CHEMISTRY Vol. I
FINAL EXAM
QUESTION BANK

CH:1

Q. 1.

A) SI unit of quantity electric current is _____ **(Q.31- Pg.4)**

a] Volt b] Ampere
c] Candela d] Newton

B) A sample of pure water, whatever the source always contains _____ by mass of oxygen and 11.1% by mass of hydrogen. **(Q.7- Pg.32)**

a] 88.9 b] 18
c] 80 d] 16

C) How many g of H_2O are present in 0.25 mol of it? **(Q.14- Pg.32)**

a] 4.5 b] 18
c] 0.25 d] 4.5

Q. 2.

A) What is volume of carbon dioxide, CO_2 occupying by **(Q.106- Pg.27)**

i) 5 moles and
ii) 0.5 mile of CO2 gas measured at STP.

Q. 3.

A) Convert the following degree Celsius temperature to degree Fahrenheit. **(Q.34- Pg.8)**

i) 40°C ii) 30°C

Q. 4.

A) State the low of multiple proportions. **(Q.39- Pg.9)**

CH:2

Q. 1.

A) SI unit of mass is _____ **(Q.3- Pg.68)**

a] kg b] mol
c] pound d] m^3

B) The hydrocarbon contains 79.87% carbon and 20.13% of hydrogen. What is its empirical formula? **(Q.9- Pg.68)**

a] CH b] CH_2
c] CH_3 d] C_2H_5

C) When two properties of a system are mathematically related to each other, the relation can be deduced by _____. **(Q. 23- Pg.68)**

a] Working out mean deviation b] Plotting a graph
c] Calculation relative error d] All of the above

Q. 2.

A) Express the following quantities in exponential terms. **(Q.18- Pg.38)**

i) 0.0003498 ii) 235.4678 iii) 70000.0 iv) 1569.00

Q. 3.

A) Assuming the atomic weight of a metal M to be 56, find the empirical formula of its oxide containing 70.0% of M. **(Q.72- Pg.53)**

Q. 4.

A) Explain following terms. **(Q.95- Pg.61)**

i) Mole fraction ii) Molarity iii) Molality

Q. 5.

A) Why dose molarity of a solution depend upon temperature? **(Q.96- Pg.61)**

CH: 3

Q. 1.

A) Which of the following Method can be used to separate to compound with different celebrities in same solvent? **(Q.3- Pg.85)**

a] Frictional crystallization b] crystallization distillation
c] solvent d] extraction

B) Mixture of acetone and benzene can be separate by following method_____. **(Q.6- Pg.85)**

a] Simple distillation b] frictional distillation
c] distillation under reduce pressure d] sublimation

Q. 2.

A) Why is condenser used in distillation process? **(Q.24- Pg.76)**

Q. 3.

A) Define distillation. **(Q.21- Pg.75)**

Q. 4.

A) Name the common solvent used in the process of crystallization. **(Q.14- Pg.74)**

CH: 4

Q. 1.

A) p- orbitals are _____in shape **(Q.19- Pg.122)**

a] spherical b] dumbbell
c] double dumbbell d] diagonal

B) "No two electrons in same atom can have identical set of four quantum numbers" This statement is known as_____ **(Q.23- Pg.123)**

a] pauli's exclusion principle b] Hund's rule
c] Aufbau rule d] Heisenberg uncertainty principle

Q. 2.

(A) Differentiate between isotopes and isobars. **(Q.25- Pg.94)**

Q. 3.

A) Sate hands-rule of maximum multiplicity with suitable example. **(Q.82- Pg.112)**

Q. 4.

A) An atom of an element content 29 electron and 35 neutrons. Deduce: **(Q.892- Pg.114)**

i) the number of protons ii) the electronic configuration of the element.

Q. 5. **(Q.92- Pg.115)**

A) Write condensed orbital name notation of electronic configuration of following elements.

i) silicon (Z=14) ii) carbon (Z=6) iii) calcium (Z=20)

Q. 6.

A) Indicate the number of unpaired electrons in: **(Q.95- Pg.115)**

i) si (Z -14) ii) cr (Z- 24)

CH: 5

Q. 1. **(Q.3- Pg.168)**

A) Valence Shell Electron Pair Repulsion (VSEPR) Theiry is use to predict witch of the following?

a] Energy level in an atom b] The shapes of molecules and ions.
c] The electronegativitys of elements. d] The type of bonding in compounds.

B) The angle between two covalent bonds is minimum in _____. **(Q.13- Pg.168)**

a] CH_4 b] C_2H_2
c] NH_3 d] H_2O

Q. 2.

A) Predict the shape and bond angle in the following molecules: **(Q.48- Pg.140)**

i) CF_4 ii) NF_3 iii) HCN iv) H_2S

Q. 3.

A) Identify the type of orbital overlap present in: **(Q.56- Pg.142)**

i) H_2 ii) F_2 iii) H-F molecule

Q. 4.

A) Give the type of overlap by witch pi (π) bond is formed. **(Q.59- Pg.143)**

Q. 5.

A) With type of hybridization is present in ammonia molecule? Write the geometry and bond angle present in ammonia. **(Q.74- Pg.149)**

B) In ammonia molecule the bond angles 107°18' and in water molecule, it is 104°35', although in both the central atoms are sp^3 hybridized. Explain. **(Q.77- Pg.150)**

CH: 6

Q. 1.

A) Oxidation number of carbon in H_2CO_3 is **(Q.27- Pg.214)**

a] +1 b] +2

c] +3 d] +4

B) Which is the CORRECT stock notation for manganese dioxide? **(Q.29- Pg.214)**

a] $Mn(I)O_2$ b] $Mn(II)O_2$

c] $Mn(III)O_2$ d] $Mn(IV)O_2$

Q. 2.

A) Calculate the oxidation number of underline atoms **(Q.29- Pg.29)**

i) $H\underline{N}O_3$ ii) $H_3\underline{P}O_3$ iii) $K_2\underline{C}_2O_4$ iv) $\underline{cr}_4o_7^{2-}$

Q. 3.

A) Balance to following equation by oxidation number method **(Q.49- Pg.193)**

$MnO_{4(aq)}^- + Br_{(aq)}^- \rightarrow MnO_{2(s)} + BrO_{3(aq)}^-$ (basic)

Q. 4.

A) Balance the following redox equation by half reaction method **(Q.56- Pg.202)**

$H_2C_2O_{4(aq)} + MnO_{4(aq)}^- \rightarrow CO_{2(g)} + Mn_{(aq)}^{2+}$ (acidic)

CH: 7

Q. 1.

A) In the modern periodic table, the period number indicate the _____ **(Q.10- Pg.248)**

a] atomic number b] atomic mass

c] principle quantum number d] azimuthal quantum number

B) Which of the atomic number represent the s block elements? **(Q.18- Pg.248)**

a] 7, 15 b] 3, 12

c] 6, 14 d] 9, 17

Q. 2. A) The electronic configurations of some elements are given below

i) $1s^2$ ii) $1s^2 2S^2 2p^6$

In which group and period of the periodic table they are placed? **(Q.41- Pg.226)**

Q. 3. A) Explain the following: $_{13}Al$ is metal, $_{14}Si$ is metalloid and $_{15}P$ is nonmetal. **(Q.49- Pg.228)**

Q. 4. A) Explain the first ionization enthalpy of 'B' is smaller than that of 'Be'. **(Q.87- Pg.238)**

CH: 8

Q. 1.

A) Which of the following is radioactive alkali metal **(Q.16- Pg.283)**

a] Rubidium b] Caspian

c] Francium d] Beryllium

B) Identify the odd one. **(Q.18- Pg.283)**

a] Rb b] Ra

c] Sr d] Be

C) The first ionization enthalpies of alkaline earth metals are_____ then those of corresponding alkali metals. **(Q.20- Pg.283)**

a] higher b] lower
c] same d] none of these

D) Lithium shows and diagonal relationship with_____. **(Q.24- Pg. 283)**

a] beryllium b] magnesium
c] calcium d] boron

Q. 2. A) Explain the reaction of group 2 elements with air **(Q.48- Pg.262)**

Q. 3. A) Explain: Lithium floats on water while sodium floats and catches fire when put in water. **(Q.52- Pg.262)**

Q. 4. A) Write balanced chemical equation for the following.
Beryllium oxide is treated separately with aqueous HCL and aqueous NaOH solution. **(Q.68- Pg.268)**

CH: 9

Q. 1.

A) The electronic configuration of boron family is ns2 np6 NH2 mp1 **(Q.1- Pg.313)**

a] $ns^2 np^2$ b] $ns^2 np^5$
c] $ns^2 np^6$ d] $ns^2 np^1$

B) Group oxidation state of group 15 elements is _____ **(Q.9- Pg.313)**

a] +4 b] +1
c] +3 d] +5

C) Among the group 13 elements, the property of allotropy shown by_____ **(Q.19- Pg.313)**

a] indium b] aluminum
c] thallium d] boron

D) Which of the following is NOT an allotrope of carbon? **(Q.20- Pg.314)**

a] Bucky ball b] Diamond
c] Graphite d] Emerald

Q. 2. A) Give reason: Ga+ salts are better reducing agent while Tl^{3+} salts are better oxidizing agent.

Q. 3. A) Distinguish between Diamond and Graphite. **(Q.23- Pg.292)**

Q. 4. A) Name a molecule having banana Bond. **(Q.58- Pg.299)**

Q. 5. A) Match the pairs from column A and B. **(Q.5- Pg.302)**

	Column A		**Column B**
i.	BCl_3	a.	Angular molecule
ii.	SiO_2	b.	Linear covalent molecule
iii.	CO_2	c.	Tetrahedral molecule
		d.	Planer trigonal molecule

CHEMISTRY Vol. II
FINAL EXAM
QUESTION BANK

Section A (MCQ)

Q. 1.

1) Interactive force are_____ in ideal gas **(Q.17- Pg.46)**
   a] nil b] small
   c] large d] same as that of real gas

2) Gum in water is an example of_____ **(Q.25- Pg.75)**
   a] true solution b] suspension
   c] lyophilic sol d] lyophobic sol

3) The equilibrium, $H2O_{(l)} \rightleftharpoons H^{-}_{(aq)} + HO^{-}_{(aq)}$ is _____ **(Q.1- Pg.106)**
   a] dynamic b] static
   c] physical d] mechanical

4) The process by which nuclei having law masses are united to form nuclei with large masses is _____ **(Q.19- Pg.143)**
   a] chemical reaction b] nuclear fission
   c] nuclear fusion d] chain reaction

5) the homologous series of alcohols has general molecular formula _____ **(Q.13- Pg.196)**
   a] $C_nH_{2n+1}OH$ b] $C_nH_{2n+2}OH$
   c] $C_nH_{2n-2}OH$ d] $C_nH_{2n}OH$

6) 1- Chloropropane on treatment with alc, KOH produces _____. **(Q.25- Pg.255)**
   a] propane b] propene
   c] propyne d] propyl alcohol

7) Health benefit are obtained by consumption of_____. **(Q.4- Pg.280)**
   a] Saturated fats b] trans fat
   c] monounsaturated fats d] all if these

8) The chemical responsible for rancid flavour of fats is_____ **(Q.2- Pg.280)**
   a] butyric acid b] glycerol
   c] protein d] saturated fat

Section B.

