केंद्रीय विद्यालय संगठन

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Question Bank (Class XI - Chemistry)

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UNIT 1. SOME BASIC CONCEPTS OF CHEMISTRY

Concept - Significant Figures & Law Of Chemical Combination

KNOWLEDGE

One Mark Questions

Q1- Define the term unit. **(L-1)**

Ans. A unit is defined as the standard of reference chosen to measure any physical quantity.

Q2-Who discovered electron? **(L-2)**

Ans. J. J. Thomson

Q3- What is a pure substance? **(L- 1)**

Ans. A substance which contains only one kind of atom or molecule is called a pure substance .

Q4- Define average atomic mass. **(L-1)**

Ans. Average atomic mass is the average of atomic mass of all the isotopes of an element.

Q5- What is one a.m.u. or one 'u '? **(L-1)**

Ans:- One a.m.u. or u is equal to $1/12^{th}$ of the mass of an atom of carbon -12.

Two marks Questions-

Q1-What is the SI unit of mass? How is it defined? **(L-2)**

Ans.The SI unit of mass is kilogram. It is equal to the international prototype of the kilogram.

Q2- What are derived units ?Give an example. **(L-2)**

Ans. A unit obtained by multiplying or dividing one fundamental unit by another fundamental unit(S) is known as derived unit.

EXAMPLE : Density of a substance is defined by :

Density = mass of sample / volume of sample

= SI unit of mass / SI unit of volume

= kg/m^3 = $kg\ m^{-3}$

Q3. Define the term precision and accuracy. **(L-2)**

Ans. The term precision refers for the closeness of set of values obtained from identical measurement of a quantity, whereas accuracy is a related term, refers to the closeness of a single measurement to its true value.

UNDERSTANDING

One Mark Questions

Q1-What do you mean by significant figure? **(L-2)**

Ans. Total number of digits in a number including the last digit whose value is uncertain is called the number of significant figure.

Q2-How many fundamental units are there in SI system? **(L-1)**
Ans. There are seven fundamental units in SI system.

Q3. Define the law of conservation of mass. **(L-1)**
Ans. Matter can neither be created nor destroyed in the course of a Physical or chemical process although it may change from one form to another.

Q4. Which of the following statement about a compound is incorrect?**(L2)**

(I) A molecule of a compound has atom of different elements.
(II) A compound cannot be separated into its constituent elements by physical method of separation.
(III) A compound retained the physical properties of its constituent
(IV) The ratio of atoms of different element in a compound is fixed

Ans. (III) because a compound doesn't retain the physical properties of its constituents.

Q5-which of the following statements is correct about the reaction given below:-

$4Fe\ (s) + 3O_2\ (g) \rightarrow 2Fe_2O_3\ (g)$ **(L-2)**

(i) Total mass of iron and oxygen in reactants = total mass of iron and oxygen in product, therefore it follows law of conservation of mass.
(ii) Total mass of reactants = total mass of product; therefore, law of multiple proportions is followed.
(iii) Amount of Fe_2O_3 can be increased by taking any one of the reactants (iron or oxygen) in excess.
(iv) Amount of Fe_2O_3 produced will decreases it the amount of any one of the reactants (iron or oxygen) is taken in excess.

Ans. (i) law of conservation of mass states that the total mass of the reactants is equal to the total mass of the products.

Q6. One of the statements of Dalton's atomic theory is given below:

"Compounds are formed when atoms of different elements combine in a fixed ratio"

Which of the following laws is not related to this statement? **(L-3)**

(i) Law of conservation of mass (iii) law of multiple proportions.
(iii) Law of definite proportions (iv) Avogadro's law

Ans. (i), (iv). Statements (i) and (iv) involve masses and volume, respectively. Therefore, these are not related to the statements.

Two marks Questions

Q1-Express the following in scientific notation: **(L-2)**

(I) 0.0048 (II) 234,000 (III) 8008 (IV) 500.0

Ans.- (I) 4.8×10^{-3} (II) 2.34×10^{5} (III) 8.008×10^{3} (Iv) 5.000×10^{2}

Q2- How many significant figure are present in the following ? **(L-2)**

(I) 0.0025 (II) 208 (III) 5005 (IV) 126000

Ans.- (I) 2 (II) 3 (III) 4 (IV) 3

Q3-Round up the following upto three significant figure: **(L-3)**

(i) 34.216 (II) 10.4107 (III) 0.04597 (IV) 2808

Ans.- (I) 34.2 (II) 10.4 (III) 0.0460 (IV) 2810

Q4. Express the result of the following calculation to the appropriate number of significant figures: **(L-3)**

(I) 3.24 ×0.08666/5.0065 (II) 0.58 + 324.65

Ans. (I) 0.281/5.006=0.0561

(II) 0.58 + 324.65= 325.23

APPLICATION

One mark Questions-

Q1. What are the various types of mixtures ? **(L-2)**

Ans. Mixtures are of two types:

(I) Homogeneous – A mixture is said to be homogenous if its composition is uniform throughout.

(II) Heterogeneous – A mixture is said to be heterogeneous if its composition is not uniform throughout.

Q2- A piece of metal is 3 inch. What is its length in cm? **(L-3)**

Ans.3 inch= 3 ×2.54cm/1inch=7.62cm

Q3. A jug contain 2 L of milk .calculate the volume of the milk in m^3.**(L3)**

Ans. 2L =2×1000cm^3 ×1m^3/10^6 cm^3=2 × 10^{-3} m^3.

Two marks Questions-

Q1. How many second are there in 2 days ? **(L-3)**

Ans. 2 days = 2 days × 24 h/ 1 day × 60 min/1h × 60 s/1 min= 172800s.

Q2.If the speed of light is 3.0 × 10^8 ms^{-1} ,calculate the distance covered by light in 2.00ns. **(L-3)**

Ans.-Distance covered = speed ×time

=3.0 × 10^8 m s^{-1} ×2.00 ns

=3.0 × 10^8 m s^{-1} × 2.00 ns × 10^{-9}s/1ns

=0.600 m

Q3- 45.4 L of nitrogen reacted with 22.7 L of oxygen and 45.4 L of nitrogen oxide was formed. The reaction is given below:

$2N_2(g) + O_2(g) \rightarrow 2N_2O(g)$

Which law is being obeyed in this experiment? Write the statement of this law. **(L-3)**

Ans. Gay lussac's law of gaseous volume is being obeyed.

According to gay lussac's law of gaseous volumes, gases combine or are produced in a chemical reaction in a simple ration by volume, provided that all gases are the same temperature and pressure.

Three marks Questions

Q1- Convert into meter : **(L-3)**

(I) 7 nm (diameter of small virus)

(II) 40 Em(thickness of milky way galaxy)

(III) 1.4Gm(diameter of sun)

Ans. (I) 7nm= 7nm/nm× 10^{-9}m=7×10^{-9} m.

(II) 40Em= 40×10^{18}m=4×10^{19}m. (Note E= Exa, 1E= 10^{18})

(III) 1.4Gm= 1.4×10^{9} m.

Q2 Express the following in SI unit base unit using power of notation : **(L-3)**

(a) 1.35 mm (b) 1 day (C) 6.45 ml

Ans. (a) 1.35mm =1.35 × 10^{-3}m

(b) 1 day = 0.1 × 10^{1} day

(c) 6.45 ml = 6.45× 10^{-3} L

Q3- What is a chemical equation? What are its essential features? **(L-2)**

Ans. the qualitative and quantitative representation of a chemical reaction in short form in terms of symbols and formulae is called chemical equation. For example, on heating calcium carbonate, it gives $Caco_3 \rightarrow Ca0 + CO_2$

Essential features:

(I) It should represent a true chemical reaction.

(II) The formulae for all reactants and products must be correct.

(III) It should be arithmetically balanced, i.e., the number of atoms of each element on both sides of arrow should be equal.

Q4-Carbon is found to form two oxides, which contain 42.9% and 27.3% carbon respectively. Show that these figures illustrate the law of multiple proportions. **(L-3)**

Ans:-% composition of carbon in different oxides –

Element	First oxide	Second oxide
carbon	42.9%	27.3%
oxygen	100-42.9=57.1	100-27.3=72.7

In first oxide, 57.1 part by mass of oxygen with 42.9 parts by mass of carbon

Therefore-1 part oxygen will combine with carbon=42.9/57.1=0.751

Similarly In second oxide contains oxygen72.7 parts with 27.3 parts carbon

One part oxygen combine with carbon =27.3/72.7=0.376

The ratio of the masses of carbon that combine with the same mass oxygen is =0.751:0.376

Or 2:1, since this is a simple whole numbers ratio , so the above data illustrate the law of multiple proportion.

Q5- (i) What would be the SI unit for the quantity pV^2T^2/n?

(ii) Convert liter- atmosphere to joule (SI units of energy). **(L-3)**

Ans. (i) SI unit would be

$N\ m^{-2}\ (m^3)^2\ (K)^2 / mol$

$N\ m^4\ K^2\ mol^{-1}$

(ii). $1\ L\ atm \times 10^{-3}\ m^3/1L \times 101.325 Pa/atm = 101.325\ Pa\ m^3$

$101.325\ Pa\ m^3 = 101.325(N/m^2)\ m^3$

$= 101.325\ N\ m = 101.325\ J$

Concept- Mole concept ,concentration terms and balancing

KNOWLEDGE

One Mark Questions

Q1 How many molecules are present in one mole of substance? **(L I)**

Ans. 6.022×10^{23} molecules.

Q.2 What is molar mass? **(L I)**

Ans. The mass of one mole of a substance is called its molar mass. **(L I)**

Q3 What is a balanced chemical equation. **(L I)**

Ans. A chemical equation which has an equal number of atoms of each element in the reactants and the products is called balanced chemical equation.

Q4 Define Molarity. **(L I)**

Ans. It is the number of moles of the solute dissolved per litre of the solution.

Q.5 Define Molality. **(L I)**

Ans. It is the number of moles of the solute dissolved per 1000 g of the solvent.

Two Marks Questions

Q 1 a) 1 mole of H_2 gas at STP = _____litre

b) 1 mole of CO_2 gas at STP = _____litre. **(L I)**

Ans. a) 22.4 b) 22.4

Q2 Define mole? **(L I)**

Ans. The amount of substance that contains the same number of entities(atoms, molecules, ions or other particles) as the number of atoms present in 12g of carbon-12 isotope.

Q3 What do you mean by (a) ppm (b) mass%.**(L I)**

Ans. (a) It is the parts of a component or solute per million parts of the solution.

(b) The mass% of a component in a given solution is the mass of the component per 100 g of the solution.

Q4 How are 0.50 m Na_2CO_3 and 0.50 M Na_2CO_3 different? **(L I)**

Ans. 0.50 m Na_2CO_3 solution means that 0.5 mol (or 53g) of Na_2CO_3 are present in 1000 g of solvent.

0.50 M Na_2CO_3 solution means that 0.5 mol (or 53g) of Na_2CO_3 are present in 1L of solution.

Que.5 Describe: a) gram molecular mass b) Molar Volume. **(L I)**

Ans. a) Molecular mass of a substance expressed in grams is called gram molecular mass.

b) Volume of one mole of any substance is called its Molar volume.

Three Marks Questions

Q1 Match the following

a) Mass of one molecule (i) $\frac{\text{Atomicmass (g)}}{6.022\text{x } 10^{23}}$

b) Mass of one atom (ii) $\frac{\text{Molecularmass (g)}}{6.022\text{x}10^{23}}$

c) No. of moles of a compound (iii) $\frac{\text{Mass of compound}}{\text{Molecular mass (g)}}$ **(L I)**

Ans. a) (ii) b) (i) c) (iii)

Q2 (i) Gram atomic mass of oxygen = _____ g

(ii) Gram molecular mass of oxygen = _____ g

(iii) 1 Gram atom of oxygen = _____ g**(L I)**

Ans. (i) 16g (ii) 32g (iii) 16g

Q3 a) Why Molarity varies with temperature? **(L I)**

b) Which concentration term is suitable when solute is present in very minute quantities or traces?

c) What is the sum of mole fraction of all the components of a solution?

Ans. a) Because it is number of moles of solute per litre of solution, and volume varies with temperature.

b) ppm(Parts per million)

c) 1

Q4 Give the units of: (a) Molarity (b) Molality (c) Mole fraction**(L I)**

Ans. (a) mol L^{-1} (b) mol Kg^{-1} (c) No units.

Q5 (a) Why is it necessary to balance a chemical equation?

(b)Name two methods for balancing a chemical equation. **(L I)**

Ans. a) Because a correct chemical equation must be in accordance with the law of conservation of mass according to which the total mass of the reactants must be equal to the total mass of the product.

b) Hit and trial method, Oxidation number method.

UNDERSTANDING

One Mark Questions

Q 1 What are the SI units of molarity**?** **(L 2)**

Ans. mol dm^{-3}.

Q2 What do you mean by 1M Nacl solution? **(L 2)**

Ans. It means 1 mole of NaCl (58.5g) of NaCl is present in 1 litre solution.

Q3 Calculate the mass of an atom of silver (atomic mass= 108) **(L 2)**

Ans. Mass of 6.022×10^{23} atoms of Ag = 108 g

Mass of one atom of Silver $\frac{108}{6.022 \times 10^{23}}$ = 1.79×10^{-22}g

Q4 Calculate the number of moles of iodine in a sample containing 1.0×10^{22}molecules**(L 2)**

Ans. 6.022×10^{23} molecules of iodine = 1 mol of iodine

1.0×10^{22} molecules of iodine = $\frac{1}{6.022 \times 10^{23}} \times 1.0 \times 10^{22}$

= 0.0166 mol of iodine

Q5 Calculate the volume occupied by 10 mole of CO_2 at STP. **(L 2)**

Ans. 1 mol of CO_2 at STP = 22.7 L

10 mole of CO_2 at STP = 22.7 x 10 =227 L

Two Marks Questions

Q1 How many molecules and atoms of Sulphur are present in 0.1 mole of S_8 molecules. **(L 2)**

Ans. 1 mole of S_8 molecules = 6.022×10^{23} molecules

0.1 mole of S_8 molecules = $6.022 \times 10^{23} \times 0.1 = 6.022 \times 10^{22}$ molecules

One molecule of S_8 contains 8 atoms of Sulphur

Therefore 6.022×10^{22} molecules of S_8 contain $= 6.022 \times 10^{22} \times 8 = 4.816 \times 10^{23}$ atoms.

Q2 Calculate the number of moles in

(a) 7.85 g of Iron (atomic mass of Fe=55.8u)

(b) 4.68 mg of silicon. (atomic mass of Si=28.1u) **(L 2)**

Ans. a) Atomic mass of Iron = 55.8 u

Moles of Iron = $\frac{\text{Mass of Iron}}{\text{Atomic Mass}} = \frac{7.85}{55.8}$ = 0.141 mol

b) 4.68 mg of Silicon = 4.68×10^{-3}g of silicon

moles of Silicon = $\frac{\text{Mass of Silicon}}{\text{Atomic Mass (g)}} = \frac{4.68 \times 10^{-3}}{28.1}$ = 1.66×10^{-4} mol.

