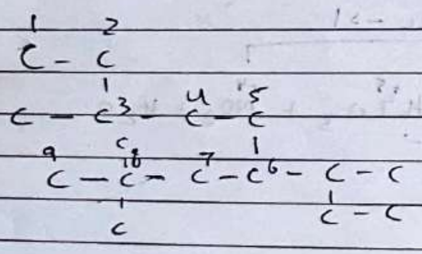
x —— x —— x —— x —— x

Q.(1)



→ ~~4-(2,2-dimethyl propyl)-3,7-dimethyl nonane~~

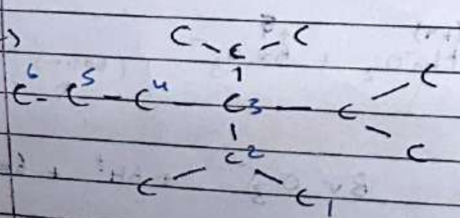
Q →



→ ~~3,6,8-trimethyl-6-(1-methyl propyl)-nonane~~

→ ~~2,2,7-trimethyl-4-(1-methyl propyl)-nonane~~

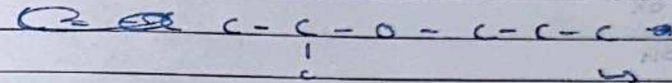
Q →



→ 2-methyl-3,3-(1-methyl ethyl)-hexane

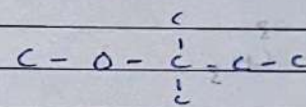
Q. Draw structure of all isomeric ethers having molecular $C_6H_{14}O$

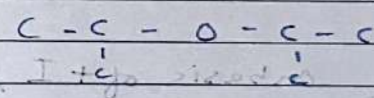
C-C-C-O-C-C-C → Propyl Propyl Ether

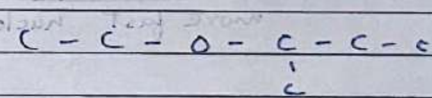


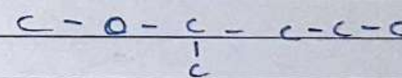
C-C-O-C-C-C-C

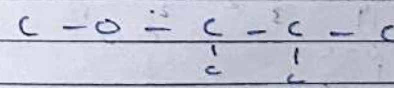
C-O-C-C-C-C-C











Q. $C_4H_6O_6$

→ COOH
H - C - OH
H - C - OH
COOH

Q. $CH_3 - CH_2 - CH_2 - CH_2 - Cl$

$CH_3 - CH(Cl) - CH_2 - CH_3$

$CH_3 - C(CH_3)_2 - Cl$ ← on basis of +I, more fast nucleophilic substitution

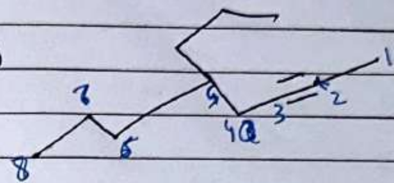
Q. IUPAC

(1) $CH_3CH_2CH(CH_3) - CH_2CH_2 - CH(CH(CH_3)CH_2CH_3) - CH_2 - C(C)(C) - C$

→ ~~3-met~~ 2,2,7 ~~3,8,8~~ - trimethyl-4-(1-methyl propyl)-non-5-...

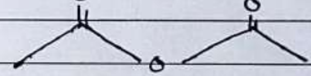
(ii) $C_6H_5 - CH = CH - CH_2Cl$

→ 3-chloro-1-phenyl-prop-1-ene

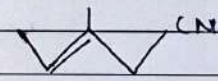
(iii) 

→ 5-propyl-~~hept~~ oct-2-yne

(IV) $CH_3 - CH = CH - CHO$ → But-2-enal

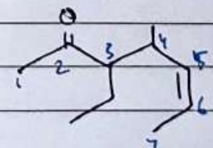
(V) 

→ Ethanoic Anhydride

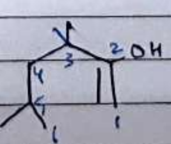
(vi) 

→ 3-methyl-pent-3-ennitrile

vii) $HC \equiv C - CH = CH - CH = CH_2$ → Hex-1,3-dien-5-yne

viii) 

→ 3-ethyl-4-methyl-hept-5-en-2-one

(IX) 

→ ~~2-hydroxy-3,3,5-dimethyl hex-1-en-2-ol~~ tri

3,3,5-trimethyl-hex-1-en-2-ol.