1) What are the different forms (physical state) in which water exist? **(Q.2- Pg.2)**

2) Name the types of intermolecular force present in Ar, Cl_2, CCl_4 and HNO_3. **(Q.26- Pg.7)**

3) A hot air balloon has volume of 2800 M^3 at 99°C. What is the volume if the air cools at 80°C? **(Q.78- Pg.22)**

4) Nitrogen gas is filled in container of volume 2.32 L at 32°C and 4.7 atm pressure, calculate number of moles of the gas ` **(Q.109- Pg.31)**

5) Drive the ideal gas equation. **(Q.84- Pg.24)**

6) Distinguish between Physisorption and chemisorption. Give one example. **(Q.19- Pg.53)**

7) Explain the term emulation and type of emulations **(Q.89- Pg.70)**

8) What is an open system? **(Q.8- Pg.81)**

9) Explain Le-Chatelier's principle suitably with reference to change in temperature. **(Q.71- Pg.99)**

10) State the law of mass action. **(Q.24- Pg.86)**

11) Differentiate between Irreversible and reversible reaction. **(Q.11- Pg.82)**

12) What is a saturated solution? **(Q.19- Pg.83)**

13) Drive the expression for equilibrium constant, K_C for reaction $A + B \rightleftharpoons C + D$ **(Q.28- Pg.86)**

14) Identity the type of equilibrium in the following physical process
i) Comphor $_{(s)} \rightleftharpoons$ Camphor $_{(g)}$
ii) Water $\rightleftharpoons$ Ice
iii) Ammonium chloride $_{(s)} \rightleftharpoons$ Ammonium chloride $_{(g)}$ **(Q.16- Pg.83)**

15) Define: i) Isotopes ii) Isobars **(Q.8- Pg.112)**

16) Explain in brief, nuclear fission. **(Q.101- Pg.132)**

17) Identify the functional group in the following compounds:
i) n-Butyl alcohol ii) Propanone iii) Acetylene **(Q.29- Pg.158)**

18) Write bond line formulae and condensed formulae for the following compounds:
i) 3-Methyloctane ii) Hept-2-ene
iii) 2,2,4,4-Tetramethylpentane iv) Methoxyethane **(Q.11- Pg.151)**

19) Explain Mesmerism with example. **(Q.71- Pg.173)**

20) Distinguish: Homolysis and heterolysis. **(Q.83- Pg.177)**

21) What are hydrocarbons **(Q.1- Pg.202)**

22) Write IUPAC names of structures **(Q.8- Pg.203)**

23) What is Grignard reagent? Explain its preparation. **(Q.26- Pg.207)**

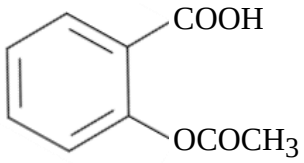
24) write a short Notes on pyrolysis of alkanes. **(Q.46- Pg.212)**

25) State Markovnikov's rule and explain it with the help of an example. **(Q.90- Pg.221)**

26) How is benzene prepared from ethyne/acetylene? **(Q.180- Pg.241)**

27) Complete the reaction given below. **(Q.29- Pg.158)**

28) Write the molecular formula and name of below. **(Q.47- Pg.268)**



29) What are anlogesis? Explain their mode of action. **(Q.42- Pg.268)**

30) When is an antipyretic drug used? **(Q.43- Pg.268)**

31) Match the pairs from column A and B. **(Q.100- Pg.278)**

	Group A		**Group B**
i.	Paracetamol	a.	Antibiotic
ii.	Chloramphenicol	b.	Synthetic detergent
iii.	BHT	c.	Soap
iv.	Sodium stearate	d.	Antioxidant
		e.	Analgesic

***Q.106. What is volume of carbon dioxide, CO_2 occupying by**

i. 5 moles and **ii. 0.5 mole of CO_2 gas measured at STP.**

Solution:

Given: i. Number of moles of CO_2 = 5 mol

ii. Number of moles of CO_2 = 0.5 mol

To find: Volume at STP

Formula: Number of moles of a gas (n) = $\frac{\text{Volume of a gas at STP}}{\text{Molar volume of a gas}}$

Calculation: Molar volume of a gas = 22.4 dm^3 mol^{-1} at STP.

Number of moles of a gas (n) = $\frac{\text{Volume of a gas at STP}}{\text{Molar volume of a gas}}$

∴ i. Volume of the gas at STP = Number of moles of a gas (n) × Molar volume of a gas

= 5 mol × 22.4 dm^3 mol^{-1} = **112 dm^3**

ii. Volume of the gas at STP = Number of moles of a gas (n) × Molar volume of a gas

= 0.5 mol × 22.4 dm^3 mol^{-1} = **11.2 dm^3**

Ans:

i. Volume of 5 mol of CO_2 = **112 dm^3** ii. Volume of 0.5 mol of CO_2 = **11.2 dm^3**

Q.34. Convert the following degree Celsius temperature to degree Fahrenheit.

i. 40 °C **ii. 30 °C**

Solution:

i.

Given: Temperature in degree Celsius = 40 °C

To find: Temperature in degree Fahrenheit

Formula: $°F = \frac{9}{5}(°C) + 32$

Calculation: Substituting 40 °C in the formula,

$$°F = \frac{9}{5}(°C) + 32$$

$$= \frac{9}{5}(40) + 32 = 72 + 32 = \mathbf{104\ °F}$$

ii.

Given: Temperature in degree Celsius = 30 °C

To find: Temperature in degree Fahrenheit

Formula: $°F = \frac{9}{5}(°C) + 32$

Calculation: Substituting 30 °C in the formula,

$$°F = \frac{9}{5}(°C) + 32$$

$$= \frac{9}{5}(30) + 32 = 54 + 32 = \mathbf{86\ °F}$$

Ans:

i. The temperature 40 °C corresponds to **104 °F.**

ii. The temperature 30 °C corresponds to **86 °F.**

Q.39. State the law of multiple proportions.

Ans: The law states that, *"When two elements A and B form more than one compound, the masses of element B that combine with a given mass of A are always in the ratio of small whole numbers".*

***Q.18. Express the following quantities in exponential terms.**

i. 0.0003498 **ii. 235.4678** **iii. 70000.0** **iv. 1569.00**

Ans:

i. $0.0003498 = \mathbf{3.498 \times 10^{-4}}$

ii. $235.4678 = \mathbf{2.354678 \times 10^{2}}$

iii. $70000.0 = \mathbf{7.00000 \times 10^{4}}$

iv. $1569.00 = \mathbf{1.56900 \times 10^{3}}$

Ans: Empirical formula of the compound = Na_2CO_3

***Q.72. Assuming the atomic weight of a metal M to be 56, find the empirical formula of its oxide containing 70.0% of M.**

Solution:

Given: Atomic mass of M = 56

Percentage of M = 70.0%

To find: The empirical formula of the compound

Calculation: % M = 70.0%

Hence, % O = 30.0%, Atomic mass of O = 16 u

$$\text{Moles of M} = \frac{\text{\% of M}}{\text{Atomic mass of M}} = \frac{70.0}{56} = 1.25 \text{ mol}$$

$$\text{Moles of O} = \frac{\text{\% of O}}{\text{Atomic mass of O}} = \frac{30.0}{16} = 1.875 \text{ mol}$$

Hence the ratio of number of moles of M:O is

$$\frac{1.25}{1.25} = 1 \text{ and } \frac{1.875}{1.25} = 1.5$$

Convert the ratio into whole number by multiplying by the suitable coefficient, i.e., 2.

Therefore, the ratio of number of moles of M:O is 2:3.

Hence, the empirical formula is $\mathbf{M_2O_3}$.

Ans: Empirical formula of the compound = $\mathbf{M_2O_3}$

***Q.95. Explain the following terms:**

i. Mole fraction **ii. Molarity** **iii. Molality**

Ans:

i. **Mole fraction:** ***Mole fraction*** *is the ratio of number of moles of a particular component of a solution to the total number of moles of the solution.*

If a substance 'A' dissolves in substance 'B' and their number of moles are n_A and n_B, respectively, then the mole fraction of A and B are given as:

$$\text{Mole fraction of A} = \frac{\text{Number of moles of A}}{\text{Number of moles of solution}} = \frac{n_A}{n_A + n_B}$$

$$\text{Mole fraction of B} = \frac{\text{Number of moles of B}}{\text{Number of moles of solution}} = \frac{n_B}{n_A + n_B}$$

ii. **Molarity:** ***Molarity*** *is defined as the number of moles of the solute present in 1 litre of the solution.* It is the most widely used unit and is denoted by M.