Q3 Calculate the mass of 1u (atomic mass unit) in grams. **(L 2)**

Ans. 1u = $\frac{1}{12}$ Mass of the carbon atom (^{12}c)

6.022×10^{23} atoms of carbon = 12g

I atom of carbon = $\frac{12}{6.022 \times 10^{23}}$ g

= 1.99×10^{-23}g

1u = $\frac{1.99 \times 10^{-23}}{12} = 1.66 \times 10^{-24}$g

Q4 A solution is prepared by dissolving 2g of the substance A in 18 g of water. Calculate the mass percentage of solute. **(L 2)**

Ans. Mass of solute A = 2g

Mass of water = 18g

Mass of solution = 2+18 = 20g

Mass percentage = $\frac{\text{Mass of A}}{\text{Mass of solution}} \times 100\text{g}$

$= \frac{2}{20} \times 100 = 10\%$

Q.5 A solution is prepared by dissolving 18.25g of NaOH in distilled water to give 200 ml of solution. Calculate the molarity of the solution. **(L 2)**

Ans. Moles of NaOH = $\frac{18.25}{40}$

Volume of solution = 200 ml

Molarity = $\frac{\text{No of moles of solute}}{\text{Vol.of solution (L)}} = \frac{18.25/40}{200/1000}$

$= \frac{18.25 \times 1000}{40 \times 200} = 2.28\ \text{M}$

Three Marks Questions

Q1 Calculate the mass of

(a) 1 molecule of N_2

(b) 1 molecule of H_2O

(c) 100 molecules of sucrose **(L 2)**

Ans. (a) 6.022×10^{23} molecules of N_2 = 28 g

1 molecule of N_2= $\frac{28}{6.022 \times 10^{23}} = 4.65 \times 10^{-23}$g

(b) 6.022×10^{23} molecules of H_2O = 18g

1 molecule of N_2= $\frac{18}{6.022 \times 10^{23}} = 2.99 \times 10^{-23}$g

(c) 6.022×10^{23} molecules of sucrose = 342g

100 molecule of sucrose = $\frac{342}{6.022 \times 10^{23}} \times 100 = 5.68 \times 10^{-20}$g

Q2 Calculate the number of atoms in each of the following

(a) 52 mol of Argon

(b) 52 u of Helium

(c) 52 g of Helium**(L 2)**

Ans.(a) 1 mole of Argon contains = 6.022×10^{23} atoms

52 mol of Argon contains = $6.022 \times 10^{23} \times 52 = 3.13 \times 10^{25}$atoms

(b) 4 u of Helium = 1 atom

52 u of Helium = $\frac{1}{4} \times 52$ =13 atoms

(c) 4 g of Helium = 6.022×10^{23} atoms

52 g of Helium = $\frac{6.022 \times 10^{23}}{4} \times 52$

= 7.83×10^{24} atoms.

Q3 In three moles of ethane (C_2H_6) calculate the following:

(a) Number of moles of carbon

(b) Number of moles of hydrogen atom

(c) Number of moles of ethane**(L 2)**

Ans. (a) 1 mole of C_2H_6 contain = 2 moles of carbon

3 moles of C_2H_6 contain = 6 moles of carbon

b) 1 mole of C_2H_6 contain = 6 moles of hydrogen atom

3 moles of C_2H_6 contain = 18 moles of hydrogen atom

c) 1 moles of C_2H_6 contain = 6.022×10^{23} molecules

3 moles of C_2H_6 contain = $6.022 \times 10^{23} \times 3 = 1.0807 \times 10^{24}$ molecules.

Q.4 How many moles and how many grams of NaCl are present in 250 ml of a 0.50 M NaCl solution? **(L 2)**

Ans. Molarity = $\frac{\text{Moles ofsolute}}{\text{Volume of solution (L)}}$

$0.50 = \frac{\text{No. of moles of NaCl}}{250/1000}$

$0.50 = \frac{\text{No.of moles of Nacl}}{250} X1000$

No. of moles of NaCl = $0.50 \times \frac{250}{1000} = 0.125\ mol$

Gram molecular mass of NaCl = 23 +35.5 = 58.5 g

Mass of NaCl (g) = 0.125 x 58.5 = 7.3125 g

Q5 A solution is 25% H_2O, 25% C_2H_5OH and 50% acetic acid by mass. Calculate mole fraction of each component. **(L 2)**

Ans. Let the total mass of solution = 100g

Mass of water = 25g

Mass of C_2H_5OH = 25g

Mass of acetic acid = 50 g

$^nH_2O = \frac{25}{18} = 1.388$

$^nC_2H_5OH = \frac{25}{46} = 0.543$

$^nCH_3COOH = \frac{50}{60} = 0.833$

total number of moles = 1.388+0.543+0.833 = 2.764

mole fraction of $H_2O = \frac{1.3888}{2.764} = 0.502$

mole fraction of $C_2H_5OH = \frac{0.543}{2.764} = 0.196$

mole fraction of $CH_3COOH = \frac{0.8333}{2.764} = 0.302$

APPLICATION

One Mark Questions

Q1 Which one is more concentrated? 1 M NaCl or 1 m NaCl**. (L 3)**

Ans. 1 M NaCl

Q2 A solution has three components A, B, C. mole fraction of A and B are 0.50, 0.20 respectively. What is the mole fraction of C? **. (L 3)**

Ans. mole fraction of C = 1-(0.50+0.20) = 0.30

Q3 What is the effect of temperature on mole fraction? **. (L 3)**

Ans. No effect.

Q.4 What is the ratio of molecules between 1 mole of H_2O and 1 mole of sucrose (C_{12} H_{22} O_{11})?**(L 3)**

Ans. 1:1

Q.5 Calculate the number of molecules present in 1 dm^3 of hydrogen at STP. **. (L 3)**

Ans. 1 mole of H_2 at STP occupy 22.4 dm^3

1 mole of H_2 = 22.4 dm^3 =6.022 x 10^{23} molecules

22.4 dm^3 of hydrogen contain molecules = 6.022 x 10^{23}

1 dm^3 of hydrogen contain molecules = $\frac{6.022X10^{23}}{22.4}$ = 2.69 x 10^{22} molecules.

Two Marks Questions

Q1 Silver is very precious metal and is used in Jwellery. One million atoms of silver weigh 1.79 x 10^{-16} g. Calculate the atomic mass of silver. **. (L 3)**

Ans. Atomic mass of an element is the mass of 6.022 x 10^{23}atoms.

Now, 10^6 atoms of silver weigh = 1.79 x 10^{-16}

6.022 x 10^{23} atoms of silver weigh

=$1.79 \text{ X } 10^{-16} \text{x} \frac{6.022X10^{23}}{10^6}$ = 107.8 g

Atomic mass of silver = 107.8

Q2 The cost of table salt (NaCl) and sugar ($C_{12}H_{22}O_{11}$) are Rs. 2 per kg and Rs. 6 per kg respectively. Calculate their cost per mole. **. (L 3)**

Ans. (a) Cost of table salt per mole:

Molecular mass of table salt (NaCl) = 23+35.5=58.5

Now, 1000 g of NaCl cost = Rs. 2

Therefore 58.5 g of NaCl will cost = $\frac{2}{1000}$ x 58.5 =0.117 rupees

= 12 paise (approx.)

b) Cost of sugar per mole:

Molecular mass of sugar ($C_{12}H_{22}O_{11}$)= 12x12+22x1 +11x16 = 342

Now, 1000 g of sugar cost = Rs. 6

Therefore 342 g of sugar will cost = $\frac{6}{1000}$ x 342 = 2.052 rupees

= 2.0 rupees (approx.)

Q3 Calculate the concentration of nitric acid in moles per litre in a sample which has a density, 1.41 g mL^{-1} and the mass percent of nitric acid in it being 69%**.. (L 3)**

Ans. 69 mass percent of nitric acid means that 69 g of HNO_3 are present in 100 g of solution.

Volume of solution = $\frac{\text{Mass}}{\text{Density}} = \frac{100\,\text{g}}{1.41\,\text{mL}^{-1}}$ = 70.92 mL

Moles of $HNO_3 = \frac{69}{63} = 1.095$

Therefore Molarity = $\frac{\text{Moles of } HNO_3}{\text{Volume of solution (in ml)}} \text{ x } 1000$

$= \frac{1.095}{70.92} \text{ x } 1000$ = 15.44 M

Q4 Calculate the molarity of pure water (density of water = 1 g mL^{-1}) **. (L 3)**

Ans. Density of water = 1 g mL^{-1}

Mass of 1000 mL of water = Volume x Density

1000 x 1 = 1000 g

Moles of water = $\frac{1000}{18}$ = 55.55

Now, 55.55 moles of H_2O are present in 1000 ml or 1L of water. Therefore Molarity = 55.55 M.

Q5 What is the molarity of a solution of methanol in water in which the mole fraction of methanol is 0.25. **. (L 3)**

Ans. 1 mole of solution contains 0.25 mol of methanol and 1 – 0.25 = 0.75 mol of water.

Mass of water = 0.75 x 18 = 13.5

Molality of methanol solution = $\frac{\text{Moles of Methanol}}{\text{Mass of solvent}} \text{ x } 1000$

$\frac{0.25}{13.5} \text{ x } 100$ = 18.5 m

Three Marks Questions

Q1 Calculate the weight of carbon monoxide having same number of oxygen atoms as are present in 88 g of carbon dioxide. **. (L 3)**

Ans. Molecular mass of CO_2 = 12 + 2 x 16 = 44

1mol of CO_2 = 44 g

44 g of CO_2 contain = 6.022 x 10^{23} molecules

88 g of CO_2 contain = $\frac{6.022 \text{x} 10^{23} \text{x } 88}{44}$

= 12.046 x 10^{23} molecules

Each molecule of CO_2 contain 2 oxygen atoms

No. of oxygen atoms in 12.046 x 10^{23} molecules of CO_2

= 2 x 12.046 x 10^{23} = 2.4092 x 10^{24}

Now, we have to calculate the mass of CO containing 2.4092 x 10^{24} atoms of oxygen.

Mass of CO containing 6.022 x 10^{23} oxygen atoms = 28 g.

Mass of CO containing 2.4092 x 10^{23} oxygen atoms = $\frac{28}{6.022X10^{23}} \text{ x } 2.4092\text{x}10^{24} = 112$ g

Q2 Chlorophyll, the green colouring matter of plants contains 2.68% of magnesium by weight. Calculate the number of magnesium atoms in 2.00 g of chlorophyll (at. Mass of Mg = 24). **. (L 3)**

Ans. Mass of chlorophyll = 2.0 g

Percentage of Mg = 2.68 g

Mass of Mg in 2.0 g of chlorophyll = $\frac{2.68 \text{ x } 2.0}{100}$ = 0.054 g

6.022 X 10^{23} atoms of magnesium = 24 g

24 g of Mg contains = 6.022 X 10^{23} atom

0.054 g of Mg contains = $\frac{6.022 \text{ x } 12.0}{24}$ = 1.3 X 10^{21} atoms

Q3 Balance the following skeletal equation:

$As_2O_3 + SnCl_2 + HCl \longrightarrow SnCl_4 + As + H_2O$. **(L 3)**

Ans. The skeletal equation is:

$As_2O_3 + SnCl_2 + HCl \longrightarrow SnCl_4 + As + H_2O$

Balancing arsenic and oxygen atoms by multiplying As by 2 and H_2O by 3

$As_2O_3 + SnCl_2 + HCl \longrightarrow SnCl_4 + 2As + 3\ H_2O$

Multiplying HCl by 6 to balance H atoms

$As_2O_3 + SnCl_2 + 6\ HCl \longrightarrow SnCl_4 + 2As + 3\ H_2O$

To balance chlorine atoms, multiply $SnCl_2$ and $SnCl_4$ both by 3.

$As_2O_3 + 3SnCl_2 + 6HCl \longrightarrow 3SnCl_4 + 2As + 3\ H_2O$

Q4 If the density of methanol is 0.793 kgL^{-1}, what is the volume needed for making 2.5 L of its 0.25 M solution? **. (L 3)**

Ans. Let us calculate moles of methanol present in 2.5 L of 0.25 M solution.

Molarity = = $\frac{\text{Moles of } CH_3OH}{\text{Volume in L}}$

0.25 = $\frac{\text{Moles of } CH3OH}{2.5}$

Moles of CH_3OH = 0.25 x 2.5 = 0.625 moles

Mass of CH_3OH = 0.625 x 32 = 20 g

(Molecular mass of CH_3OH = 32)

Now 0.793 x 10^3 g of CH_3OH is present in 1000 mL

20 g of CH_3OH will be present in = $\frac{1000}{0.793\ X\ 103}$ x 20 = 25.2 mL

Q5 What volume of 10 M HCl and 3 M HCl should be mixed to get 1L of 6 M HCl solution? **. (L 3)**

Ans. Suppose volume of 10 M HCl required to prepare 1 L of 6 M HCl = x litre

Volume of 3 M HCl required = (1-x) litre

Applying molarity equation:

$M_1V_1 + M_2V_2 = M_3V_3$

10 M HCl 3 M HCl 6 M HCl

10 X x + 3(1-x) = 6 X 1

10x + 3 – 3x = 6

7 x = 3 or $x = \frac{3}{7}$ = 0.428 mL

Therefore Vol. of 10 M HCl required = 0.428 L = 428 mL.

Vol. of 3 M HCl required = 1-0.428 = 0.527 L = 572 mL.

UNIT 2: STRUCTURE OF ATOM

Concept: Atomic Models, Spectrum & Dual Nature

KNOWLEDGE

One Mark Questions

Q1 State Heisenberg Uncertainty Principle.**(L-I**)

Ans. It is impossible to determine the exact position & exact momentum or velocity of microscopic particle.

Q2-Write E.C. for Oxygen

Ans. $1s^2$, $2s^2$, $2px^2$, $2py^1$, $2pz^1$ **(L-II)**

Q3 What is the difference between Quantum and photon? **(L-III)**

Ans. The smallest packet of Energy of any radiation is called as Quantum and that of Light is known as Photon.

Two Mark Questions

Q1 Which orbital has quantum no(a) n= 3 & l=1 **(L2)**

(b) n= 2, l= 0 (L-I)

Ans: (a)3p orbitals. (b) 2s

Q2- Find out the number of waves produced by Bohr electron in its third orbit. **(L-III)**

Ans. Number of waves = $2\pi r/\lambda$

$=2\pi r \times mv/h$

$= 2\pi/h \times nh/2\pi$

$= n$

$=3$

Three Mark Questions

Q1. Name the spectral series which appear in the region of electromagnetic spectrum. **(L-I)**

(a) Visible region

(b) UV region

(c) Far IR region

Ans: (a) Balmer Series

(b) Lymen Series

(c) Pfund Series

Q2.Find the wave length of Yellow emission of sodium whose frequency 5.09×10^{14} per sec.**(L-II)**

Ans: wave length = C/V_0

$= 3\times 10^8/5.09\times10^{14}$

$= 5.89 \times10^{-7}$ meter

Q3- Mention formulas of Bohrs atomic model with respect to the following**(L-III)**

(a) For radius

(b) Angular Momentum

(c) Energy of photon

Ans.