Molarity is expressed as follows:

$$\text{Molarity (M)} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litres}}$$

iii. **Molality:** ***Molality*** *is the number of moles of solute present in 1 kg of solvent.* It is denoted by m.

Molality is expressed as follows:

$$\text{Molality (m)} = \frac{\text{Number of moles of solute}}{\text{Mass of solvent in kilograms}}$$

***Q.96. Why does molarity of a solution depend upon temperature?**

Ans:

i. Molarity is the number of moles of the solute present in 1 litre of the solution. Therefore, molarity depends on the volume of the solution.

ii. Volume of the solution varies with the change in temperature.

Hence, molarity of a solution depends upon temperature.

Q.97. Why is molality NOT affected by temperature?

Q.14. Name the common solvents used in the process of crystallization.

Ans: The commonly used solvents are water, ethyl alcohol, methyl alcohol, acetone, ether or their combinations.

[illegible] difference in their boiling point.

***Q.21 Define: Distillation**

Ans: *The process in which liquid is converted into its vapour phase at its boiling point and the vapour is then condensed back to liquid on cooling is known as* ***distillation****.*

*** Q.24. Why is a condenser used in distillation process?**

Ans: In the process of distillation, a liquid is converted into its vapour and the vapour is then condensed back to liquid on cooling. The condenser has a jacket with two outlets through which water is circulated. Hence, to provide efficient cooling, a condenser is used.

Q.25 Differentiate between isotopes and isobars.

Ans:

No.	Isotopes	Isobars
i.	Isotopes are atoms of same element.	Isobars are atoms of different elements.
ii.	They have same atomic number but different atomic mass number.	They have same atomic mass number but different atomic numbers.
iii.	They have same number of protons but different number of neutrons.	They have different number of protons and neutrons.
iv.	They have same number of electrons.	They have different number of electrons.
v.	They occupy same position in the modern periodic table.	They occupy different positions in the modern periodic table.
vi.	They have similar chemical properties.	They have different chemical properties.
e.g.	${}^{12}_{6}C$ and ${}^{14}_{6}C$	${}^{14}_{6}C$ and ${}^{14}_{7}N$

Q.82. State Hund's rule of maximum multiplicity with suitable example.

Ans: Hund's rule of maximum multiplicity:

i. **Statement:** *"Pairing of electrons in the orbitals belonging to the same subshell does not occur unless each orbital belonging to that subshell has got one electron each."*

ii. Example, according to Hund's rule, each of the three-degenerate p-orbitals must get one electron of parallel spin before any one of them receives the second electron of opposite spin. Therefore, the configuration of four electrons occupying p-orbitals is represented as

↑↓	↑	↑

and not as

↑↓	↑↓	

Q.89. An atom of an element contains 29 electrons and 35 neutrons. Deduce:

i. The number of protons **ii. The electronic configuration of that element**

Ans:

i. In an atom, number of protons is equal to number of electrons.
The given atom contains 29 electrons.

∴ Number of protons = 29

ii. The electronic configuration of an atom of an element containing 29 electrons is:
$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^{10}$

Note: Given element is copper (Cu) with Z = 29

Q.92 Write condensed orbital notation of electronic configuration of the following elements:

i. Lithium (Z = 3) **ii. Carbon (Z = 6)** **iii. Oxygen (Z = 8)**

iv. Silicon (Z = 14) **v. Chlorine (Z = 17)** **vi. Calcium (Z = 20)**

Ans:

No.	Element	Condensed orbital notation
i.	Lithium (Z = 3)	[He] $2s^1$
ii.	Carbon (Z = 6)	[He] $2s^2\ 2p^2$
iii.	Oxygen (Z = 8)	[He] $2s^2\ 2p^4$
iv.	Silicon (Z = 14)	[Ne] $3s^2\ 3p^2$
v.	Chlorine (Z = 17)	[Ne] $3s^2\ 3p^5$
vi.	Calcium (Z = 20)	[Ar] $4s^2$

Q.95. Indicate the number of unpaired electrons in:

i. Si (Z = 14) **ii. Cr (Z = 24)**

Ans:

i. Si (Z = 14): $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

Orbital diagram:

1s	2s	2p			3s	3p		
↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑	

Number of unpaired electrons = 2

ii. **Cr (Z = 24):** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1\ 3d^5$

Orbital diagram:

1s	2s	2p			3s	3p			4s	3d				
↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑↓	↑	↑	↑	↑	↑	↑

Number of unpaired electrons = 6

Q.48. Predict the shape and bond angles in the following molecules:

i. CF_4 ii. NF_3 iii. HCN iv. H_2S

Ans:

i. **CF_4:** There are four bond pairs on the central atom. Hence, shape of CF_4 is tetrahedral and F–C–F bond angle is 109° 28′.

ii. **NF_3:** There are three bond pairs and one lone pair on the central atom. Hence, shape of NF_3 is trigonal pyramidal and F–N–F bond angle is less than 109° 28′.

iii. **HCN:** There are two bond pairs on the central atom. Hence, shape of HCN is linear and H–C–N bond angle is 180°.

iv. **H_2S:** There are two bond pairs and two lone pairs on the central atom. Hence, shape of H_2S is bent or V-shaped and H–S–H bond angle is slightly less than 109° 28′.

Q.55. Explain with example:

i. s–s σ overlap **ii. p–p σ overlap** **iii. s–p σ overlap**

Ans:

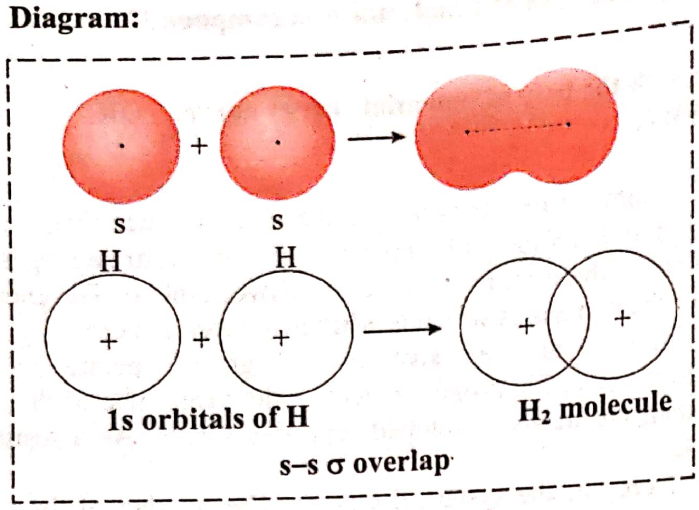
i. s–s σ overlap:

a. The overlap between two half-filled s orbitals of two different atoms containing unpaired electrons with opposite spins is called s–s overlap.

e.g. Formation of H_2 molecule by s–s overlap:

Hydrogen atom (Z = 1) has electronic configuration: $1s^1$. The $1s^1$ orbitals of two hydrogen atoms overlap along the internuclear axis to form a σ bond between the atoms in H_2 molecule.

b. **Diagram:**



ii. **p–p σ overlap:**

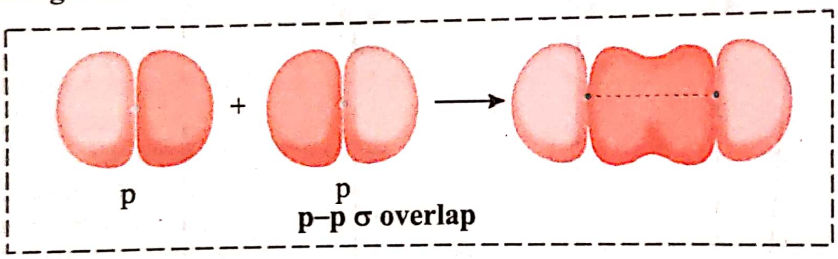
a. This type of overlap takes place when two p orbitals from different atoms overlap along the internuclear axis.

e.g. **Formation of F_2 molecule by p–p overlap:**

Fluorine atom (Z = 9) has electronic configuration $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$.

During the formation of F_2 molecule, half-filled $2p_z$ orbital of one F atom overlaps with similar half-filled $2p_z$ orbital containing electron with opposite spin of another F atom axially and a p–p σ bond is formed.

b. **Diagram:**



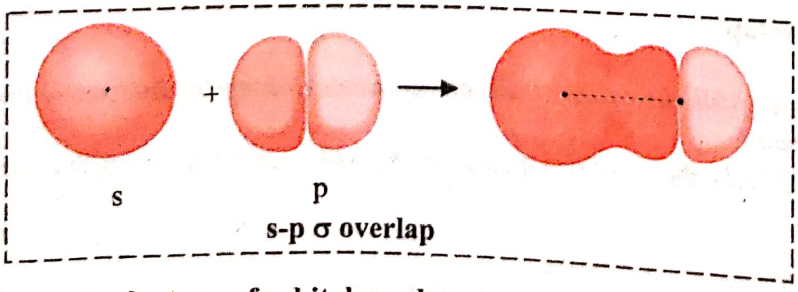
iii. **s–p σ overlap:**

a. In this type of overlap one half filled s orbital of one atom and one half filled p orbital of another orbital overlap along the internuclear axis.

e.g. **Formation of HF molecule by s–p overlap:**

Hydrogen atom (Z = 1) has electronic configuration: $1s^1$ and fluorine atom (Z = 9) has electronic configuration $1s^2 2s^2 2p_x^2 2p_y^2 2p_z^1$. During the formation of HF molecule, half-filled 1s orbital of hydrogen atom overlaps coaxially with half-filled $2p_z$ orbital of fluorine atom with opposite electron spin and an s-p σ bond is formed.

b. **Diagram:**



***Q.56. Identify the type of orbital overlap present in:**

i. H_2 ii. F_2 iii. H–F molecule.

Explain diagrammatically.

Ans: *Refer Q.55.*

***Q.57. Draw orbital diagrams of:**

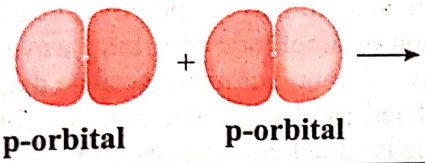
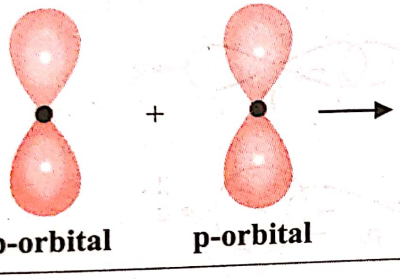
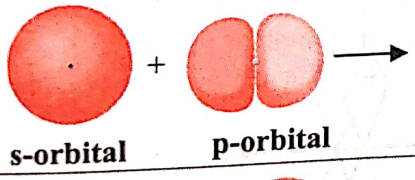
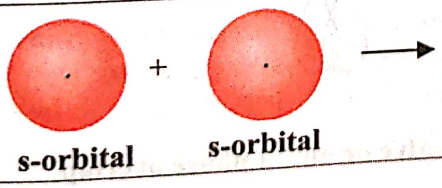
i. Fluorine molecule ii. Hydrogen fluoride molecule

Ans: *Refer Q.55.*

Q.59. Give the type of overlap by which pi (π) bond is formed.

Ans: The type of overlap by which pi (π) bond is formed is p–p lateral overlap.

Q.60. Identify the type of bond formed:

	Overlap of atomic orbitals	Type of bond formed
i.		.....
ii.		.....
iii.		.....
iv.		.....

Ans:

i. σ bond ii. π bond iii. σ bond iv. σ bond

Q.61. [illegible] is stronger than pi (π) bond.

Q.74. Which type of hybridization is present in ammonia molecule? Write the geometry and bond angle present in ammonia.

Ans: The type of hybridization present in ammonia (NH_3) molecule is sp^3.
Geometry of ammonia molecule is pyramidal or distorted tetrahedral.
Bond angle in ammonia molecule is $107°18'$.

Q.77. In ammonia molecule, the bond angle is 107°18′ and in water molecule, it is 104°35′, although in both the central atoms are sp^3 hybridized. Explain.

Ans:

i. The ammonia molecule has sp^3 hybridization. The expected bond angle is 109°28′. But the actual bond angle is 107°28′. It is due to the following reasons.

a. One lone pair and three bond pairs are present in ammonia molecule.

b. The strength of lone pair – bond pair repulsion is much higher than that of bond pair–bond pair repulsion.

c. Due to these repulsions, there is a small decrease in bond angle (~2°) from 109°28′ to 107°18′.

ii. The water molecule has sp^3 hybridization. The expected bond angle is 109°28′. But the actual bond angle is 104°35′. It is due to the following reasons.

a. Two lone pairs and two bond pairs are present in water molecule.

b. The decreasing order of the repulsion is Lone pair–Lone pair > Lone pair–Bond pair > Bond pair–Bond pair.

c. Due to these repulsions, there is a small decrease in bond angle (~5°) from 109°28′ to 104°35′.

Q.29. Calculate the oxidation number of underlined atoms.

i. $H_2\underline{S}O_4$ ii. $H\underline{N}O_3$ iii. $H_3\underline{P}O_3$ iv. $K_2\underline{C}_2O_4$

v. $H_2\underline{S}_4O_6$ vi. $\underline{Cr}_2O_7^{2-}$ vii. $NaH_2\underline{P}O_4$

Ans:

i. **$H_2\underline{S}O_4$**

Oxidation number of H = +1

Oxidation number of O = –2

H_2SO_4 is a neutral molecule.

∴ Sum of the oxidation numbers of all atoms of H_2SO_4 = 0

∴ 2 × (Oxidation number of H) + (Oxidation number of S) + 4 × (Oxidation number of O) = 0

∴ 2 × (+1) + (Oxidation number of S) + 4 × (–2) = 0

∴ Oxidation number of S + 2 – 8 = 0

∴ **Oxidation number of S in H_2SO_4 = +6**

iii. **$H_3\underline{P}O_3$**

Oxidation number of O = –2

Oxidation number of H = +1

H_3PO_3 is a neutral molecule.

∴ Sum of the oxidation numbers of all atoms = 0

∴ 3 × (Oxidation number of H) + (Oxidation number of P) + 3 × (Oxidation number of O) = 0

∴ 3 × (+1) + (Oxidation number of P) + 3 × (–2) = 0

∴ Oxidation number of P + 3 – 6 = 0

∴ **Oxidation number of P is H_3PO_3 = +3**

ii. **$H\underline{N}O_3$**

Oxidation number of H = +1

Oxidation number of O = –2

HNO_3 is a neutral molecule.

∴ Sum of the oxidation numbers of all atoms of HNO_3 = 0

∴ (Oxidation number of H) + (Oxidation number of N) + 3 × (Oxidation number of O) = 0

∴ (+1) + (Oxidation number of N) + 3 × (–2) = 0

∴ Oxidation number of N + 1 – 6 = 0

∴ **Oxidation number of N in HNO_3 = +5**

iv. **$K_2\underline{C}_2O_4$**

Oxidation number of K = +1

Oxidation number of O = –2

$K_2C_2O_4$ is a neutral molecule.

∴ Sum of the oxidation number of all atoms = 0

∴ 2 × (Oxidation number of K) + 2 × (Oxidation number of C) + 4 × (Oxidation number of O) = 0

∴ 2 × (+1) + 2 × (Oxidation number of C) + 4 × (–2) = 0

∴ 2 × (Oxidation number of C) + 2 – 8 = 0

∴ 2 × (Oxidation number of C) = + 6

∴ Oxidation number of C = $+\frac{6}{2}$

∴ **Oxidation number of C in $K_2C_2O_4$ = +3**

v. $H_2\underline{S}_4O_6$

Oxidation number of H = +1

Oxidation number of O = –2

$H_2S_4O_6$ is a neutral molecule.

∴ Sum of the oxidation numbers of all atoms = 0

∴ 2 × (Oxidation number of H) + 4 × (Oxidation number of S) + 6 × (Oxidation number of O) = 0

∴ 2 × (+1) + 4 × (Oxidation number of S) + 6 × (–2) = 0

∴ 4 × (Oxidation number of S) + 2 – 12 = 0

∴ 4 × (Oxidation number of S) = + 10

∴ Oxidation number of S = $+\frac{10}{4}$

∴ **Oxidation number of S in $H_2S_4O_6$ = +2.5**

vi. $\underline{Cr}_2O_7^{2-}$

Oxidation of O = –2

$Cr_2O_7^{2-}$ is an ionic species.

∴ Sum of the oxidation numbers of all atoms = – 2

∴ 2 × (Oxidation number of Cr) + 7 × (Oxidation number of O) = –2

∴ 2 × (Oxidation number of Cr) + 7 × (–2) = –2

∴ 2 × (Oxidation number of Cr) – 14 = – 2

∴ 2 × (Oxidation number of Cr) = – 2 + 14

∴ Oxidation number of Cr = $+\frac{12}{2}$

∴ **Oxidation number of Cr in $Cr_2O_7^{2-}$ = +6**

vii. $NaH_2\underline{P}O_4$

Oxidation number of Na = +1

Oxidation number of H = +1

Oxidation number of O = –2

NaH_2PO_4 is a neutral molecule

Sum of the oxidation numbers of all atoms = 0

(Oxidation number of Na) + 2 × (Oxidation number of H) + (Oxidation number of P) + 4 × (Oxidation number of O) = 0

(+1) + 2 × (+1) + (Oxidation number of P) + 4 × (–2) = 0

(Oxidation number of P) + 3 – 8 = 0

Oxidation number of P in NaH_2PO_4 = +5

***Q.30. Assign oxidation number to each atom in the following**

Q.49. Balance the following reactions by oxidation number method.

i. $Cr_2O_{7(aq)}^{2-} + SO_{3(aq)}^{2-} \longrightarrow Cr_{(aq)}^{3+} + SO_{4(aq)}^{2-}$ **(acidic)**

ii. $MnO_{4(aq)}^{-} + Br_{(aq)}^{-} \longrightarrow MnO_{2(s)} + BrO_{3(aq)}^{-}$ **(basic)**

iii. $H_2SO_{4\,(aq)} + C_{(s)} \longrightarrow CO_{2(g)} + SO_{2(g)} + H_2O_{(l)}$ **(acidic)**

iv. $Bi(OH)_{3(s)} + Sn(OH)_{3(aq)}^{-} \longrightarrow Bi_{(s)} + Sn(OH)_{6(aq)}^{2-}$ **(basic)**

Ans:

i. $Cr_2O_{7(aq)}^{2-} + SO_{3(aq)}^{2-} \longrightarrow Cr_{(aq)}^{3+} + SO_{4(aq)}^{2-}$ (acidic)

Step 1: Write skeletal equation and balance the elements other than O and H.

$Cr_2O_{7(aq)}^{2-} + SO_{3(aq)}^{2-} \longrightarrow 2Cr_{(aq)}^{3+} + SO_{4(aq)}^{2-}$

Step 2: Assign oxidation number to Cr and S. Calculate the increase and decrease in the oxidation number and make them equal.

$$\underset{\boxed{2\times(+6)}}{Cr_2}\,\underset{7\times(-2)}{O_{7(aq)}^{2-}} + \underset{\boxed{+4}}{S}\underset{3\times(-2)}{O_{3(aq)}^{2-}} \longrightarrow \underset{+3}{2Cr_{(aq)}^{3+}} + \underset{\boxed{+6}}{S}\underset{4\times(-2)}{O_{4(aq)}^{2-}}$$

Increase in oxidation number: $\underset{+4}{SO_3^{2-}} \longrightarrow \underset{+6}{SO_4^{2-}}$

(Increase per atom = 2)

Decrease in oxidation number: $\underset{+6}{Cr_2O_7^{2-}} \longrightarrow \underset{+3}{2Cr_{(aq)}^{3+}}$

(Decrease per atom = 3)

To make the net increase and decrease equal, we must take 3 atoms of S and 2 atoms of Cr. (There are already 2 Cr atoms.)