(a)For radius- r= 52.9 n^2 pm

(b)Angular Momentum – mvr= nh/2π

(c)Energy of photon- E= -2.18 x 10^{-18} / n^2 j

Q4- A 25 watt bulb emits monochromatic light of wave length 0.75 x10^{-6} meter . calculate rate of emission of quanta per sec.**(L-III)**

Ans. W= pxt

W=25 x 1 J

n = w/hc/ ʎ

=25x 0.75 x10^{-6}/6.626x 10^{-34}x 3x 10^{8}

=7.18 x 10^{19}

UNDERSTANDING

One Mark Questions

Q1**.** How was Neutron discovered? Write equation only? **L-2)**

Ans-$_4Be^9$+$_2He^4$ →$_6C^{12}$+$_0n^1$

Q2. Name the fundamental particles of atom. **(L-I)**

Ans. Electron, Proton & Neutron.

Q3. Write the charge of an electron in Coulombs.**(L-I)**

Ans. -1.6 x 10^{-19} Coulombs.

Two Marks Questions

Q1. Calculate the wave length of an electron whose KE is 3x 10^{-25} J . **(L-III)**

Ans: KE= ½ mv^2 put the values & calculate V(m = 9.1 x 10^{-31} Kg)

V= 812 m/s

Wave length = h/mv

= 8967 A^0

Q2. Arrange EMR in increasing order of their wave length.**(L-II)**

Microwave , X-rays , Radio Waves & UV rays

Ans: X-rays < UV rays < Micro wave < Radio

Q3. Which element show photo electric effect & why? how will you find kinetic energy of ejected electron ? **(L-II)**

Ans. Cs or K due to low IE, KE = h(v- v_0)

Three Marks Questions

Q1. Calculate the radius of first orbit of an electron in hydrogen atom. **(L-III)**

Ans. r = 5.29n^2/Z

r = 0.53 x 10^{-8} cm

Q2. An element with mass number 81 contains 31.7% more neutrons as compare to protons find out atomic symbol of element. **(L-II)**

Ans.Let protons = x

Mass number = P+n

Then neutrons= x + 31.7% of x

81= x + 1.317x

X=35

Symbol= Br

APPLICATION

One Mark Questions

Q1. What is threshold frequency? **(L-I)**

Ans –The minimum frequency required to eject out electron from an atom.

Q2. Why; e/m value is not constant for canal rays ? **(L-II)**

Ans. Mass of particles of cathode rays is not constant.

Q3-Why ; an electron cannot exist in the nucleus whose radius is 10^{-15} meter? **(L-III)**

Ans: by using uncertainty principal calculated value of uncertainity in velocity is more than the velocity of light.

Two Marks Questions

Q1.Write the draw back of Rutherford Atomic Model. **(L-I)**

Ans (1). He was unable to explain the stability of Atom.

(2). He could not explain the line spectrum.

Q2. Write two properties which cannot be explain by wave nature of radiation**(L-II)**

Ans. 1.Photo electric effect

2. Black Body radiation

Q3. When would deBroglie wave length of a moving electron becomes equal to that of proton. **(L-III)**

Ans. $\lambda=h/mv$ derive from this equation for an electron and proton

$V1/v2 = m2/m1$

$=1.6725 \times 10^{-27}/9.1095 \times 10^{-31}$

=1836

Velocity of electron= velocity of proton x 1836

Three Marks Questions

Q1.Give the points of Rutherford Model**. (L-I)**

Ans. 1. Atom is neutral.

2.Whole mass is concentrated in nucleus.

3.Electrons are revolving in orbits.

Q2. Find out frequency & wave length of a photon emitted during a transition from n=5 to n=2 in H atom. **(L-II)**

Ans: $\Delta E= 2.18 \times 10^{-18}(1/n_1^2 - 1/n_2^2)$

$= 2.18 \times 10^{-18}(1/5^2 - 1/2^2)$

$= -4.58 \times 10^{-19}$ J

Frequency= Δ E/h

$= 4.58 \times 10^{-19}$ J/6.626×10^{-34} Hz

$=6.91 \times 10^{14}$ Hz

Wave length= C/V_0

$=3x10^8/6.91x10^{14}$

=434 nm

Q3-Ejection of photo electron from silver metal can be stopped by applying a voltage of 0.35 volt, when radiation of wave length of 256.7×10^{-9} meter is used. Calculate work function. **(L-III)**

Ans :

Energy of incident radiation= hc/ λ

Put the values

$=7.74 \times 10^{-19}$ J

$=7.74 \times 10^{-19} \times 1.602 \times 10^{-19} = 4.83$ eV

W_0 = E- KE

=4.83 - 0.35

=4.48 eV

Q4-Lines of a spectrum are considered as finger prints, why.what is Rydberg formula and it value**. (L-I)**

Ans.No two persons can have identical finger prints. Like that every element emit or absorb a radiation of fixed wave length.

Rydberg formula $1/\lambda = R_H(1/n_1^2 - 1/n_2^2)$

Rh=109677 cm^{-1}

Q5-A 10 g Table Tennis Ball is moving with a speed of 90 m/s which is measured with an accuracy of 4% find out uncertainty in it speed as well as position. **(L-III)**

Ans:

m = 10g

m = 0.01kg

Δv = 4% of 90 m/s

= 3.6 m/s

$\Delta x = h/4\pi\, m\Delta v$

Put the values

$=1.46 \times 10^{-33}$ meter

Concept- Quantum numbers and Electronic Configuration

KNOWLEDGE

One mark questions

Q.1 How many electrons with *l=2* are there in an atom having atomic number 54 **(L_2)**

Ans. $3d^{10}$ & $4d^{10}$ = 20.

Q.2 What is electronic configuration of Cu (*z=29)* and Cr (*z=24)* by aufbau principle?**(L_2)**
Ans. Cu(29) = $1s^2,2s^2,2p^6,3s^2,3p^6, 3d^{10},4s^1$. Cr (*z=24)* =$1s^2,2s^2,2p^6,3s^2,3p^6, 3d^5,4s^1$.

Q.3 Define Pauli's exclusion principle ? **(L_1)**
Ans. No two electrons in an atom can have same set ofall four quantum numbers. If three are same one Quantum number must have different value.

Q.4 Which atoms are indicated by configuration [Ar]$4s^2 3d^1$, [Ne]$3s^2 3p^3$?**(L_1)**
Ans. Scandium, Phosphorous

Q.5 What are different types of quantum numbers , write them with their symbols ?**(L_1)**
Ans. 1.Principal Quantum Numbers (n)
2.Azimuthal Quantum Numbers (l)
3.Magnetic Quantum Numbers (m)
4.Spin Quantum Numbers(s)

Two marks Questions
Q1. How many nodal planes are there in $d_{x^2-y^2}$ & 2s?(L_3)
Ans. Two & Zero.

Q2.Define Aufbau Principle. Give a Suitable example.**(L_2)**
Ans. Electrons are filled in an atom according to increasing energies of atomic orbitals. Eg Z=36 eg, is $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6$.

Q3.What does $|\Psi|^2$mean ?**(L_2)**
Ans. The maximum probability of finding an electron or probability electron density.

Q4.What is the electronic configuration of palladium ?**(L_3)**
Ans. Pd(46) $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6,4d^{10}$.

Q5.Describe why the electronic configuration of chromium and copper is $3d^5\ 4s^1$ and $3d^{10}\ 4s^1$ and not $3d^4\ 4s^2$ and $3d^9 4s^2$ respectively ?**(L_3)**
Ans. Due to stable electronic configuration of $3d^5$ & $3d^{10}$ as half filled & fully filled d-orbitals are most stable as compared to $3d^4$& $3d^9$. It is because of symmetrical distribution of electron density as well as greater transition energies.

Three Mark Questions
Q.1. a) Where is the probability of finding an electron is zero? **(L_1)**
b) How many maximum electrons can be found in 3d orbital with spin quantum number -1/2? (L_1)
c) Which quantum no. determines the orientation of the orbital? **(L_1)**
Ans.a) at Node.
b) 5-electrons.
c) magnetic quantum no.

Q.2. a) How is the fifth dz^2-orbital different from the other four? **(L_1)**

b) Which orbital doesn't have directional character?**(L_2)**

c) On what basis does the energy of the orbital increase? **(L_2)**

Ans. a) It has no nodal plane.

b) s-orbital.

c) On increasing the value of (n+l)

Q.3. a) Select the correct set of quantum numbers **(L_1)**

S. No.	n	l	m
1.	1	1	+2
2.	2	1	+1
3.	3	2	-2
4.	3	4	-2

b) What would happen if the second electron in the first orbital of helium has parallel spin? **(L_2)**

Ans. a) 2 & 3.

b) Due to parallel spin same types of magnetic field are developed which produce more repulsion hence energy of the orbital increased much & becomes more unstable.

Q.4. a) Which quantum number doesn't come from non- relativistic Schrodinger wave equation? **(L_1)**

b) If l=3, what can be said about n? **(L_1)**

c) Write the electronic configuration of chromium. **(L_2)**

Ans. a) spin quantum no.(s)

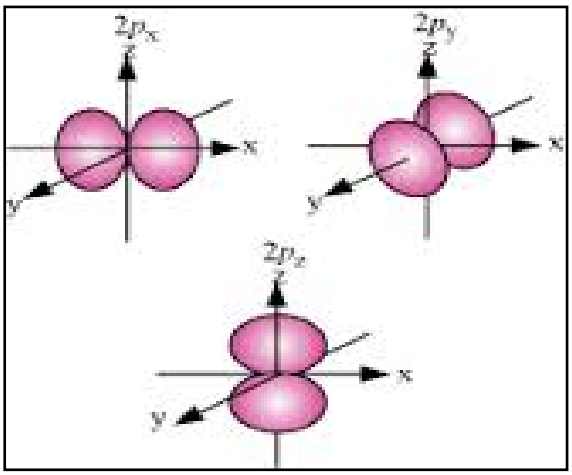
b) 4

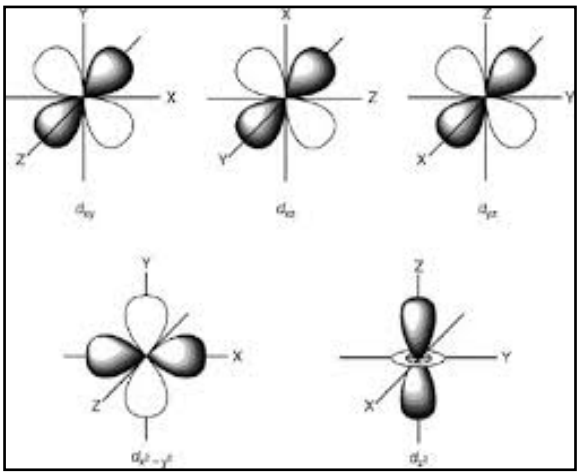
c) $1s^2,2s^2,2p^6,3s^2,3p^6,4s^1,3d^5$.

Q.5. Draw the boundary surface diagrams for –

(1) p_x
(2) p_y
(3) p_z
(4) d_{xy}
(5) d_{yz}
(6) d_{xz}
(7) d_{X2-Y2}
(8) d_{z2}

Ans





UNDERSTANDING

One Mark Question

Q1. How many maximum 3s electrons can have magnetic spin quantum number -1/2?**(L_2)**

Ans. 1 electrons.

Q2. Find the number of radial and angular nodes in 3d subshell? **(L_3)**

Ans. Zero-angular node as well as radial nodes.

Q3. Why is s-orbital orbital considered non directional while p-orbital directional?**(L_2)**

Ans. Electron density in s-orbital is equal in all direction while it dumble shaped along one axis in p-orbitals.

Q4.Which of the following can exhibit maximum Para magnetism: Ca, Fe^{+2} ,Cu^{+2}? Give reasons. **(L_2)**

Ans.Fe^{2+} due to presence of 4 unpaired electrons in 3d orbitals.

What will be the increasing order of energy of 2s, 3s, 3d, 4f in atom? **(L_2)**

Ans. 2s< 3s < 3d < 4f

Two Mark Questions

Q1. Why is the probability density $(\Psi)^2$ considered only over a small volume?**L_2)**

Ans. The volume of an orbital i.e. probable density is much smaller than the shell of an atom.

Q2."In reality all the s-orbitals are spherically symmetric." What does this represent?**(L_2)**

Ans. The probable density of an electron in s-orbital is equally distributed at all coordinates in space.

Q3.Is the energy of an electron in 2s orbital same as of that in 2p orbital? Why? **(L_2)**

Ans. No, the energy depends upon (n+l) values in an atom. Hence 2p orbital has greater energy than 2s.

Q4.Write the electronic configuration of the element in which the element holds orbitals having the same energies even for different azimuthal quantum number?**(L_2)**

Ans. Kr (Z=36)e.c is $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6$.

$2p^6$orbital has same energy as$3s^2$, &$3d^{10}$ orbital has same energy as $4p^6$ etc.

Q5. What accounts for the stability of an electron in multi-electron atom?**(L_3)**

Ans. i.The angular momentum of an electron is integral multiple of h/2π

ii. The symmetrical electron density of an orbit.

iii.The maximum transition energy of an orbital.

Three Mark Questions

Q.1. The elements P (atomic weight 39) and Q (atomic weight 80) contain 20 and 45 neutrons respectively in their nucleus .Give their electronic arrangements separately. Also give their position in the modern periodic table. **(L_2)**

Ans. Z=19 $1s^2,2s^2,2p^6,3s^2,3p^6,4s^1$. Z=35 $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^5$.

P-4^{th},G-1^{st}. P-4^{th},G-17^{th}.

Q.2. Why principal quantum no. is required? What does it mean? What will be it's possible values? **(L_2)**

Ans. It shows the distance of electron from nucleus. It refers as principal energy level. The possible values of (n) are 1 to 7. (As per existing elements)

Q.3 Give three differences between orbit and orbital. **(L_2)**

Ans

ORBIT	ORBITAL
1 It is a well defined circular path around the nucleus in which electron move.	**1** It is a 3D region around the nucleus where the probability of finding electron is maximum.
2 Maximum no. of electrons in an orbit is $2n^2$.	**2** Maximum 2 electrons in an orbital.
3 Do not have directional characteristics.	**3** Except s all have directional characteristics.

Q 4 Predict the electron configurations of S, K ,Ti, Sn**. (L1)**

Ans

1. S: 1s2 2s2 2p6 3s2 3p4
2. K: 1s2 2s2 2p6 3s2 3p6 4s1
3. Ti: 1s2 2s2 2p6 3s2 3p6 3d2 4s2
4. Sn: 1s2 2s2 2p6 3s2 3p6 3d104s2 4p6 4d105s2 5p2

APPLICATION

One Mark Questions

Q1. How many quantum numbers are needed to designate an orbital?**(L_2)**

Ans.Three quantum numbers.

Q2. Explain the significance of Azimuthal quantum number.**(L_1)**
Ans. It refers as sub-energy level of an atom.

Q3. n = 3, l = 3, m_l = -3, m_s = +1/2. Is the given set of quantum numbers possible? If not, explain by giving reasons. **(L_2)**
Ans. It is not possible because 3f does not exist in an atom.

Q4. How many of the following are possible: 1p, 2s, 3p, 3f, 3d.(L_1)
Ans.2s , 3p & 3d are possible.