$Cr_2O_{7(aq)}^{2-} + 3SO_{3(aq)}^{2-} \longrightarrow 2Cr_{(aq)}^{3+} + 3SO_{4(aq)}^{2-}$

Step 3: Balance 'O' atoms by adding $4H_2O$ to the right-hand side.

$Cr_2O_{7(aq)}^{2-} + 3SO_{3(aq)}^{2-} \longrightarrow 2Cr_{(aq)}^{3+} + 3SO_{4(aq)}^{2-} + 4H_2O_{(l)}$

Step 4: The medium is acidic. To make the charges and hydrogen atoms on the two sides equal, add $8H^+$ on the left-hand side.

$Cr_2O_{7(aq)}^{2-} + 3SO_{3(aq)}^{2-} + 8H_{(aq)}^{+} \longrightarrow 2Cr_{(aq)}^{3+} + 3SO_{4(aq)}^{2-} + 4H_2O_{(l)}$

Step 5: Check two sides for balance of atoms and charges.

Hence, balanced equation: $Cr_2O_{7(aq)}^{2-} + 3SO_{3(aq)}^{2-} + 8H_{(aq)}^{+} \longrightarrow 2Cr_{(aq)}^{3+} + 3SO_{4(aq)}^{2-} + 4H_2O_{(l)}$

ii. $MnO_{4\,(aq)}^{-} + Br_{(aq)}^{-} \longrightarrow MnO_{2(s)} + BrO_{3\,(aq)}^{-}$ (basic)

Step 1: Write skeletal equation and balance the elements other than O and H.

$MnO_{4\,(aq)}^{-} + Br_{(aq)}^{-} \longrightarrow MnO_{2(s)} + BrO_{3\,(aq)}^{-}$

Step 2: Assign oxidation number to Mn and Br. Calculate the increase and decrease in the oxidation number and make them equal.

$$\underset{\boxed{+7}}{Mn}\underset{4\times(-2)}{O_{4\,(aq)}^{-}} + \underset{-1}{Br_{(aq)}^{-}} \longrightarrow \underset{\boxed{+4}}{Mn}\underset{2\times(-2)}{O_{2(s)}} + \underset{\boxed{+5}}{Br}\underset{3\times(-2)}{O_{3\,(aq)}^{-}}$$

Increase in oxidation number: $\underset{-1}{Br^-} \longrightarrow \underset{+5}{BrO_3^-}$

(Increase per atom = 6)

Decrease in oxidation number: $\underset{+7}{MnO_4^-} \longrightarrow \underset{+4}{MnO_2}$

(Decrease per atom = 3)

To make the net increase and decrease equal, we must take 2 atoms of Mn.

$2MnO_{4\,(aq)}^{-} + Br_{(aq)}^{-} \longrightarrow 2MnO_{2(s)} + BrO_{3\,(aq)}^{-}$

Q.56. Balance the following redox equation by half reaction method:

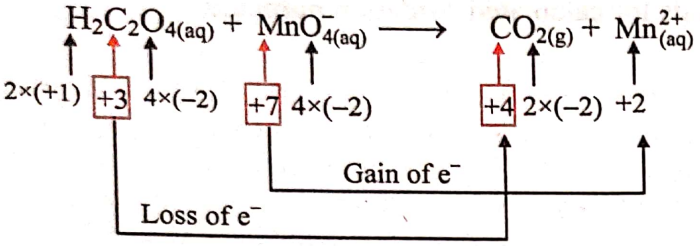
i. $H_2C_2O_{4(aq)} + MnO^-_{4(aq)} \longrightarrow CO_{2(g)} + Mn^{2+}_{(aq)}$ **(acidic)**

ii. $Bi(OH)_{3(s)} + SnO^{2-}_{2(aq)} \longrightarrow SnO^{2-}_{3(aq)} + Bi_{(s)}$ **(Basic)**

Ans:

i. $H_2C_2O_{4(aq)} + MnO^-_{4(aq)} \longrightarrow CO_{2(g)} + Mn^{2+}_{(aq)}$

Step 1: Write unbalanced equation for the redox reaction. Assign oxidation number to all the atoms reactants and products. Divide the equation into two half equations.



Oxidation half reaction: $H_2C_2O_{4(aq)} \longrightarrow CO_{2(g)}$

Reduction half reaction: $MnO^-_{4(aq)} \longrightarrow Mn^{2+}_{(aq)}$

Step 2: Balance the atoms except O and H in each half equation. Balance half equation for O atoms adding $4H_2O$ to the right side of reduction half equation.

Oxidation: $H_2C_2O_{4(aq)} \longrightarrow 2CO_{2(g)}$

Reduction: $MnO^-_{4(aq)} \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

Step 3: Balance H atoms by adding H^+ ions to the side with less H. Hence, add $2H^+$ ions to the right side oxidation half equation and $8H^+$ ions to the left side of reduction half equation.

Oxidation: $H_2C_2O_{4(aq)} \longrightarrow 2CO_{2(g)} + 2H^+_{(aq)}$

Reduction: $MnO^-_{4(aq)} + 8H^+_{(aq)} \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

Step 4: Now add 2 electrons to the right side of oxidation half equation and 5 electrons to the left side reduction half equation to balance the charges.

Oxidation: $H_2C_2O_{4(aq)} \longrightarrow 2CO_{2(g)} + 2H^+_{(aq)} + 2e^-$

Reduction: $MnO^-_{4(aq)} + 8H^+_{(aq)} + 5e^- \longrightarrow Mn^{2+}_{(aq)} + 4H_2O_{(l)}$

Step 5: Multiply oxidation half equation by 5 and reduction half equation by 2 to equalize number electrons in two half equations. Then add two half equation.

Oxidation: $5H_2C_2O_{4(aq)} \longrightarrow 10CO_{2(g)} + 10H^+_{(aq)} + 10e^-$

Reduction: $2MnO^-_{4(aq)} + 16H^+_{(aq)} + 10e^- \longrightarrow 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$

Add two half equations:

$5H_2C_2O_{4(aq)} + 2MnO^-_{4(aq)} + 6H^+_{(aq)} \longrightarrow 10CO_2 + 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}$

The equation is balanced in terms of number of atoms and the charges.

Hence, balanced equation: $\mathbf{5H_2C_2O_{4(aq)} + 2MnO^-_{4(aq)} + 6H^+_{(aq)} \longrightarrow 10CO_2 + 2Mn^{2+}_{(aq)} + 8H_2O_{(l)}}$

Q.41 The electronic configurations of some elements are given below:

i. $1s^2$ **ii. $1s^2\ 2s^2\ 2p^6$**

In which group and period of the periodic table they are placed?

Ans:

i. $1s^2$

Here n = 1. Therefore, the element belongs to the 1st period.

The outer electronic configuration $1s^2$ corresponds to the maximum capacity of 1s, the complete duplet. Therefore, the element is placed at the end of the 1st period in the group 18 of inert gases in the modern periodic table.

ii. $1s^2\ 2s^2\ 2p^6$

Here n = 2. Therefore, the element belongs to the 2nd period.

The outer electronic configuration $2s^2\ 2p^6$ corresponds to complete octet. Therefore, the element is placed in the 2nd period of group 18 in the modern periodic table.

***Q.49. Explain the following: $_{13}Al$ is a metal, $_{14}Si$ is a metalloid and $_{15}P$ is a nonmetal.**

Ans:

i. Electronic configuration of Al is [Ne] $3s^2\ 3p^1$, $_{14}Si$ is [Ne] $3s^2\ 3p^2$ and that of $_{15}P$ is [Ne] $3s^2\ 3p^3$.

ii. Metals are characterized by the ability to form compounds by loss of valence electrons.

iii. 'Al' has 3 valence electrons, thus shows tendency to lose 3 valence electrons to complete its octet. Hence, Al is a metal.

iv. Nonmetals are characterized by the ability to form compounds by gain of valence electrons in valence shell.

v. 'P' has 5 valence electrons thus, shows tendency to gain 3 electrons to complete its octet. Hence, 'P' is a nonmetal.

vi. 'Si' has four valence electrons, thus it can either lose/gain electrons to complete its octet. Hence, 'Si' behaves as a metalloid.

Q.87. Explain the following statements giving reasons:

i. The first ionization enthalpy of 'B' is smaller than that of 'Be'.

ii. The first ionization enthalpy of 'O' is smaller than that of 'N'.

Ans:

i.
a. Beryllium has electronic configuration $1s^2 2s^2$ while that of boron is $1s^2 2s^2 2p^1$.
b. 'Be' loses the electron from 2s orbital while 'B' loses the electron from 2p orbital which has less penetration than the 2s orbital. Therefore, it is easier to remove a 2p electron than a 2s electron.
c. Also, 'Be' has completely filled stable 2s subshell. It takes more energy to remove electron from completely filled subshell.

Hence, the first ionization enthalpy of 'B' is smaller than that of 'Be'.

ii.
a. Oxygen has electronic configuration $1s^2 2s^2 2p^4$ while that of nitrogen is $1s^2 2s^2 2p^3$.
b. 'O' loses the electron from a doubly occupied '2p' orbital. Due to electron–electron repulsion it is easier to lose this electron than an electron from the singly occupied 2p orbital in nitrogen atom.
c. Also, 'N' has half-filled stable 2p subshell. It takes more energy to remove electron from half-filled subshell.

Hence, the first ionization enthalpy of 'O' is smaller than that of 'N'.

Q.48 **Explain the reaction of group 2 elements with air.**

Ans: **Reaction of group 2 elements with air:**

i. Alkaline earth metals react with oxygen present in the air to form a protective oxide film on their surface which prevents them from further air oxidation.

ii. When burnt in air, all the group 2 elements form oxides of MO type. The product is a mixture of oxide and nitride.

a. $$\underset{\text{Magnesium}}{2Mg} + \underset{\text{Oxygen (air)}}{O_2} \xrightarrow{\Delta} \underset{\text{Magnesium oxide}}{2MgO}$$

b. $$\underset{\text{Magnesium}}{3Mg} + \underset{\text{Nitrogen (air)}}{N_2} \xrightarrow{\Delta} \underset{\text{Magnesium nitride}}{Mg_3N_2}$$

iii. Further heating of the oxide in air results in formation of peroxide.