Q5 What is the maximum number of electrons that can be accommodated in an atom in which the highest principal quantum number is 4?**(L_2)**
Ans. $1s^2,2s^2,2p^6,3s^2,3p^6,4s^2,3d^{10},4p^6$ = 36 electrons can accommodated.

Two Mark Questions
Q1.Explain why half-filled orbitals have extra stability.**(L_2)**
Ans. It has symmetrical electron density as well as greater exchange energy.

Q2. Tell what would happen to the stability of an atom, with atomic number higher than18, if the aufbau principle was not introduced.**(L_2)**
Ans. We cannot find out the exact reason of stability of an atom & why they should have filled inner orbits before outermost shell.

Q3. Explain the significance of spin quantum number.**(L_2)**
Ans.The direction of spinning of an electron in an orbit as well as the net magnetic moment of an orbital.

Q4. Select the correct set of quantum numbers for the 42^{nd} electron of the 42^{nd} element of the periodic table.
(a) n=5, l=3
(b) n=4 , l=2
(c) n=5 , l=0
(d) cannot be determined**(L_2)**
Ans. (b)
Q5. Name all five d-orbitals.**(L_1)**
Ans. dxy, dyz, dxz, dx^2-y^2, dz^2.

Three Mark Questions
Q.1. What will be the value of n & l of the followings? **(L_1)**
1. $4s^1$
2. $5d^1$
3. $4f^1$.

Ans (1)n=4 & l=0
(2)n=5 & l=2
(3)n=4 & l=3

Q.2. What is Hund's rule of maximum multiplicity? What is its significance? **(L_2)**

Ans Pairing of electrons in an orbital takes place only when all orbitals of same sub-shell become singly occupied. It helps to equalize energy of a sub-shell

Q.3. What do you mean by Pauli'e exclusive principle? What is its significance? **(L_2)**

Ans No two electrons will have same set of all q.no. If n,l,m are same i.e. same orbital 's' will be differ. It shows that all electrons have a definite place in an atom or their own identity.

Q.4. What is Aufbau's principle? How it helps to fill electrons in an atom in different orbitals? **(L_2)**

Ans Electrons are filled in orbitals of an atom according to increasing energies which is in accordance to (n+l) values of electrons. If (n+l)values are same the electron goes to orbital having lower value of n.

Q.5. Correct the values of wrong q.nos. (L_2)

Sr.No.	(n)	(l)	(m)
1.	1	1	-1
2.	2	1	0
3.	3	3	-3
4.	4	4	-3
5.	5	4	1

Ans.

Sr.No.	(n)	(l)	(m)
1.	1	0	0
2.	2	0,1	0, (-1,0,1)
3.	3	0,1or2	0,(-1,0,1,),(-2,-1,0,1,2)
4.	4	0,1,2,3	0,(-1,0,1), (-2,-1,0,1,2),(-3,-2,-1,0,1,2,3)
5.	5	0,1,2,3,4	0,(-1,0,1), (-2,-1,0,1,2),(-3,-2,-1,0,1,2,3), (-4,-3,-2,-1,0,1,2,3,4)

UNIT –3 CLASSIFICATION OF ELEMENTS & PERIODICITY IN PROPERTIES

Concept: Periodic Laws &s,p,d,f Configurations

KNOWLEDGE

One Mark Questions

Q1.Name the scientist who proposed modern periodic law.(L1)

Ans: Henry Moseley

Q2.Which group elements are called d-blocks Elements ?l(L2)

Ans: group 3 to 12

Q3.State Mendeleev Periodic Law.(L1)

Ans: The chemical and physical properties of the elements are periodic functions of their atomic masses.

Two Marks Question

Q1In p block elements which group is known as halogens and chalcogens?(L-3)

Ans: 17 =halogen
16=chalcogens

Q2 State modern periodic law. Name the scientist who states this law.(L-1)

Ans: The chemical and physical properties of the elements are periodic functions of their atomic numbers.Mosley state this law.

Q3 What are the important features of Mendeleev periodic table?(L1)

Ans: based on(i) increasing atomic mass (ii) similarities in properties of elements.(iii) 63 elements divided in 7 horizontal row called periods and 8 vertical groups

Three Marks Questions

Q1.Why are isotopes not considered in Mendeleev's periodic table?Name the elements which are predicted by Mendeleev as eka –silicon and eka –aluminum (L-III)

Ans.Because Mendeleev gave priority to similarities in properties.

Germanium and gallium

Q2 Write the common name of the different groups of the periodic table: (L-2)

Ans:Group 1- Alkali MetalsGroup2- Alkaline Earth Metal Group (3-12) Transition Metals

Group13- Boron Family Group 14- Carbon Family Group 15- Nitrogen Family Group 16- Chalcogens

Group 17- Halogens Group18- Noble Gas/ Inert Group

Q.3 (I) Write IUPAC Name & symbol of elements having atomic no; 101 &131 (L-3)

(II) Why are d- block elements called as Transition Metals?

Ans: (I) 101 unnilunium (unu) 131 (utu) untriunium

(II)Because in periodic table these are in Between extreme metallic and nonmetallic elements

UNDERSTANDING

One Mark Questions

Q1 How many elements are found in 4^{Th} period in d- block?(L1)

Ans: 10 elements

Q2 How many groups and periods are found in long form periodic table?(L1)

Ans: 7 periods 18 groups

Q3 Name the group in which members together called representative elements.(L2)

Ans: S and P block elements

Two Marks Question

Q1 What are Dobereiner's triads? Give example of 2 triads.(L2)

Ans: he arranged the elements in several sets of 3 elements .these sets were called triads which resembled with each other in chemical properties and atomic mass of the middle element was approx the mean of the atomic masses of the remaining two.

Example (i) chlorine, bromine and iodine A.T of cl =35.5 and iodine =127 .middle element bromine has (35.5 +127)/2 =81.25

(ii) Calcium (40) ,strontium(88.5) and barium (137)

Q2 Write the general E.C of s, p, d and f Block elements.(L2)

Ans: (i) s block- ns^{1-2}

(ii) p block – ns^2np^{1-6}

(iii) d block – $(n-1)d^{1-10}ns^{1-2}$

(iv) f block -- $(n-2)\ f^{1-14}(n-1)d^{0-1}ns^2$

Q3 Name a metal and non metal which is liquid at room temp. (L2)

Ans: mercury and bromine

Three Marks Questions

Q1 Assign the position of the element having outer electronic configuration

(i)ns^2np^4 for n=3 , {L3]

(ii) $(n-1)\ d^2ns^2$ for n=4

(iii) $(n-2)f^7(n-1)d^1ns^2$ for n=6

Ans: (i) n= principal no. which shows no of periods. N=3 so E.C =3s23p4=elements having position 3^{rd} period 16^{th} group.

(ii) n=4 so elements belong in 4^{th} period .it is d block element .d2= 2 electron in d orbital it belongs to 4^{th} group in d block.

(iii) n=6 and electron goes in fshell, so it is f block element having 6^{th} period and 7^{th} element of lanthanides series.

Q2 Give 3 features of s block Elements. (L2)

Ans: (i) group 1& 2 elements belong to this block

(ii) Having general formula =ns^{1-2}

(iii) Group 1 element called alkali metals. Group 2 called alkaline earth metals

(a) Soft and highly reactive.

(b) Low ionization enthalpy, so highly electropositive
(c) Give colors to flame.

Q3 Give 3 features of p- block Elements.(L2)
Ans: (i) some of them are non metals especially those heading all the groups.
(ii) Moving down the group metallic character increases
(iii) Many of them are highly electronegative and form covalent compound

APPLICATION

One Mark Questions

Q1 . What is base of long form periodic table?(L2)
Ans: Bohr burry scheme

Q2. Write the electronic configuration of scandium having atomic number 21.(L3)
Ans-Sc = [Ar]3d1 4S2

Q3. What is the base of modern periodic law?(L1)
Ans-Atomic number

Two Mark Questions

Q1 How many elements are in the first and second inner transition series.name these series(L1)
Ans: 14 elements in each series. (i) Lanthanides series (ii) actinides series

Q2 What do you mean by Metalloids? In which block metalloids are found?(L2)
Ans: elements showing some properties of metals and non metals both are called mettaloids .it are found in P block elements in BW 13 and 18 groups.

Q3 Name all metalloids.(L1)
Ans: Si, Ge, As, Sb, Te, Po, At

Concept: Trends In Properties In Periodic Table

KNOWLEDGE

One Mark Questions

Q. 1 Among Li, Na, K, Rb, Cs, the element with lowest ionization energy is_____(L-1)
Ans. Cs has lowest ionization enthalpy.

Q.2 Which out of F or Cl has a more negative electron gain enthalpy? (L-1)
Ans. Cl has more negative electron gain enthalpy. It is because there is more inter electronic repulsion between valence electrons of F, due to smaller size than Cl.

Q.3 why do noble gases have bigger atomic size than halogens? (L-1)
Ans.Noble gases have higher atomic size than halogens because Van der Waals radii are bigger than covalent radii.

Two Marks Questions

Q.1 Consider the following species (L-1)

N^{-3}, O^{-2}, F-, Na^{+}, Mg^{+2} and Al^{+3}

(a). what is common in them?

(b). arrange them in the order of increasing ionic radii.

Ans. (a). They have same number of electrons.

(b). $Al^{3+}<Mg^{2+}<Na^{+}<F^{-}<O^{2-}<N^{3-}$

Q.2 Match the following: (L-2)

Column1	Column2
(A). Cl, Br, I	(p). Ioniosation enthalpy increases
(B). B, C, O	(q). Negative electron gain enthalpy decreases
(C). O^{-2}, O^{-}, O	(r). Atomic size decreases
(D). Cl, F, P	(s). Belong to the same group

Ans.2 A-q,s ; B-p,r; C-r; D-q;

Q.3 Among the elements of the 3rd period from Na to Ar, pick out the element: (L-2)

(a). with highest first ionization enthalpy.

(b). with largest atomic radius.

(c). that is most reactive non-metal.

(d). that is most reactive metal.

Ans.3 (a). Ar has highest first ionization enthalpy.

(b). Na has large atomic radius (covalent radius).

(c). Cl is more reactive non-metal in 3rd period.

(d). Na is most reactive metal in third period.

Three Marks Questions

Q.1 Explain the term (L-1)

(a). Screening effect

(b). Penetration effect

(c). Metallic character

Ans. (a).Screening effect. The inner electrons between valence electron and nucleus shield the valence electrons from nucleus; it is called shielding effect.

(b). Penetration effect. Due to shape of the orbital,s electron penetrates nearer to the nucleus than p, d or f-electrons and are more tightly held.

(c). Metallic character. Lower the ionization energy more will be the tendency to lose electron, higher will be the metallic character.

Q.2 (a). Which is largest in size- Cu^{+}, Cu^{+2}, Cu and why? (L-3)

(b). which element in the periodic table has the highest ionization enthalpy?

(c). Which element is more metallic in the periodic table.?

Ans. (a). Cu is largest due to less effective nuclear charge. It has 29 electrons, 29 protons, Cu^{+} has 28 electrons and 29 protons, Cu^{2+} has 27 electrons and 29 protons.

(b). He has highest ionization enthalpy.

(c). Mg is more metallic due to lower ionization energy.

Q.3 How does electro negativity vary down the group 17 and why? How does it vary from left to right in the period? Name an element having highest electro negativity. (L-2)

Ans. Electro negativity decreases down the group due to increase in atomic size. It increases along the period from left to right due to decrease in atomic size.

Fluorine (F) has highest electro negativity.

UNDERSTANDING

One Marks Questions

Q.1 Would you expect the second electron gain enthalpy of O as positive, more negative or less negative than the first? Justify your answer. (L-2)

Ans. Second electron affinity of O is largely +ve because of repulsion between negatively charged ions and second electron to be added. Energy required to overcome repulsion is more than the energy released in gaining electron, so net energy is absorbed.

Q.2 Arrange the following in the decreasing order of Vander Waal's radii: Cl, H, O, N.(L-2)

Ans.The overall decreasing order is: Cl> N > O >H.

Q.3Explain why Halogens have very high negative electron gain enthalpy? (L-1)

Ans.The electron gain enthalpy for halogens is highly negative because they can acquire the nearest stable noble gas configuration by accepting an extra electron.

Two Marks Questions

Q.1 How would you explain the fact that the first ionization of Na is lower than that of Mg but its second ionization enthalpy is higher than that of Mg? (L-3)

Ans. The electronic configurations of Na and Mg are: Na:$1s^2 2s^2 2p^6 3s^1$ And Mg: $1s^2 2s^2 2p^6 3s^2$ thus, the first electron in both the cases has to be removed from the 3s orbital, but the nuclear charge of Na is lower than that of Mg, therefore, the first ionization energy of Na is lower than that of Mg. But after the removal of the first electron, Na acquire the nearest noble gas configuration (Ne) which makes Na highly stable, but an electron is still left in the p orbital of Mg. Hence second ionization energy of Na is higher than that of Mg.

Q.2 Explain why Electron gain enthalpy of noble gases is positive. (L-1)

Ans. Noble gases have large positive electron gain enthalpies because the extra electron has to be placed in the next higher principal quantum energy level, thereby producing highly unstable electronic configuration.

Q.3 Explain why cations are smaller and anions are larger in size than their parent atom. (L-2)

Ans.The ionic radius of cation is always smaller than the parent atom because the loss of one or more electrons increases the effective nuclear charge. As a result, the force of attraction of nucleus for the electrons increases and hence, the ionic radii decreases. In contrast, the ionic radius of an anion is always larger than its parent atom because the addition of one or more electrons decreases the effective nuclear charge. As a result, the force of attraction of the nucleus for the electrons decreases and hence the ionic radii increases.

Three Marks Questions

Q.1 Arrange the following order of the property indicated: (L-3)

(a). F, Cl, Br and I (negative electron gain enthalpy)

(b). Mg, Al, Si and Na (ionization enthalpy)

(c). C, N, O and F (second ionization enthalpy)

Ans. (a). I<Br<F<Cl

(b). Na<Al<Mg<Si

(c). C<N<F<O.

Q.2 Arrange the elements with the atomic numbers 9, 12 and 36, identify the element which is (a) highly electro negative (b) an inert gas in nature (c) highly electro positive in nature. Give reasons also. (L-3)

Ans. The electronic configurations of the elements are:-

Z(9) : $1s^2 2s^2 2p^5$

Z(12) : $1s^2 2s^2 2p^6 3s^2$

Z(36) : $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10} 4s^2 4p^6$

(a). The element with Z =9 (F), is highly electronegative because it requires only one electron to have the configuration of nearest noble gas element and has also very small size. It is infact, the most electronegative (4.0) in the period table.

(b). The element with Z= 36 (Kr) is an inert gas element as it has ns^2p^6electronic configuration.

(c). The element with Z =12 (Mg) is highly electropositive in nature since by using two valence electrons, it will have the configuration of the noble gas Neon.

Q.3 Chlorine can be converted into chloride ion more easily as compared to fluoride ion from fluorine. (L-3)

Ans.3 The negative electron gain enthalpy of chlorine ($\Delta_{eg}H$ =-349kJmol^{-1}) is more than that of fluorine ($\Delta_{eg}H$= -328kJmol^{-1}). This means that an atom of chlorine has a greater attraction for the outside electron than in case of fluorine. Therefore, chlorine can be converted to chloride ion more readily as compared to fluorine forming fluoride ion.

APPLICATION

One Mark Questions

Q.1 The atomic radius of F, Br, and I are 64, 114, and 138 pm respectively. From this information estimate a reasonable atomic radius of Cl. (L-1)

(a) 53 pm (b)89 pm (c) 126 pm (d)162 pm (e)196 pm

Ans. 89 pm.

Q.2 Arrange the following elements in order of increasing effective nuclear charge: Bi, As, P, N, Sb (

(a). Bi, Sb, As, P, N

(b). N, P, As, Sb, Bi

(c). Bi, As, P, N, Sb

(d). N, As, P, Bi, Sb

Ans. (b). N, P, As, Sb, Bi

Q.3 Arrange the following elements in increasing order of metallic character: B, Al, Mg and K. (L-2)
Ans. The correct order is: B<Al<Mg<K.In general metallic character increases down the group and decreases along the period.

Two Marks Questions

Q.1 Why is fluorine (F_2) more reactive than chlorine (Cl_2)? (L-2)
Ans. F_2 is more reactive than Cl_2 due to greater repulsion in the non-bonded electron pairs in the molecule of F_2 as compared to Cl_2 therefore the bond cleavage in fluorine becomes easier.

Q.2 Among the second period elements, the actual ionization enthalpies are in order:
Li<B<Be<C<O<N<F<Ne. (L-3)
Explain why
(i). Be has higher first ionization enthalpy than B?
(ii). O has lower first ionization enthalpy than N and F?
Ans. (a).Be has higher first ionization enthalpy than B because Be has more stable electronic configuration $1s^2 2s^2$than B $1s^2 2s^2 2p^1$.
(b). $\Delta_i H_1$ of O is expected to be more than that of N but is actually lesser because the electronic configuration of N is more symmetrical as well as stable in comparison to O.$\Delta_i H_1$ of O is less than that of F because the ionization enthalpy in general increases along a period.

Q.3 How will you react to the statement that the electronegativity of N on Pauling scale is 3.0 in all the nitrogen compounds? (L-3)
Ans.It is not correct to say that the electronegativityof nitrogen in all compound is 3. It depends upon its state of hybridization in a particular compound. It may be noted that greater the percentage of s-character, more will be the electronegativity of the element. Thus, the electronegativity of nitrogen increases in moving from sp^3hybridised orbitals to sp hybridised orbitals i.e. as sp^3<sp^2<sp.

Three Marks Questions

Q.1 The $\Delta H_1$and the ΔH_2in(kJ mol^{-1})and the $\Delta_{eg}H$ (in kJ mol^{-1}) of a few elements are given below:

Elements	ΔH_1	ΔH_2	$\Delta_{eg}H$
I	520	7300	-60
II	419	3051	-48
III	1681	3374	-328
IV	1008	1846	-295
V	2372	5251	+48
VI	738	1451	-40

Which of the above element is likely to be: (L-3)
(a). The least reactive element.
(b). The most reactive metal.
(c). The most reactive non-metal.
(d) The least reactive non-metal.
(e) The metal which can form a stable binary halide of the formula MX_2 (X halogen).
(f)The metal which can form a predominantly stable covalent halide of the formula MX (X halogen)?
Ans.
(a).V is least reactive element due to highest ionization enthalpy.
(b). II is the most reactive metal due to least ionization enthalpy.
(c). III is most reactive non-metal due to second highest first ionization energy.

(d). V is least reactive non-metal because it has positive electron gain enthalpy.
(e). VI can form stable binary halide of the formula MX_2 because it has lowest second ionization enthalpy.
(f). I can form covalent halide of the formula MX due to high ionization enthalpy in group 1 due to small size.

Q.2 The increasing order of reactivity among group 1 elements is Li<Na<K<Rb<Cs whereas among the group 17 elements, it is F>Cl>Br>I. Explain. (L-2)
Ans. In group 1 elements (alkali metals) the reactivity of the metals is mainly due to the electron releasing tendency of their atoms, which is related to ionization enthalpy, Since ionization enthalpy decreases down the group, the reactivity of alkali metals increases.
In group 17 elements (halogens), the reactivity is linked with electron accepting tendency of the members of the family. It is linked with electronegativity and electron gain enthalpy. Since both of them decrease down the group, the reactivity therefore decreases.

Q.3 Δ_iH_1 value of Mg is more as compared to that of Na while its Δ_iH_2 value is less. Explain. (L-2)
Ans. Δ_iH_1 value of Mg is more than that of Na due to greater symmetry and smaller size. But Δ_iH_2 value of Na is higher because Na^+ ion has the configuration of noble gas element neon while Mg^+ ion does not have a symmetrical configuration.

Q.4 From the elements: Cl, Br, F, O, Al, C, Li, Cs and Xe; choose the following: (L-2)
(a) The element with highest negative electron gain enthalpy.
(b) The element with lowest ionization enthalpy.
(c) The element with smallest ionic radius.
(d) The element with six electrons in the valence shell.
(e) The element which is a liquid at room temperature.
(f)The element which belongs to zero group.
(g) The elements which forms largest number of compounds.
Ans. (a). The element chlorine (Cl) has the highest negative electron gain enthalpy.
(b). The element cesium (Cs) has lowest ionization enthalpy.
(c). The element fluorine F has lowest atomic radius.
(d). The element oxygen (O) has 6 electrons in the valance shell.
(e). The element bromine (Br) is a liquid at room temperature.
(f). The element xenon (Xe) belongs to zero group (or group 18).
(g). The element carbon (C) forms the largest number of compounds.

Q.5 From each set, choose the element with largest ionization enthalpy and explain your answer.
(a) F, O, N (b) Mg, P, Ar (c) B, Al, Ga (L-2)
Ans. (a). The element fluorine F has the largest ionization enthalpy because in general, it increases along the period. These elements belong to the second period in the order is: N, O, F. Therefore, the last element has the largest ionization enthalpy.
(b). The element argon (Ar) has the largest ionization enthalpy because it increases along a period and these elements belong to the third period in the order of: Mg, P, Ar. Moreover, Ar is also a noble gas element with very high ionization enthalpy.
(c). The element B has the largest ionization enthalpy because in general the value decreases down the group. All these elements belong to the group 13 in the order of B, Al, Ga. Therefore, the first element B is expected to have the largest value.

UNIT 4 – CHEMICAL BONDING AND MOLECULAR STRUCTURE

Concept -VSEPR & VBT

KNOWLEDGE

One Mark Questions

Q1. On the basis of VSEPR theory predict the shape of Hydronium (H_3O^+) ion **(L-1)**

Ans. pyramidal.

Q2 what is the electrovalency of Li and O in Li_2O compound?**(L-1)**

Ans. Electrovalency of each Li atom is one while that of oxygen atom is 2.

Q3. What is the value of 1 Debye unit?**(L-1)**

Ans. 1D=3.33564 × 10 $^{-30}$ C_m

Q4.Define formal charge of an atom. **(L-1)**

Ans.The formal charge is the difference between the number of valence electrons in an isolated atom and the number of electrons assigned to that atom in a LEWIS STRUCTURE

Q5.Which rule explains the covalent character of ionic bond ?**(L-1)**

Ans. Fajan's Rule

Two Marks Questions

Q1.Define Bond length& Bond dissociation enthalpy**(L-1).**

Ans. The equilibrium distance between the centre s of the nuclei of two bonded atoms is called bond length.

The energy required to break a bond is called bond dissociation enthalpy.

Q 2. Give Four examples of molecules showing extended octet rule**.(l-1)**

Ans.PCl_5, SF_6 , IF_7 , SF_4

Q 3.On the basis of VSEPR theory give the geometry & bond angle of **(l-2)**

(i) BF_3 (ii) SiH_4

Ans. Trigonal planar 120°

Tetrahedral 109.5°

Q 4.What is the geometry of molecule of type AB_4E_2 & AB_3E**(L-2)**

Ans. Square planar & Pyramidal shape

Q 5. Write two limitation of VSEPR theory**(L-1).**

Ans. (i) It is unable to predict the shapes of many molecules

(ii) It does not consider the directional effect of bonding.

Three Marks Questions

Q 1.What is the expended octet ? Write any three example of compound showing expended octet ? **(L-1)**

Ans. Elements in and beyond third period of periodic table have , apart from 3s & 3p orbital ,3d orbital also available for bonding. In a number of compounds of this elements there are more than 8 valence electron around central atom. This is termed as expended octet.

Ex. PF_5 , SF_6 ,H_2SO_4

Q 2.(a)State one significance of Formal Charge.**(L-2)**

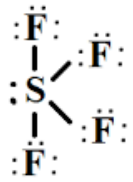
Answer. It helps us to select the most stable structure out of all the different Lewis structures.

(b)In nitrate ion what should be total of Formal Charge on each atom? Why?

Ans. The sum of formal charge is always equal to the charge present on the ion. Hence sum of charges in NO_3^- will be -1.

Q3. On the basis of VSEPR THEORY & VBT THEORY answer the following-**(L-3)**

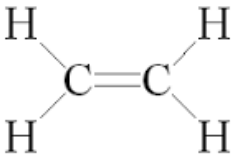
a) What is the Shape of SF_4?



b) NaCl gives a white ppt. with $AgNO_3$ but CCl_4 does not. Why?.

Answer. Being an ionic compound NaCl gives Cl negative ion and thus gives White ppt. with silver nitrate but CCl_4 is a covalent compound and thus do not give Cl negative ions.

c) Calculate sigma and pi bond-



Ans. 5 sigma and 1 pie bond

Q4.Dipole moment of NH_3 is greater than of NF_3**.?(L-3**)

Ans. Resultant moment of N-H bond adds up to the bond moment of lone pair, that of 3 N-F bonds partly cancels the resultant moment of lone pair. Thus the dipole moment of NH_3 is greater than of NF_3.

5.Name factors which are responsible for covalent character of ionic bond**(I-1).**

(i) Large size of anion

(ii) Small size of cation

(iii) Electronic configuration of the cation

UNDERSTANDING

One Mark Question

Q1. Explain why PCl_5 is trigonal bipyramidal and $IF_5$is square pyramidal?**(L-2)**

Ans. PCl_5 has 5 bond pairs of electrons around central atom while in IF_5 there are 5 bond pair & 1 lone pair of electrons around central atom.

Q2.Arrange the following in the order of decreasing bond angle**.(L-2)**

NO_2^+ , NO_2^- , NO_2

Ans. $NO_2^+ > NO_2 > NO_2^-$

Q3.Why are tripositive and tetrapositive cations rare ?**Ll-2)**

Ans. Highly charged cations such as 3^+ and 4^+ ions are formed by the removal of 3 and 4 e- respectively from the neutral atoms. For this purpose, a large amount of energy($E_1+E_2+E_3$ OR $E_1+E_2+E_3+E_4$) is required.

Q 4. Why does H2O molecule have bent geometry Bent geometry?(**L-2**)

Ans. Due to repulsion b/n two lone paires of e- present around central atom O

Q 5..What is the cause of chemical combinationl**(L-1)**

Ans. The tendency of atoms of various elements to acquire stable configuration of the nearest noble gas is the cause of chemical combination.

Two Marks Questions

Q 1.Give Reason**(L-2**)

(i)N_2 is inert at room temperature.

(ii) Overlapping of S orbital with any other orbital forms sigma bonds.

Ans .Due to high bond order (3) , it has high bond dissociation energy ,which is not possible at room temperature

(ii)Because s orbital has same electron distribution in all axis/ directions

Q 2 .What is bond enthalpy ? What is its unit ? How we calculate enthalpy in case of complex compound **?(L-2)**

Ans. Amount of energy Required ot break one mole of bonds of particular type b/w two atoms in gaseous state.

Its unit is KJ/mole

It is obtained by dividing total bond dissociation enthalpy by no. of bonds broken

Q 3 .How does covalent bond form in terms of orbital overlap concept**?(L-1)**

Ans. When two half filled orbitals overlap ,covalent bond forms .

Q 4.Out of NH_3 & BF_3 Which is polar & Why**?(L-2)**

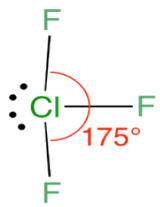
Ans. NH_3 has net dipole moment because resultant of 3N-H bond & lone pair lie in the same direction. While BF3 being trigonal planar has zero dipole moment.

Q 5.When does ionic character develop in covalent bond?(**L-3)**

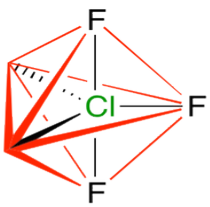
Ans. When the difference in electro negativity of the combining atom is more than 1.9 it develops 50 % ionic character .

Three Marks Questions

Q 1.Molecule has a type AB_3E_2. Draw its structure and state an example**.(L-3)**

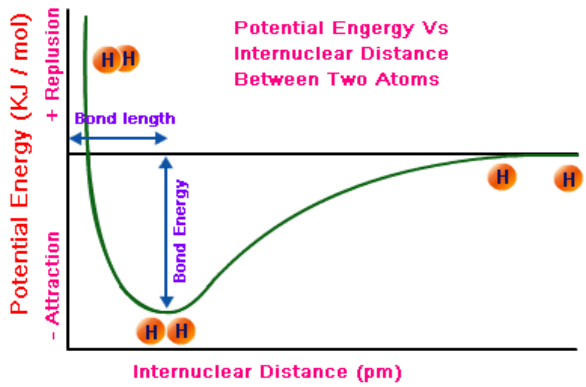


The F–Cl–F angle involving the axial F atoms is 175°



The red lines outline a trigonal bipyramid. Black lines show the electron pairs

Q 2.Draw the potential energy curve Of H_2 molecule formation?(L-3)



Q **3** .Account for the following **:(L-3)**

(i) AlF_3 is a high melting point solid whereas SiF_4 is a gas?

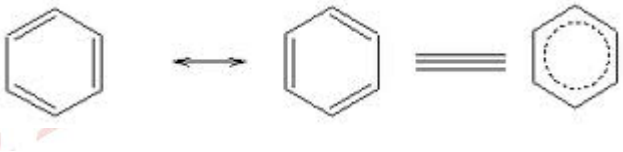
Ans.AlF_3 is an ionic solid due to large difference in electro negativity of Al and F whereas SiF_4 is a covalent compound and hence only weak Vander Waals force exists between the molecules.

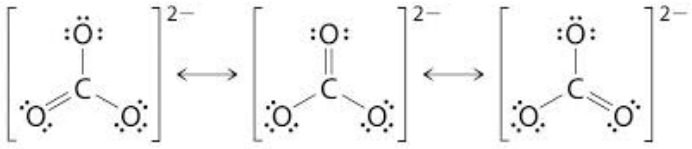
(ii) Out of peroxide ion and superoxide ion which has larger bond length and why?

Ans. The bond orders of(superoxide ion) O_2^- is 1.5 while that of(peroxide ion) O_2^{2-} is 1.0 .Smaller the bond order, greater the bond length. Hence, O_2^{2-} has larger bond length.