GG - Gyan Guru

Lithium in batteries!

Be it a smart watch or an electric car, nowadays, Li-ion batteries are used almost everywhere. In Li-ion batteries, Li acts as cathode. However, when used in a battery, Li is found to be highly unstable. Therefore, instead of elemental Li, lithium oxide (LiO) formed by the reaction of lithium and oxygen is used in such batteries as it is more stable than Li metal.

Q.49. Give reasons: Potassium superoxide is used in breathing equipment used for mountaineers and in submarines and space.

Ans:

i. Potassium superoxide has ability to absorb carbon dioxide and give out oxygen at the same time.

$$\underset{\text{Potassium superoxide}}{4KO_2} + \underset{\text{Carbon dioxide}}{2CO_2} \longrightarrow \underset{\text{Potassium carbonate}}{2K_2CO_3} + \underset{\text{Oxygen}}{3O_2\uparrow}$$

ii. Due to this property of KO_2, it is used in breathing equipment used for mountaineers and in submarines and space.

Q.50. What is the oxidation state of:

+i. Na in Na_2O_2? *(Question 8.4 of Textbook page no. 115)*

ii. K in KO_2?

Ans:

i. Oxidation state of Na in sodium peroxide (Na_2O_2):

Let x be the oxidation state of Na in Na_2O_2.

The net charge on peroxide ion $\left(O_2^{2-}\right)$ is –2.

Since any compound is electrically neutral, it has an overall charge as zero.

$\therefore$ $2x + (-2) = 0$ $\therefore$ $x = +1$

$\therefore$ Oxidation state of Na in Na_2O_2 is + 1.

ii. Oxidation state of K in potassium dioxide/potassium superoxide (KO_2):

Let x be the oxidation state of K in KO_2

The net charge on superoxide ion $\left(O_2^{-}\right)$ is – 1.

Since any compound is electrically neutral, it has an overall charge as zero.

$\therefore$ $x + (-1) = 0$ $\therefore$ $x = +1$

$\therefore$ Oxidation state of K in KO_2 is + 1.

CAUTION

Oxidation number of each oxygen in peroxide ion is –1 and in superoxide ion is –1/2. However, alkali metals have oxidation number +1 in all their compounds.

+Q.51. Magnesium strip slowly tarnishes on keeping in air but metallic calcium is readily attacked by air. Explain. *(Question 8.7 of Textbook page no. 119)*

Ans:

i. The reactivity of group 2 metals increases with increasing atomic radius and lowering of ionization enthalpy down the groups.

ii. Thus, calcium has lower ionization enthalpy. Therefore, calcium is more reactive than magnesium.

iii. Hence, Mg reacts slowly with air forming a thin film of oxide resulting into tarnishing, whereas Ca reacts readily at room temperature with oxygen and nitrogen in the air.

Q.52. Explain the following: Lithium floats on water while sodium floats and catches fire when put in water.

Ans:

i. When lithium and sodium react with water, hydrogen gas is released. Due to these hydrogen gas bubbles, lithium and sodium floats on water.

eg. $2Na + 2H_2O \rightarrow 2NaOH + H_2\uparrow$

ii. The reactivity of group 1 metals increases with increasing atomic radius and lowering of ionization enthalpy down the group.

iii. Thus, sodium having lower ionization enthalpy, is more reactive than lithium.

iv. Hence, lithium reacts slowly while sodium reacts vigorously with water.

v. Since the reaction of sodium with water is highly exothermic, it catches fire when put in water.

***Q.68. Write balanced chemical equations for the following.**
Beryllium oxide is treated separately with aqueous HCl and aqueous NaOH solutions.

Ans: Beryllium oxide (BeO) is an amphoteric oxide and thus, it reacts with both acid (HCl) as well as base (NaOH) to give the corresponding products.

i. $BeO + \underset{\text{(Acid)}}{2HCl} \longrightarrow BeCl_2 + H_2O$

ii. $BeO + \underset{\text{(Base)}}{2NaOH} \longrightarrow Na_2BeO_2 + H_2O$

Hence, Tl^{3+} ion is more stable than Tl^{1+} ion.

Q.23. Give reason: Ga^{+} salts are better reducing agent while Tl^{3+} salts are better oxidizing agent.

Ans:

i. Both gallium (Ga) and thallium (Tl) belong to group 13.

ii. Ga is lighter element compared to thallium Tl. Therefore, its +3 oxidation state is stable. Thus, Ga^{+} loses two electrons and get oxidized to Ga^{3+}. Hence, Ga^{+} salts are better reducing agent.

iii. Thallium is a heavy element. Therefore, due to the inert pair effect, Tl forms stable compounds in +1 oxidation state. Thus, Tl^{3+} salts get easily reduced to Tl^{1+} by accepting two electrons. Hence, Tl^{3+} salts are better oxidizing agent.

*[**Note:** This question is modified so as to apply the appropriate textual concept.]*

Q.24. How can you explain the higher stability of BCl_3 as compared to $TlCl_3$?

Q.58. Find out the difference between: Diamond and graphite.

Ans:

No.	Diamond	Graphite
i	It has a three-dimensional network structure.	It has a two-dimensional hexagonal layered structure.
ii.	In diamond, each carbon atom is sp^3 hybridized.	In graphite, each carbon atom is sp^2 hybridized.
iii.	Each carbon atom in diamond is linked to four other carbon atoms.	Each carbon atom in graphite is linked to three other carbon atoms.
iv.	Diamond is poor conductor of electricity due to absence of free electrons.	Graphite is good conductor of electricity due to presence of free electrons in its structure.
v.	Diamond is the hardest known natural substance.	Graphite is soft and slippery.

Q.58. Find out the difference between: Diamond and graphite.

Ans:

No.	Diamond	Graphite
i	It has a three-dimensional network structure.	It has a two-dimensional hexagonal layered structure.
ii.	In diamond, each carbon atom is sp^3 hybridized.	In graphite, each carbon atom is sp^2 hybridized.
iii.	Each carbon atom in diamond is linked to four other carbon atoms.	Each carbon atom in graphite is linked to three other carbon atoms.
iv.	Diamond is poor conductor of electricity due to absence of free electrons.	Graphite is good conductor of electricity due to presence of free electrons in its structure.
v.	Diamond is the hardest known natural substance.	Graphite is soft and slippery.

Q.59. Explain the structure of various allotropes of phosphorus

Q.68. Name a molecule having banana bond.

Ans: Diborane (B_2H_6)

Q.71. Match the pairs from column A and B.

	Column A		Column B
i.	BCl_3	a.	Angular molecule
ii.	SiO_2	b.	Linear covalent molecule
iii.	CO_2	c.	Tetrahedral molecule
		d.	Planar trigonal molecule

Ans: i – d, ii – c, iii – b

Q.2. What are the different forms (physical states) in which water exists?

Ans: Water exists in the three different forms solid ice, liquid water and gaseous vapours.

Q.26. Name the types of intermolecular forces present in Ar, Cl_2, CCl_4 and HNO_3.

Ans:

i. Ar: London dispersion forces

ii. Cl_2: London dispersion forces

iii. CCl_4: London dispersion forces

iv. HNO_3: Hydrogen bonding (dipole-dipole attraction) and London dispersion forces

ENRICH YOUR KNOWLEDGE

Q.78. A hot air balloon has a volume of 2800 m^3 at 99 °C. What is the volume if the air cools to 80 °C?

Solution:

Given: V_1 = Initial volume = 2800 m^3, T_1 = Initial temperature = 99 °C = 99 + 273.15 = 372.15 K,
T_2 = Final temperature = 80 °C = 80 + 273.15 K = 353.15 K

To find: V_2 = Final volume

Formula: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ (at constant n and P)

Calculation: According to Charles' law,

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \text{ (at constant n and P)}$$

$$\therefore \quad V_2 = \frac{V_1T_2}{T_1} = \frac{2800 \times 353.15}{372.15} = \mathbf{2657\ m^3}$$

Ans: The volume of the balloon when the air cools to 80 °C is **2657 m^3**.

Q.79. The volume of a given mass of

***Q.109. Nitrogen gas is filled in a container of volume 2.32 L at 32 °C and 4.7 atm pressure. Calculate number of moles of the gas.**

***Solution*:**

Given: V = 2.32 L, P = 4.7 atm, T = 32 °C = 32 + 273.15 K = 305.15 K

R = 0.0821 L atm K^{-1} mol^{-1}

To find: n = number of moles of gas

Formula: PV = nRT

Calculation: According to ideal gas equation,

PV = nRT

$$\therefore \quad n = \frac{PV}{RT} = \frac{4.7 \times 2.32}{0.0821 \times 305.15} = \mathbf{0.435\ moles}$$

Ans: Number of moles of N_2 gas in the given volume is **0.435 moles.**

R = Gas constant,

Q.84. Derive the ideal gas equation.

Ans: According to Boyle's law,

$$V \propto \frac{1}{P} \quad \text{(at constant T and n)} \quad ....(1)$$

According to Charles' law,

$$V \propto T \quad \text{(at constant P and n)} \quad ....(2)$$

According to Avogadro's law,

$$V \propto n \quad \text{(at constant P and T)} \quad ....(3)$$

Combining relations (1), (2) and (3), we get

$$V \propto \frac{nT}{P}$$

Converting this proportionality into an equation by introducing a constant of proportionality ('R' known as gas constant), we get

$$\therefore \quad V = \frac{nRT}{P}$$

On rearranging the above equation, we get

PV= nRT

where,

P = Pressure of gas, V = Volume of gas, n = number of moles of gas,

R = Gas constant, T = Absolute temperature of gas.

This is the ideal gas equation or equation of state.