Q4. What do you mean by canonical structures? Draw canonical structures of Carbonate ion & Benzene. [1+2]**(L-3**)

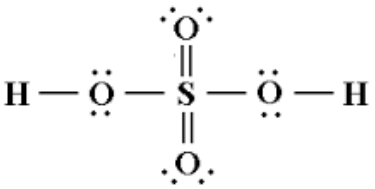
Ans. Sometimes a molecule possess several structures and the actual one is in between of them. This is called Canonical structure.

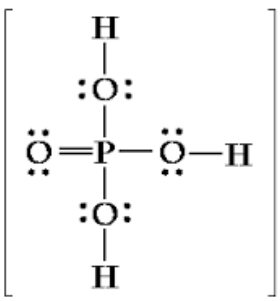




Q5. Draw the structures of H_2SO_4, H_3PO_4 . [2+1=3]**(L-2**)

Answer.





APPLICATION

One Mark Questions

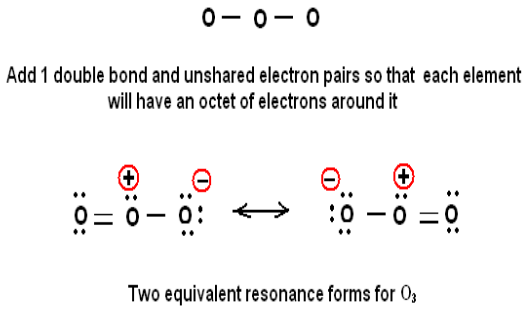
Q 1.Define polarizing power and polalrisability**(L-2)**

Ans . The ability of an atom to deform the electron cloud of an atom is called polarizing power . while the ease with which any atom can be polarized by its neighbouring bonded atom is called polarizability.

Q 2.Why PCl_5 is more covalent than PCl_3 ?(**L-2)**

Ans . Because P^{5+} has more polarising power than P^{3+}.

Q 3.Draw Resonating structure of O_3.**(L-3)**



Q 4.Why is SF_4 more reactive than SF_6 ?**(L-2)**

Ans . SF_4 has two unpaired electrons which it can donate further to extend its valency , hence it is reactive .'S' in SF_6 has maximum 6 0.S.

Q 5.Explain the following order of bond angle **(L-2)**

$NO_2^+ > NO_2 > NO_2^-$

Ans. This is because NO_2^+ has no lone pair of e-, and hence its linear.NO_2 has one unshared e- while NO_2 has one unshared e- pair.Greater the repulsion on N-O bond in case of NO_2^- than in case of NO_2.

Two Marks Questions

Q 1.Suggest the expected shape of the following molecules with reasons**(L-2)**

a.SO_2

b.NH_3

Ans.(a) In SO_2 molecule there are three electron pairs .the three electron pairs should acquire trigonal planar arrangement with bond angle 120 ° .Since one of the position is occupied by lone pair the geometry is described as V-shaped or bent shaped.

(b) In NH_3 molecule there are are four electron pairs (three bond pairs and one lone pair) .These four electron pairs adopt tetrahedral geometry but due to the repulsion by lone pair the bond decreases to 107^0 from 109.5^0 and hence the geometry of ammonia is regarded as pryamidal.

Q 2. Why is CO_2 a linear molecule while SO_2 a non-linear molecule?**(L-2)**

Ans. In SO_2 molecule there are two bond pairs and one lone pair of electron .Due to repulsion by lone pair its bond angle decreases from 120° to 119.5° hence it is not linear whereas in CO_2 molecule there is no lone pair of electron due to which it has linear geometry.

Q 3. Why He_2 molecule does not exist?**(L-2)**

Ans. It has been found that when two helium atoms approach each other four new attractive forces and five new repulsive forces come into play. Therefore repulsive forces predominate and the potential energy of the system increases which leads to instability. Or Bond order is Zero.

Q 4. Apart from tertrahedral geometry ,another possible geometry for CH_4 is square planar with the four H atoms at the corners of square and C atom at its centre. Explain why CH_4 is not square planar**.(L-3)**

Ans. In square planar geometry , the bond angle will be 90 ° which is less than bond angle in tetrahedral geometry (109.5 °).Therefore repulsive forces in square planar will be more and it will be less stable as compared to tetrahedral geometry.

Q 5.Explain the formation of H_2 molecule on the basis of valence bond theory**.(L-2)**

Ans. When two H atoms come closer the following forces operate between them:

a. Attractive :

i.nucleus of atom and its electron

ii.nucleus of one atom and electron of other.

b.repulsive :

i.electrons of two atoms.

ii.nucleus of two atoms.

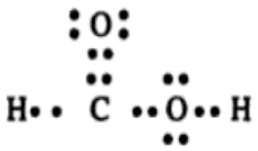
It has been found experimentally that magnitude of attractive forces is more than repulsive forces hence two atoms come closer to each other and the potential energy of the system decreases. A stage is reached when attractive forces balance repulsive forces and the system acquires minimum energy .At this stage two hydrogen atoms are said to be bonded together.

Three Marks Questions

Q1. i) Write Lewis dot structure for HCOOH. **(L-2)**

ii)Ethyne molecule is linear.

Ans: i)



(ii)Ethyne has 'sp' hybridisation and thus is linear in shape.

Q2. i) Calculate formal charges of the atoms in nitrite ion**.(L-2)**

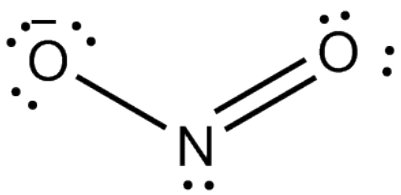
Ans. i) Formal charge = V-L- ½ S

V--Total no. of valence electrons in free atom

L-- Total no.of non-bonding electrons

S-- ½ Total no. of bonding electrons

(ii)



For N= 5 – 2 – ½ 6 = 5 – 3= 0

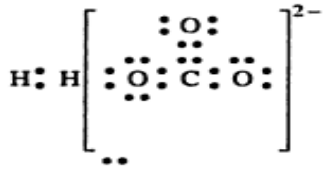
For O= 6 – 4 – ½ 4 = 2 – 2 = 0

For O(-vely charged)= 6 – 6 – 1/2 x 2 = -1

Total charge = -1

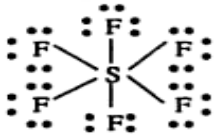
Q 3 structures for H_2CO_3, SF_6, PF5 and IF_7. Is the octet rule obeyed in all these cases? **(L3)**

Ans. (i) H_2CO_3



H-atom has two valence electrons. C and three O atoms obeying octet rule.

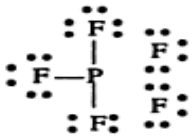
(ii) SF_6



12 electrons around the S atom

S-atom has 12 valence electrons. S-atom is not obeying octet rule.

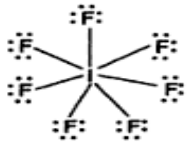
(iii) PF_5



10 electrons around the P atom

There are 10 electrons around the P atom. P has an expanded octet.

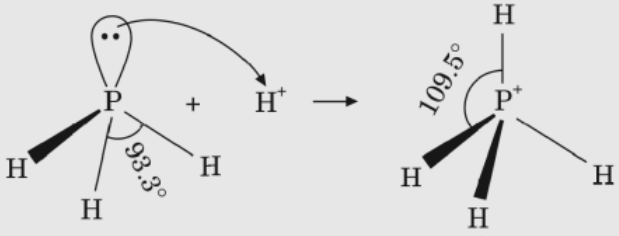
(iv) IF_7



I is not obeying the octet rule.

Q3. i) Why is bond angle in PH_4^+ higher than that in PH_3?**(L-2)**

Ans : P in PH_3 is sp^3 hybridized. PH_3 has three bond pairs and one lone pair around P. Due to stronger lone pair–bond pair repulsions than bond pair–bond pair replulsions, the tetrahedral angle decreases from 109.5° to 93.3°. As a result, PH_3 is pyramidal. However, when it reacts with a proton, it forms PH_4^+ ion which has four bond pairs and no lone pair. Due to the absence of lone pair–bond pair repulsions and presence of four identical bond pair–bond pair interactions, PH_4^+ assumes tetrahedral geometry with bond angle of 109.5°. This explains why the bond angle in PH_4^+ is higher than in PH_3. (See Fig. 32.3)



PH_3 molecule (Pyramidal)

PH_4^+ ion (Tetrahedradal)

Fig 32.3 Bond angle in PH_4^+ is larger than that in PH_3.

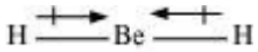
ii) Arrange the bonds in order of increasing ionic character in the molecules: **(L3**)

LiF, K_2O, N_2, SO_2 and ClF_3.

Ans- $N_2 < SO_2 < ClF_3 < K_2O < LiF$.

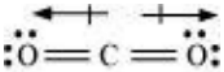
Q4. i) Explain why BeH2 molecule has a zero dipole moment although the Be–H bonds are polar.**(L-2)**

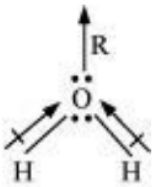
Ans. The Lewis structure for BeH2 is as follows:



There is no lone pair at the central atom (Be) and there are two bond pair. It has a linear structure. Dipole moments of each H–Be bond are equal and are in opposite directions.
Therefore, they nullify each other and the BeH_2 molecule has zero dipole moment.

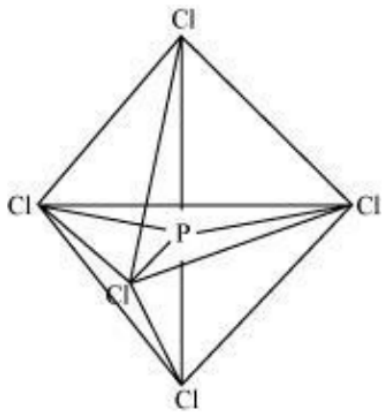
ii) Although both CO_2 and H_2O are triatomic molecules, the shape of H_2O molecule is bent while that of CO_2 is linear. Explain this on the basis of dipole moment.
Ans. CO_2 molecule has only two bonds which lie farthest to each other to minimise repulsion, making an angle of 180°.





H_2O, on the other hand, has a lone pair. As lone pair- bond pair repulsion is greater than bond pair-bond pair repulsion, the repulsions due to the lone pair decreases the angle between the two bonds, giving the molecule a bent shape.

Q5. Describe the shape of PCl_5 molecule. Why are the axial bonds longer as compared to equatorial bonds?**(L-3)**
Ans: The ground state and excited state outer electronic configurations of phosphorus (Z = 15) are:
Excited state:
Ne $3s^1\ 3p_x^1 3p_y^1\ 3p^1_z\ 3d^1$
Phosphorus atom is sp^3d hybridized in the excited state. These orbitals are filled by the electron pairs donated by five Cl atoms.
The five sp^3d hybrid orbitals are directed towards the five corners of the trigonal bi-pyramidals. Hence, the geometry of PCl5 can be represented as:



There are five P–Cl sigma bonds in PC_{l5}. Three P–Cl bonds lie in one plane and make an angle of 120° with each other. These bonds are called equatorial bonds. The remaining two P–Cl bonds lie above and below the equatorial plane and make an angle of 90° with the plane. These bonds are called axial bonds. As the axial bond pairs suffer more repulsion from the equatorial bond pairs, axial bonds are slightly longer than equatorial bonds

Concept- Hybridisation and Molecular Orbital Theory

KNOWLEDGE

One mark questions

Q1 Who gave MOT **(L-I)**

Ans Molecular orbital (MO) theory was developed by F. Hund and R.S. Mulliken in 1932

Q2 Write the shape and bond angle of sp hybrid orbitals? **(L-II)**

Ans Linear, 180^0

Q3 What is the state of hybridization of carbon atom in (i)diamond (ii) Graphite **(L-III)**

Ans. sp^3 , sp^2

Q4 What is the shape and hybridization of NH_4^+ ion ? **(L-II)**

Ans sp^3 tetrahedral

Q5 Write the shape and bond angle of sp^2 hybridized orbitals.**(L-II)**

Ans. Trigonal planar and bond angle 120^0

Two marks questions

Q1 What is hybridization? **(L-I)**

Ans: The process of intermixing of atomic orbitals of slightly different energies of same atom to get same number of new orbitals of equivalent energies and shape is called hybridization

Q2 Which hybrid orbital are used by carbon atoms in the following molecules **(L-II)**

(a) CH_3CH_2OH b) CH_3COOH .

Ans a)sp^3 ,sp^3 b)sp^3 sp^2

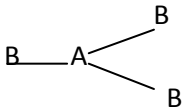
Q3. Give an example for sp^2 and sp^3 hybrid molecules also give their shape **(L-II)**

Ans sp^2 -Trigonal planar e.g, BH_3

sp^3- Tetrahadral eg CH_4

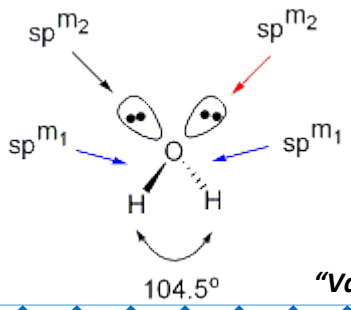
Q4 . Draw the shapes of following hybrid orbitals. sp, sp^2 **(L_II)**

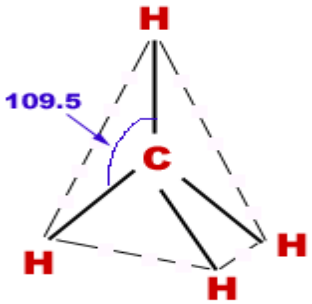
Ans sp B—A—B sp^2



Q5. Draw the shapes of H_2O and CH_4 molecule **(L-II)**

Ans





Three Marks Questions

Q1 Give conditions for the combination of Atomic Orbitals **(L-I)**

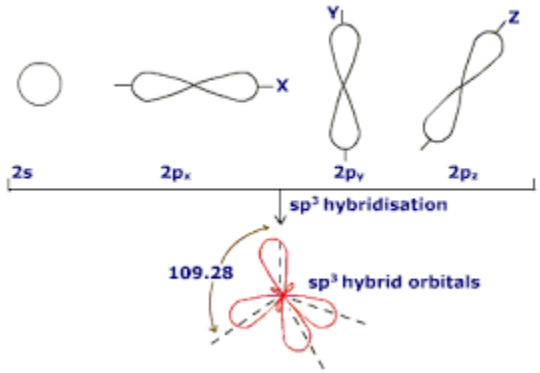
Ans i).The combining atomic orbitals must have the same or nearly the same energy

ii).The combining atomic orbitals must have the same symmetry about the molecular axis

iii) The combining atomic orbitals must overlap to the maximum extent

Q2 Explain the formation of BCl_3 using hybridization **(L-II)**

Ans In BCl_3 molecule, the ground state electronic configuration of central boron atom is $1s^2 2s^2 2p^1$. In the excited state, one of the 2s electrons is promoted to vacant 2p orbital as



Q3 Give important conditions for Hybridisation. Give Hybridisation and shape of IF_7 **(L-I)**

Ans Important conditions for hybridisation

(i) The orbitals present in the valence shell of the atom will take part in hybridisation.

(ii) The orbitals undergoing hybridisation should have almost equal energy

(iii) Promotion of electron is not essential condition prior to hybridisation.

(iv) It is not necessary that only half filled orbitals participate in hybridisation. In some cases, even filled orbitals of valence shell take part in hybridisation.

sp^3d^3 and pentagonal bipyramidal.