*[**Note:** In the ideal gas equation, R is called gas constant or universal gas constant, whose value is same for all the gases. In this equation, if three variables are known, fourth can be calculated. The equation describes the state of an ideal gas. Hence, it is also called as equation of state.]*

Q.19. Distinguish between the following: Physisorption and chemisorption. Give one example.

Ans:

No.	Physisorption	Chemisorption
i.	The forces operating are weak van der Waals forces.	The forces operating are of chemical nature (covalent or ionic bonds).
ii.	It is not specific in nature as all gases adsorb on all solids. For example, all gases adsorb on charcoal.	It is highly specific and occurs only when chemical bond formation is possible between adsorbent and adsorbate. For example, adsorption of oxygen on tungsten, hydrogen on nickel, etc.
iii.	The heat of adsorption is low and lies in the range 20-40 kJ mol^{-1}.	The heat of adsorption is high and lies in the range 40-200 kJ mol^{-1}.

iv.	It occurs at low temperature and decreases with an increase of temperature.	It is favoured at high temperature, however, the extent of chemical adsorption is lowered at very high temperature due to bond breaking.
v.	It is reversible.	It is irreversible.
vi.	Physisorbed layer may be multimolecular layer of adsorbed particles under high pressure.	Chemisorption forms monomolecular layer of adsorbed particles.
e.g.	At low temperature N_2 gas is physically adsorbed on iron.	N_2 gas chemically adsorbed on iron at high temperature forms a layer of iron nitride, which desorbs at very high temperature.

Q.89. Explain the term emulsion and types of emulsions.

Ans:

i. *A colloidal system in which one liquid is dispersed in another immiscible liquid is called an* ***emulsion.***

ii. There are liquid-liquid colloidal systems in which both liquids are either completely or partially immiscible.

iii. There are two types of emulsions:

a. **Emulsion of oil in water (o/w type):** *An emulsion in which dispersed phase is oil and dispersion medium is water is called* ***emulsion of oil in water.***

e.g.
1. Milk consists of particles of fat dispersed in water.
2. Other examples include vanishing cream, paint, etc.

b. **Emulsion of water in oil (w/o type):** *An emulsion in which dispersed phase is water and dispersion medium is oil is called* ***emulsion of water in oil.***

e.g.
1. Cod liver oil consists of particles of water dispersed in oil.
2. Some other examples of this type include butter, cream, etc.

ENRICH YOUR KNOWLEDGE

Q.8. What is an open system?

Ans: A system in which exchange of both matter and heat occurs with the surroundings is called an open system.

Q.9. What is an isolated system?

(due to volume change) on the composition of the equilibrium mixture.

Q.71. Explain Le Chatelier's principle suitably with reference to change in temperature.

Ans: Change in temperature:

i. Consider the equilibrium reaction,

$$PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)} + 92.5\ kJ$$

ii. The forward reaction is exothermic. According to Le Chatelier's principle an increase in temperature shifts the position of equilibrium to the left.

iii. The reverse reaction is endothermic. An endothermic reaction consumes heat. Therefore, increase in temperature results in shifting the equilibrium in the reverse direction to use up the added heat (heat energy converted to chemical energy).

iv. Thus, an increase in temperature favours formation of PCl_5 while a decrease in temperature favours decomposition of PCl_5.

Q.24. State law of mass action.

Ans: Law of mass action: *The law of mass action states that the rate of a chemical reaction at each instant is proportional to the product of concentrations of all the reactants.*

Q.28. Derive the expression of equilibrium constant, K_C for the reaction:

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

Ans: Consider a hypothetical reversible reaction $A + B \rightleftharpoons C+D$.

Two reactions, namely, forward and reverse reactions occur simultaneously in a reversible chemical reaction. The rate equations for the forward and reverse reactions are:

$Rate_{forward} \propto [A][B]$

$\therefore$ $Rate_{forward} = k_f [A] [B]$ .... (1)

$Rate_{reverse} \propto [C] [D]$

$\therefore$ $Rate_{reverse} = k_r [C] [D]$ .... (2)

At equilibrium, the rates of forward and reverse reactions are equal. Thus,

$Rate_{forward} = Rate_{reverse}$

$\therefore$ $k_f [A] [B] = k_r [C] [D]$

$\therefore$ $\frac{k_f}{k_r} = K_C = \frac{[C][D]}{[A][B]}$ .... (3)

K_C is called the **equilibrium constant.**

Q.29. Explain: Dynamic nature of chemical equilibrium with suitable example.

***Q.11. Differentiate irreversible and reversible reaction.**

Ans:

No.	Irreversible reaction	Reversible reaction
i.	Products are not converted back to reactants.	Products are converted back to reactants.
ii.	Reaction stops completely and almost goes to completion.	Reaction appears to have stopped but does not undergo completion.
iii.	It can be carried out in an open or closed vessel.	It is generally carried out in a closed vessel.
iv.	It takes place only in one direction. It is represented by $\longrightarrow$	It takes place in both directions. It is represented by $\rightleftharpoons$
e.g.	$C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$	$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$

Q.16. Identify the type of equilibrium in the following physical processes:

i. **$Camphor_{(s)} \rightleftharpoons Camphor_{(g)}$**

ii. **$Ammonium\ chloride_{(s)} \rightleftharpoons Ammonium\ chloride_{(g)}$**

iii. **Carbon dioxide gas $\rightleftharpoons$ Dry ice**

iv. **Water $\rightleftharpoons$ Ice**

Ans:

i. Solid – vapour equilibrium

ii. Solid – vapour equilibrium

iii. Solid – vapour equilibrium

iv. Solid – liquid equilibrium

Q.17. Name two substances that undergoes sublimation

Q.19. What is a saturated solution?

Ans: A saturated solution is the solution when additional solute cannot be dissolved in it at the given temperatur
The concentration of solute in a saturated solution depends on temperature.

Q.8. Define:

i. Isotopes **ii. Isobars**

Ans:

i. Isotopes: *Nuclides which contain same number of protons but different number of neutrons in their nuclei are called as* ***isotopes.***

e.g. $^{22}_{11}Na$, $^{23}_{11}Na$ and $^{24}_{11}Na$

ii. Isobars: *Nuclides (of different element) which have same mass number but have different number of protons and neutrons in their nuclei are called as* ***isobars.***

OR

The atoms of different elements having the same mass number but different atomic numbers are called ***isobars.***

e.g. $^{14}_{6}C$ and $^{14}_{7}N$

Q.101. Explain in brief, nuclear fission.

Ans:

i. **Nuclear fission:** *It is a process which involves splitting of the heavy nucleus of an atom into two nearly equal fragments accompanied by release of the large amount of energy.*

e.g. Nuclear fission of ^{235}U

ii. When a uranium nucleus absorbs neutron, it breaks into two lighter fragments and releases energy (heat), more neutrons, and other radiation. This can be given as,

$$^{235}_{92}U + ^{1}_{0}n \longrightarrow ^{142}_{56}Ba + ^{91}_{36}Kr + 3\,^{1}_{0}n + \text{Energy}$$

iii. **Characteristics of nuclear fission reactions:**

a. The mass of the fission products is less than the parent nucleus. A large amount of energy corresponding to the mass loss is released in each fission.

b. When one uranium 235 nucleus undergoes fission, three neutrons are emitted, which subsequently disintegrate three more uranium nuclei and thereby produce nine neutrons. Such a chain continues by itself.

c. In a very short time enormous amount of energy is liberated, which can be utilized for destructive or peaceful purposes.

d. Energy released per fission is approximately 200 MeV.

Note:

1. Each fission may lead to different products.
2. There is no unique way for fission of ^{235}U that produces Ba and Kr. There are 400 ways for fission of ^{235}U leading to 800 fission products.
3. Many of these fission products are radioactive which undergo spontaneous disintegrations giving rise to new elements in the periodic table.

Q.29. Identify the functional group in the following compounds:

i. n-Butyl alcohol ii. Propanone iii. Acetylene

Ans:

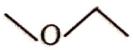
No.	Name of the compound	Formula of the compound	Functional group
i.	n-Butyl alcohol	$CH_3(CH_2)_3OH$	–OH (Hydroxyl/alcoholic)
ii.	Propanone (acetone)	$CH_3 - \overset{\overset{\displaystyle O}{\|}}{C} - CH_3$	$- \overset{\overset{\displaystyle O}{\|}}{C} -$ (Keto)
iii.	Acetylene	$HC \equiv CH$	$- C \equiv C -$ (Alkyne)

Q.11. Write bond line formulae and condensed formulae for the following compounds:

i. 3-Methyloctane ii. Hept-2-ene iii. 2,2,4,4-Tetramethylpentane

iv. Octa-1,4-diene v. Methoxyethane

Ans:

Compound	Bond line formula	Condensed formula (A)	Condensed formula (B)
3-Methyloctane		$H_3CCH_2CH(CH_3)(CH_2)_4CH_3$	$H_3C-CH_2-\underset{\underset{CH_3}{\vert}}{CH}-CH_2-CH_2-CH_2-CH_2-CH_3$
Hept-2-ene		$H_3CCH=CH(CH_2)_3CH_3$	$H_3C-CH=CH-CH_2-CH_2-CH_2-CH_3$
2,2,4,4-Tetramethylpentane		$(H_3C)_3CCH_2C(CH_3)_3$	$H_3C-\overset{\overset{CH_3}{\vert}}{\underset{\underset{CH_3}{\vert}}{C}}-CH_2-\overset{\overset{CH_3}{\vert}}{\underset{\underset{CH_3}{\vert}}{C}}-CH_3$
Octa-1,4-diene		$H_2C=CHCH_2CH=CH(CH_2)_2CH_3$	$H_2C=CH-CH_2-CH=CH-CH_2-CH_2-CH_3$
Methoxyethane		$H_3COC_2H_5$	$H_3C-O-CH_2-CH_3$