Q4 Give salient features of Molecular orbital theory **(L-I)**

Ans (i) The electrons in a molecule are present in the various molecular orbitals as the electrons of atoms are present in the various atomic orbitals.

(ii) The atomic orbitals of comparable energies and proper symmetry combine to form molecular orbitals.

(iii) In a molecular orbital an electron is influenced by two or more nuclei depending upon the number of atoms in the molecule.

(iv) The number of molecular orbital formed is equal to the number of combining atomic orbitals. When two atomic orbitals combine, two molecular orbitals are formed. One is known as bonding molecular orbital while the other is called antibonding molecular orbital.

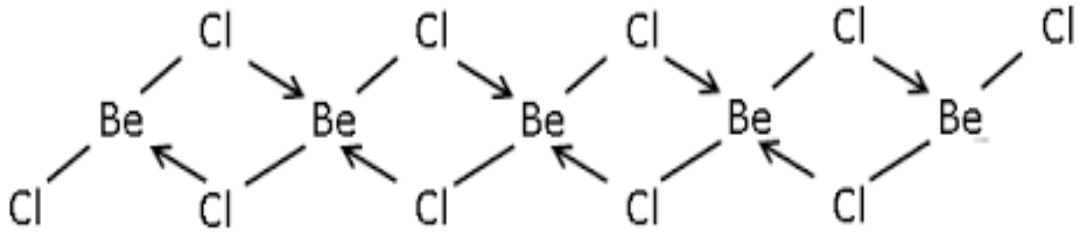
(v)The bonding molecular orbital has lower energy and hence greater stability than the corresponding antibonding molecular orbital.

(vi) The electron probability distribution around a group of nuclei in a molecule is given by a molecular orbital.

(vii) The molecular orbitals like atomic orbitals are filled in accordance with the aufbau principle obeying the Pauli's exclusion principle and the Hund's rule.

Q5 What is the hybrid state of $BeCl_2$. What will be the change in hybrid state of $BeCl_2$ in solid state?(L-II)

Ans. In vapour state $BeCl_2$ is linear with sp hybridization .In solid state it has polymeric chain with chlorine bridges Two Cl atom are linked to Be atom by coordinate bond and two by covalent bond .For these bonds to be in excited state with configuration $1s^2 2s^1 2p_x^1 2p_y^0 2p_z^0$ undergoes sp^3 hybridisation Two half filled hybrid orbitals will form covalent bond with two Cl atoms The other two Cl atoms are coordinated to Be atom by donating electron pairs into empty hybrid orbitals



UNDERSTANDING

One mark questions

Q1 Arrange the following orbitals in the increasing order of s- character: sp, sp^2 , sp^3 **(L-I)**
Ans. $sp^3 < sp^2 < sp$

Q2 How is paramagnetic character of a compound is related to the no. of unpaired electrons?**(L-II)**
Ans. Greater the number of unpaired electrons greater will be the paramagnetic character

Q3 . Calculate bond order of N_2 ? **(L-II)**
Ans. 3

Q4 Give electronic configuration for C_2? **(L-1)**
Ans. $\sigma_{1s}^2 \sigma^*_{1s}^2 \sigma_{2s}^2 \sigma^*_{2s}^2 \pi_{2py}^2 \pi_{2pz}^2$

Q5 Calculate the number of unpaired electrons in the B_2 molecule **(L-I)**
Ans 2

Two marks questions

Q1 Considering X- axis as the internuclear axis, which out of the following will not form sigma bond? Why? a) 1s and 2s b) 1s and 2px c) 2py and 2py d) 1s and 2s **(L-III)**
Ans (c) since overlapping of p orbitals side wise results in formation of pi bond and x axis is being considered as internuclear axis

Q2 Distinguish between bonding molecular orbital and anti-bonding molecular orbital.**(L-II)**
Ans.(i)The bonding molecular orbital has lower energy and hence greater stability than the corresponding antibonding molecular orbital.
(ii) Just as the electron probability distribution around a nucleus in an atom is given by an atomic orbital, the electron probability distribution around a group of nuclei in a molecule is given by a molecular orbital.

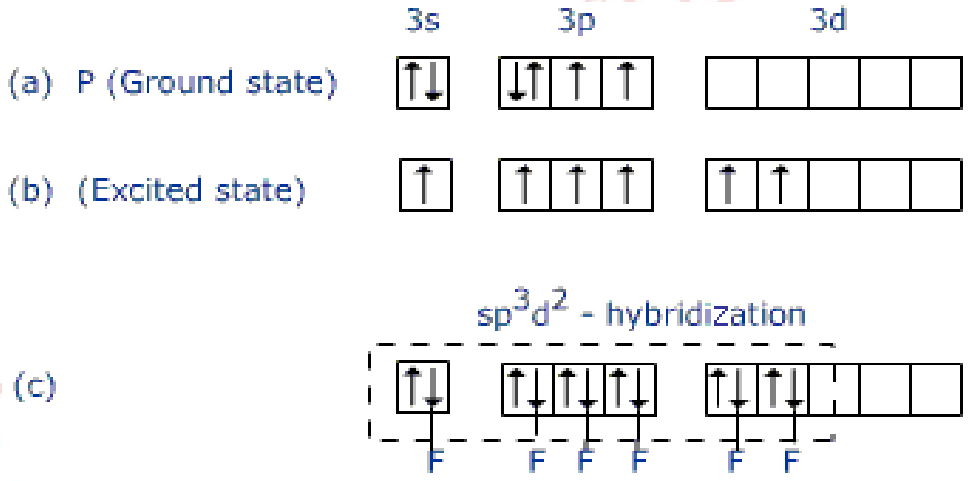
(iii)The molecular orbital formed by the addition of wave functions of atomic orbitals is called the bonding molecular orbital while the molecular orbital formed by the subtraction of wave function of atomic orbital is called antibonding molecular orbital

Q3 Define bond order and give the relationship between bond order and bond length **(L-I)**
Ans Bond order (b.o.) is defined as one half the difference between the number of electrons present in the bonding and the antibonding orbitals i.e., Bond order (b.o.) = ½ (Nb–Na)
Bond order is inversely proportional to bond length

Q4 Apart from tetrahedral geometry another possible geometry for CH_4 is square planar with four hydrogen atoms at the corners of the square and the carbon atom at the centre.Explain why CH_4 is not square planar? **(L-II)**
Ans For square planar arrangement hybridization is dsp^2 which is not possible with Carbon as it does not have d orbital with it

Q5 Out of p-orbital and sp hybrid orbital which has greater directional character and why ? **(L-III)**
Ans sp because lobes of p orbital have equal electron density whereas sp hybrid orbital has greater electron density on one side

Three Marks Questions
Q1Explain the formation of SF_6 using sp^3d^2 hybridization **(L-I)**



Ans. In SF_6 the central sulphur atom has the ground state outer electronic configuration $3s^2 3p^4$. In the exited state the available six orbitals i.e., one s, three p and two d are singly occupied by electrons. These orbitals hybridise to form six new sp^3d^2 hybrid orbitals, which are projected towards the six corners of a regular octahedron in SF_6. These six sp^3d^2 hybrid orbitals overlap with singly occupied orbitals of fluorine atoms to form six S–F sigma bonds. Thus SF_6 molecule has a regular octahedral geometry.
Q2 Explain formation of bonding and antibonding molecular orbital **(L-II)**
Ans Molecular orbitals may be described by the linear combination of atomic orbitals that can take place by addition and by subtraction of wave functions of individual atomic orbitals as shown below : ψ MO = ψ A + ψ B Therefore, the two molecular orbitals σ and σ* are formed as : σ = ψ A + ψ B σ* = ψ A – ψ B .The molecular orbital σ formed by the addition of atomic orbitals is called the bonding molecular orbital while the molecular orbital σ* formed by the subtraction of atomic orbital is called antibonding molecular orbital

Q3 Explain the formation of Lithium molecule on the basis of molecular orbital Also give its magnetic property.**(L-I)**

Ans. The electronic configuration of lithium is $1s^2$, $2s^1$. There are six electrons in Li2. The electronic configuration of Li_2 molecule, therefore, is Li2 : $(\sigma 1s)^2 (\sigma^* 1s)^2 (\sigma 2s)^2$ The above configuration is also written as $KK(\sigma 2s)^2$ where KK represents the closed K shell structure $(\sigma 1s)^2 (\sigma^* 1s)^2$.

Its bond order, therefore, is ½ (4 – 2) = 1. It means that Li_2 molecule is stable and since it has no unpaired electrons it should be diamagnetic.

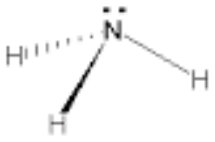
Q4 Explain the diamagnetic behaviour of Hydrogen molecule on the basis of molecular orbital theory.**(L-II)**

Ans. It is formed by the combination of two hydrogen atoms. Each hydrogen atom has one electron in 1s orbital. Therefore, in all there are two electrons in hydrogen molecule which are present in σ1s molecular orbital. So electronic configuration of hydrogen molecule is H_2 : $(\sigma 1s)^2$ .The bond order of H_2 molecule can be calculated as given below:

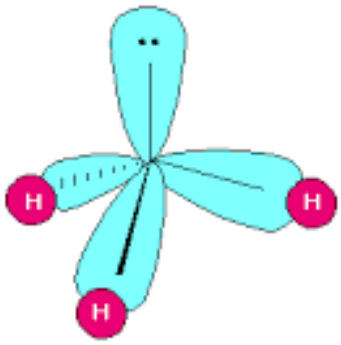
Bond order = $\frac{1(Nb-Na)}{2}$ =1 .This means that the two hydrogen atoms are bonded together by a single covalent bond

Q5 Explain the shape of NH_3 molecule using hybridization. **(L-I)**

Bonding molecule orbital picture for ammonia, NH_3

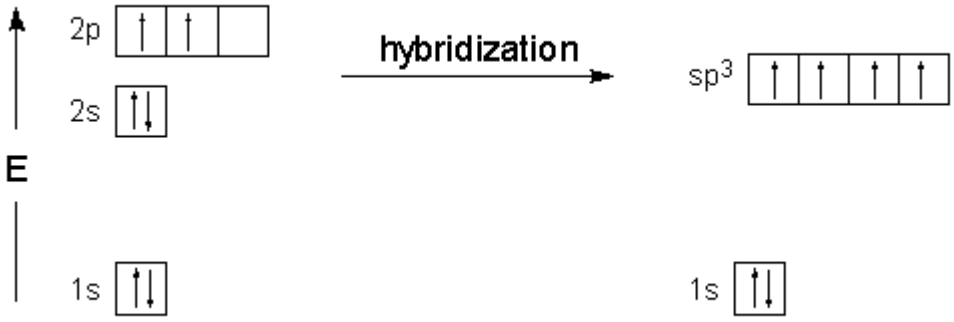


Lewis structure



Orbital picture

Ans



APPLICATION

One mark Questions

Q1 What is the percentage of s character in sp^3 hybridizations? **(L-I)**

Ans 25%

Q2 What is the hybridization of carbon in carbon dioxide ? **(L-I)**

Ans sp

Q3 Explain why ethyne molecule is linear?**(L-II)**

Ans It is because each carbon atom in ethyne is sp hybridized

Q4 Name one compound each involving sp^3 , sp^2 , sp hybridization .**(L-I)**

Ans sp^3 – CH_4 , sp^2 – C_2H_4 , sp – C_2H_2

Q5 Which orbitals can overlap to form a sigma bond and which orbitals can do so to form a pi bond?**(L-III)**

Ans s-s , s-p , p-p can form sigma bond p-p can form pi bond

Two marks Questions

Q1 Describe the change in the hybridization of the Al atom in the following reaction.**(L-II)**

$AlCl_3 + Cl^- \rightarrow AlCl_4^-$

Ans Hybridisation changes from sp^2 to sp^3

Q2 Is there any change in hybridization of B and N as a result of the reaction? **(L-III)**

$BF_3 + NH_3 \rightarrow BF_3.NH_3$

Ans Hybridisation of B changes from sp^2 to sp^3 and that of nitrogen remains same as sp^3

Q3 Distinguish between atomic orbital and molecular orbital.**(L-I)**

Ans An atomic orbital is monocentric while a molecular orbital is polycentric.

Q4 Arrange the following in order of decreasing bond angles **(L-II)**

i) CH_4, NH_3, H_2O, BF_3, C_2H_2

ii) NH_3, NH_2^- ,NH_4^+

Ans (i)C_2H_2(180) > BF_3(120)>CH_4 (109.28)>NH_3(107) > H_2O(104.5)

(ii)NH_4^+> NH_3 >NH_2^- ,

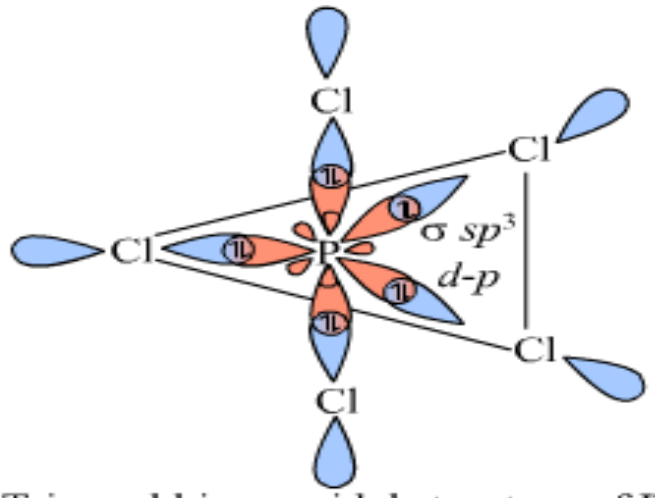
Q5 Which d orbital is involved in dsp^2 hybridization and why ?**(L-III)**

Ans $d_{x^2-y^2}$ because its four lobes lie along the x-axis and y axis. The two p orbitals can combine along these axis.