Q.71. Explain: Metamerism

Ans:

i. ***Metamerism*** *may be defined as a type of isomerism in which different compounds have same molecular formula and the same functional group but have unequal distribution of carbon atoms on either side of the functional group. Such isomers are known as metamers.*

ii. **e.g.** Ether with molecular formula $C_4H_{10}O$ has three metamers. They have same functional group as ether but have different distribution of carbon atoms attached to etheral oxygen. These metamers are:

a. $CH_3 - CH_2 - O - CH_2 - CH_3$ Ethoxyethane (Diethyl ether)

b. $CH_3 - O - CH_2 - CH_2 - CH_3$ Methoxypropane (Methyl n-propyl ether)

c. $CH_3 - O - \underset{\underset{CH_3}{|}}{CH} - CH_3$ 2- Methoxypropane (Isopropyl methyl ether)

***Q.83. Distinguish: Homolysis and heterolysis.**

Ans:

No.	Homolysis (Homolytic fission)	Heterolysis (Heterolytic fission)
i.	The symmetrical breaking of a covalent bond in which each departing atom takes one electron from the bonding pair is called as homolytic fission.	The unsymmetrical breaking of a covalent bond in which one of the departing atoms retains the bonding pair is called as heterolytic fission.
ii.	In this type of fission, formation of free radicals (uncharged species) bearing unpaired electrons take place.	In this type of fission, formation of charged species called ions, like carbocation or carbonium ion take place.
iii.	The covalent bond between two atoms of the same element or two atoms having nearly the same electronegativity breaks in this manner. **e.g.** $Cl-Cl \xrightarrow[\text{homolysis}]{\text{UV light}} \dot{Cl} + \dot{Cl}$	The covalent bond between two atoms of the different element or two atoms having different electronegativity values breaks in this manner. $CH_3-\underset{\underset{CH_3}{\vert}}{\overset{\overset{CH_3}{\vert}}{C}}-Br \xrightarrow[\text{heterolysis}]{\text{Polar solvent}} CH_3-\overset{\overset{CH_3}{\vert}}{\underset{\underset{CH_3}{\vert}}{C^+}} + \ddot{\underset{..}{Br}}^-$
iv.	This takes place favourably in a nonpolar solvent.	This takes place favourably in a polar solvent.
v.	Generally, reaction takes place at high temperature or in presence of UV light or peroxides.	Heterolysis takes place in solutions (polar condition).

15.1 ALKANES

Q.1. Can you recall? *(Textbook page no. 233)*

i. What are hydrocarbons?

Ans: The compounds which contain carbon and hydrogen as the only elements are called hydrocarbons.

ii. Write structural formulae of the following compounds: propane, ethyne, cyclobutane, ethene, benzene.

Ans:

	Compounds	Structural formulae
a.	Propane	$H_3C - CH_2 - CH_3$
b.	Ethyne	$HC \equiv CH$
c.	Cyclobutane	$H_2C - CH_2$ | | $H_2C - CH_2$

	Compounds	Structural formulae
d.	Ethene	$H_2C = CH_2$
e.	Benzene	

Q.8. Write all the possible structural isomers of a saturated hydrocarbon having molecular formula C_5H_{12}.

Ans:

i. $H_3C-(CH_2)_3-CH_3$

Pentane

ii. $H_3C-\underset{\underset{CH_3}{|}}{CH}-CH_2CH_3$

2-Methylbutane

iii. $H_3C-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{C}}-CH_3$

2,2-Dimethylpropane

Q.26. Explain the preparation of Grignard reagents.

OR

What is Grignard reagent? Explain its preparation.

Ans: Grignard reagent are alkyl magnesium halides obtained by treating alkyl halides with dry magnesium metal in the presence of dry ether.

General reaction:

$$\underset{\text{Alkyl halide}}{R-X} + Mg \xrightarrow[\Delta]{\text{dry ether}} \underset{\text{Alkyl magnesium halide}}{R-Mg-X}$$

ENRICH YOUR KNOWLEDGE

Q.46. Write a short note on pyrolysis of alkanes.

Ans: Alkanes on heating at higher temperature in absence of air decompose to lower alkanes, alkenes and hydrogen, etc. This is known as pyrolysis or cracking.

e.g. Pyrolysis of hexane

$$C_6H_{14} \xrightarrow{773\ K} \begin{cases} C_6H_{12} + H_2 \\ C_4H_8 + C_2H_6 \\ C_3H_6 + C_2H_4 + CH_4 \end{cases}$$

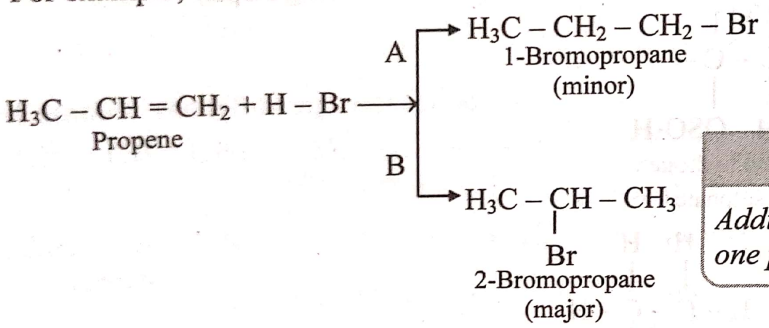
ii. The order of reactivity of halogen acids is HI > HBr > HCl

Q.90. State Markovnikov's rule and explain it with the help of an example.

Ans:

i. **Markovnikov's rule:** When an unsymmetrical reagent is added to an unsymmetrical alkene, the negative part (X-) of the reagent gets attached to the carbon atom which carries less number of hydrogen atoms.

ii. For example, addition of HBr to unsymmetrical alkenes yield two isomeric products.



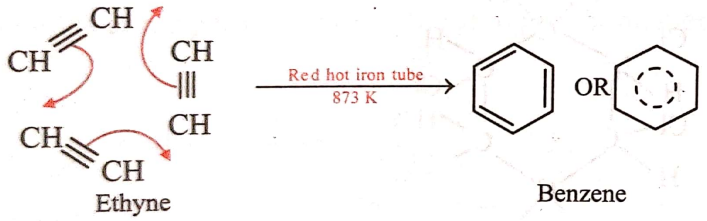
CAUTION

Addition of HBr to symmetrical alkenes yields only one product.

iii. Experimentally it has been found that 2-Bromopropane is the major product.

Q.180. How is benzene prepared from ethyne/acetylene?

Ans: From ethyne (By trimerization): Alkynes when passed through a red hot iron tube at 873 K, polymerize to form aromatic hydrocarbons. Ethyne when passed through a red hot iron tube at 873 K undergoes trimerization to form benzene.



Q.29. Identify the functional group in the following compounds:

i. n-Butyl alcohol ii. Propanone iii. Acetylene

Ans:

No.	Name of the compound	Formula of the compound	Functional group
i.	n-Butyl alcohol	$CH_3(CH_2)_3OH$	–OH (Hydroxyl/alcoholic)
ii.	Propanone (acetone)	$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3$	$-\overset{\overset{\displaystyle O}{\|}}{C}-$ (Keto)
iii.	Acetylene	$HC \equiv CH$	$-C \equiv C-$ (Alkyne)

Q.39. i. Which type of drug is used as medicine?
ii. What does a medicine contain?
iii. What are medicines used for?

Ans:

i. A drug having therapeutic and useful biological response is used as medicine.

ii. A medicine contains a drug as its active ingredient. Besides, it contains some additional chemicals which make the drug suitable for its use as medicine.

iii. Medicines are used in diagnosis, prevention and treatment of a disease.
[Note: Drugs being foreign substances in a body, often give rise to undesirable, adverse side effects.]

Q.40. Explain the terms "Drug design".

Ans: Drug design is an important branch of medicinal chemistry which aims at synthesis of new molecules having better biological response. Now-a-days, there is an increasing trend in drug design to take cognizance of traditional medical knowledge such as Ayurvedic medicine or natural materials to discover new drugs.

ENRICH YOUR KNOWLEDGE

Do you know? *(Textbook page no. 265)*
The drug manufacturing companies usually have a patent for drugs which are sold with the brand name. After the expiry of patent, the drug can be sold in the name of its active ingredient. These are called generic medicines.

***Q.41. Name the class of drug often called as painkiller.**

Ans: Analgesics are the class of drug often called as painkiller.

Q.42. What are analgesics? Explain their mode of action.

Ans: Analgesics:

i. Drugs which give relief from pain are called analgesics.
e.g. Aspirin, paracetamol

ii. Most of the analgesics are anti-inflammatory drugs, which kill pain by reducing inflammation or swelling.

Q.43. Can you tell? *(Textbook page no. 264)*
When is an antipyretic drug used?

Ans: An antipyretic drug is used to reduce fever (that is, it lowers body temperature when a fever is present).

Q.44. Mention the medicinal properties of salicylic acid.

Ans: Salicylic acid has pain-killing and fever reducing properties.

Q.45. i. What is aspirin? Write its use. ii. Mention its side effect.

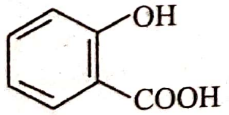
Ans:

i. Aspirin is acetyl derivative of salicylic acid.
It is widely used as an analgesic.

ii. It has a fewer side effects than salicylic acid. However, it retains stomach irritating side effects of salicylic acid.

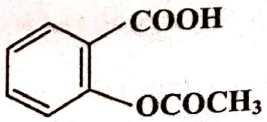
Q.46. Draw the structure of salicylic acid and write its IUPAC name.

Ans: Structure of salicylic acid:



IUPAC name: 2-Hydroxybenzoic acid

***Q.47. Write the molecular formula and name of**



Ans: Molecular formula: $C_9H_8O_4$
Name: Aspirin

***Q.100. Match the pairs.**

	A group		B group
i.	Paracetamol	a.	Antibiotic
ii.	Chloramphenicol	b.	Synthetic detergent
iii.	BHT	c.	Soap
iv.	Sodium stearate	d.	Antioxidant
		e.	Analgesic

Ans: i – e, ii – a, iii – d, iv – c