Three marks Questions

Q1 Describe the shape of PCl_5.Why axial bonds are longer than equatorial bonds in PCl_5 ? **(L-II)**

Ans sp^3d P-Cl equatorial bond length is $2.04A^0$ whereas P-Cl axial is $2.19A^0$ because repulsion exerted on axial bond pairs is more than equatorial bond

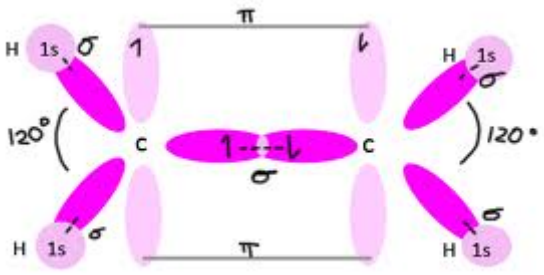


Trigonal bipyramidal structure of PCl_5

Q2 Compare the relative stability of following species and indicate their magnetic properties .
O_2, O_2^+ O_2^- **(L-I)**
Ans. Stability increases as $O_2^- < O_2, < O_2^+$
Bond order $1\frac{1}{2}$,2, $2\frac{1}{2}$
Magnetic properties -Paramagnetic

Q3 What is the effect of the process $C_2 \rightarrow C_2^+ + e^-$ on bond order of C_2 **(L-II)**
Ans. . Molecular Orbital Configuration of C_2 is $\sigma_{1s}^2\, \sigma^*_{1s}{}^2\, \sigma_{2s}^2\, \sigma^*_{2s}{}^2\, \pi_{2py}^2\, \pi_{2pz}^2$
C_2 has bond order of 2 while that of C_2^+ is 1.5 so in process bond order decreases by 0.5

Q4 Draw and explain diagram showing hybridization in ethane**(L-I)**
Ans In the formation of ethene molecule, one of the sp^2 hybrid orbitals of carbon atom overlaps axially with sp^2 hybridised orbital of another carbon atom to form C–C sigma bond. While the other two sp2 hybrid orbitals of each carbon atom are used for making sp^2–s sigma bond with two hydrogen atoms. The unhybridised orbital (2px or 2py) of one carbon atom overlaps sidewise with the similar orbital of the other carbon atom to form weak π bond



Q5 Show the non-existence of helium molecule based on molecular orbital theory**. (L-I)**
Ans Helium molecule (He_2): The electronic configuration of helium atom is 1s2. Each helium atom contains 2 electrons, therefore, in He_2 molecule there would be 4 electrons. These electrons will be accommodated in σ1s and σ*1s molecular orbitals leading to electronic configuration: He2 : $(\sigma 1s)^2$ $(\sigma^* 1s)^2$ .Bond order of He^2 is ½(2 – 2) = 0. He_2 molecule is therefore unstable and does not exist.

UNIT – 5 STATES OF MATTER

Concept- Intermolecular forces and gas laws

KNOWLEDGE

One Mark Questions

Q1. What will be the molar volume of nitrogen and argon at 273.15 K and 1atm pressure?**(L-2)**

Ans. At 273.15K and 1atm pressure every gas has molar volume = 22.4L.

Q 2.What do you mean by thermal energy? **(L-1**)

Ans. Thermal energy is the energy of a body arising from motion of its atoms or molecules.

Q 3.Name two intermolecular forces that exist between HF molecules in liquid state**.(L-2)**

Ans. Dipole-dipole interaction and hydrogen bonding.

Q 4.Define Boyle's law. How is it represented mathematically? **(L-1)**

Ans.The volume of a given mass of a gas is inversely proportional to its pressure at constant temperature

Mathematically V α 1/P. PV = constant.

Two Marks Questions

Q 1.How is the strength of hydrogen bond determined? **(L-2)**

Ans. Strength of H bonding determined by the coulombic interaction between the electronegative atom of one molecule and H atom of other molecule.

Q 2 .Why liquids diffuse slowly as compared to gases? **(L-2)**

Ans.In liquid the intermolecular forces (vander waal's forces) are greater than in gas.

Three Mark Questions

Q 1 .Define (a) Dipole-Dipole Forces (b) Avogadro law (c) Intermolecular forces **(L-1)**

Ans.(a) Dipole-dipole forces : The force of attraction which act between two molecules having permanent dipoles.

(b) Avogadro Law : Equal volumes of all gases under the similar condition of temperature and pressure contain equal number of molecules . V α n

(c) Intermolecular Forces: The forces of attractions and repulsion between interacting particles.

Q 2 .Describe Charle's Law. In terms of Charle's Law explain why -273^0 C is the lowest temperature?

Ans. The volume of a fixed mass of a gas is directly proportional to its absolute temperature at constant Pressure. V α T , constant P.

At -273 ^{0} C, volume of the gas approaches to zero i.e the gas ceases to exist.

Q 3 .Define dispersion forces. Write characteristic features of dispersion forces**.(L-2)**

Ans. Dispersion forces: The forces of attraction between two temporary dipoles.

Characteristics of dispersion forces:

(i) These forces are always attractive.

(ii) These forces are effective only at short distance.

(iii) Their magnitude depends on the polarisability of the particles

UNDERSTANDING

One Mark Question

Q1**.** Write various means to easily liquify the gases. **(L-1)**

Ans. By lowering the temperature and increasing the pressure.

Q2. According to you, what are the factors that determine the state of matter **(L-2)**

Ans. The factors that determine the different states of the matter are pressure, temperature .

Q 3.Arrange solid, liquid and gas in order of energy. Give reason**.(L-1)**

Ans. Solid < liquid < gas. This is because solid absorb energy to change into a liquid which further absorb energy to change into a gas.

Two Marks Questions

Q 1 Give one example for each of the following types of inter-particle forces **(L-2)**

(a) London dispersion forces

(b)Dipole-Dipole forces

(c) Hydrogen bond

(d) Ion-dipole forces

Ans. (a) noble gases.

(b) between HCl molecules.

(c) Between water molecules or HF molecules.

(d)Between NO_3^- and water molecules.

Q 2 .Why liquids do not have definite shape although they have definite volume? **(L-3)**

Ans.Because inter molecular forces are strong enough to hold the molecules but not so strong as to fix them into definite position.

Q 3 .Which type of intermolecular forces are effected in each of the following process**:(L-2)**

(i)Sublimation of iodine.

(ii)Evaporation of water.

Ans. (i) Sublimation of iodine : Dispersion forces.

(ii)Evaporation of water : Hydrogen bond.

Three Mark Questions

Q 1.Which type of intermolecular forces exists among the following molecules?**(L-2)**

(a) H_2S molecules

(b) H_2O

(c) Cl_2 and CCl_4

(d) SiH_4

(e) Helium

(f) He atoms and HCl molecules

Ans. (a) Dipole-Dipole interactions.

(b)H-Bond.

(c)Dispersion forces.

(d)Dispersion forces.

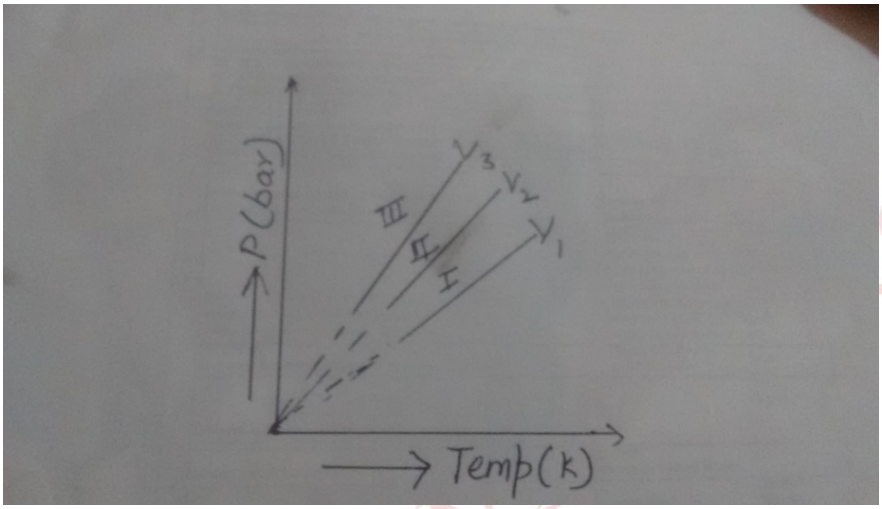
(e)Dispersion forces.

(f)Induced dipole-dipole interactions.

Q 2 Elaborate the statement that physical state of existence at given conditions is a balance between the thermal energy and intermolecular forces. **(L-3)**

Ans. Intermolecular forces tend to keep the molecules together but thermal energy of the molecules tends to keep them apart. The three states of matter are the result of the balance between intermolecular forces and thermal energy of the molecules.

Q 3 What are isochores? From the three isochores I, II, III given below, for a certain amount of ideal Gas,What is the correct arrangement of volumes V_1, V_2 and V_3. **(L-3)**



Ans. Isochore is the plot beween P and T for a definite amount of a gas at a constant volume.
From different isochors at different volumes draw a line parallel to Temperature axis represent a constant P and cutting the three isochors at T_1,T_2 and T_3 respectively.Fr om the graph we find T_1,>T_2 >T_3. Since V α T , at constant P. Thus $V_1 > V_2 > V_3$.

APPLICATION

One Mark Questions

Q 1. What would happen if dipole develops momentarily in atoms and non polar molecules which are electrically symmetrical? **(L-2)**

Ans. London forces or dispersion forces are developed.

Q 2. On the basis of Boyle's Law explain why mountaineers carry oxygen cylinder with them. **(L-2)**

Ans. At high altitude as the atmospheric pressure is low , the air is less dense. As a result less oxygen is available for breathing **.**

Q 3. Predict what will happen if intermolecular forces between the molecules are very weak **(L-2)**

Ans. When intermolecular forces are very weak , molecules do not cling together t o make liquid and solid.

Two Marks Questions

Q 1. In a hospital an oxygen cylinder holds 10 L of oxygen at 200atm pressure. If a patient breathes in 0.50ml of oxygen at 1atm with each breath, for how many breaths the cylinder will be sufficient. (Assume that all the data is at 30^0 C.) **(L-3)**

Ans. Apply Boyle's Law $P_1 V_1 = P_2 V_2$

$200 \times 10 = 1 \times V_2$

$V_2 = 2000$ L

No. of breaths = Total volume/ vol. consumed per breath

$= 2000/0.5 \times 10^{-3}$ L

$= 4 \times 10^6$

Q 2 . What will be the volume of hydrogen when 3 litres of it are cooled from 15^0C to -73^0C at constant pressure**? (L-2)**

Ans. $T_1 = 15+273 = 288$K , $V_1 = 3$L

$T_2 = -73 + 273 = 200$ K , $V_2 = ?$

$V_1/T_1 = V_2 / T_2$, $V_2 = (3 \times 200) / 288 = 2.08$ L.

Q 3. Explain the absolute zero (in terms of volume) with the help of isobar. **(L-3)**

Ans: At absolute zero ,volume approach to zero and below this temperature, the volume will be negative, which is meaningless. Hence absolute zero is the lowest possible temperature .

Three Marks Questions

Q1 Use the information and data given below to answer the questions **(L-3)**

- Stronger intermolecular forces result in higher boiling point
- Strength of London forces increases with the number of electrons in the molecule
- Boiling point of HF ,HCl, HBr and HI are 293K,189K,206K and 238K respectively

(a) Which type of intermolecular forces are present in the molecules HCl, HBr and HI?

(b) Looking at the trend of boiling points of HCl, HBr and HI, explain, out of dipole interaction and London interaction, which one predominant here?

(c) Why is the boiling point of HF highest while that of HCl lowest?

Ans :(a) In the molecules HCl, HBr and HI, dipole-dipole interaction and London forces are present.

(b) Dipole moment of HCl > HBr > HI but boiling point of HCl < HBr <HI.It means London forces are predominant over dipole-dipole interaction which depends upon surface area.HCl has least surface area,

Whereas HI has maximum surface area.

(c) HF has highest dipole moment due to highest difference in electronegativity, therefore hydrogen bonding is also present due to which force of attraction will increase, hence it has higher boiling point.

Q 2 . A gas is enclosed in a room .The temperature, pressure, density, and number of moles respectively is T^0C ,P atm, d g cm^{-3} n moles.

(a) What will be the pressure, temperature, density and number of moles in each compartment, if the room is partitioned into four equal compartments?

(b)What will be the values of pressure, temperature, density and number of moles if an equal volume of the gas at pressure 'P' and temperature 'T' is let in the same room? **(L-2)**

Ans: (a)Pressure =Patm ,

Temp. $= T^oC$,

density $= d$ g/cm^3 &

No. of moles=n/4

(b) Pressure =2Patm ,

Temp. $= T^oC$,

density =2d g/cm^3 &
No. of moles=2n.

Q 3 . An open vessel contains 200mg of air at 17^0C.What weight percentage of air would be expelled if the vessel is heated to 117^0C? **(L-3)**

Ans: Suppose vol. of 200mg of air at 17^0C =V mL

Apply Charle's Law $V_1/ T_1=V_2/ T_2$

$V_1/ 290 = V_2/390$

$V_2 =1.34 V_1$,

volume of air expelled = $1.34V_1 –V_1 =o.34V_1$ mL

% of air expelled: $0.34V_1$x 100 $/V_1$ = 34%

Q 4 . In a J tube partially filled with mercury the volume of an air column 4.2ml and the mercury level in two limbs is same. Some mercury is now added to the tube so that the volume of the air is enclosed in shorter limb is now 2.8ml.What is the difference in the levels of mercury in this situation (atm pressure=1bar**.) (L-3**)

Ans: P_1= 1bar= 750.12mmHg

P2 = (P_1 + h)

V_1=4.2mL ,V_2 =2.8mL

$P_1V_1= P_2 V_2$

or $P_2 = P_1V_1/ V_2$

= 750.12 x4.2 /2.8 =1125.18mmHg

Now 1125.18 = 750.12 + h

h = 1125.18 -750.12 = 375.06 mmHg or 37.506cm.

Q 5 An iron tank contains helium at a pressure of 2.5atm at 25^0C .The tank can withstand a maximum pressure of 10atm.the building in which tank has been placed catches fire. Predict whether, the tank will blow up first or melt (m.p of Fe=1535^0C.) **(L-3**)

Ans :. P_1 = 2.5 atm

P_2 = ?

T_1= 25^oC =298 K

T_2 = 1535^0C =1808 K

According to Gay Laussac law,

$P_1/ T_1 = P_2 / T_2$

P_2 = 2.5 x 1080/ 298 =15.16 atm.

Since pressure of gas in the tank is much more than 10 atm at the m.p. of Fe.Thus tank will blow up before reaching m.p.

Concept – Ideal gas Equation, kinetic molecular theory of gases, ideal gas and real gases, liquefaction of gases, liquid state

KNOWLEDGE

One mark questions

Q1.What is Boyle's point**?(L1)**

Ans. The temperature at which the real gas obeys ideal gas law for an appreciable range of pressure is called Boyle's point.

Q2.Why liquid drops are spherical in shape? **(L2)**

Ans. Because of surface tension, the molecules tend to minimize the surface area and sphere has minimum surface area.

Q3.State with expression Dalton's law of partial pressure**?(L1)**

Ans. The total pressure exerted by the mixture of non reactive gases is equal to the sum of the partial pressures of individual gases.

$P_{total} = p_1 + p_2 + p_3 + \ldots\ldots\ldots\ldots$

Two marks questions:-

Q1. What would have the effect on the gas pressure if collisions between the gas molecules are not elastic**?(L2)**

Ans. The gas pressure would gradually become zero as molecules will gradually slow down and ultimately settle down due to constant loss of energy.

Q2.What are the two faulty assumptions of kinetic theory of gases**?(L3)**

Ans. i) There is no force of attraction and repulsion between the molecules of a gas.

ii) Volume of the molecules of a gas is negligibly small in comparison to the empty space between them.

Q3. Give the units of Vander Waal's constants **a** and **b.(L2)**

Ans. Unit of **a** is **bar L^2 mol^{-2}** and that of **b** is **L mol^{-1}**.

Three mark questions

Q1. Define i) surface tension ii) viscosity. Give their units.**(L1)**

Ans.i) The force acting parallel to the surface and perpendicular to a line of unit length anywhere in the surface is called surface tension. Its unit is Nm^{-1}.

ii) The force of friction which one part of the liquid offers to another part of the liquid is called viscosity. Its unit is poise.

Q2.Give three differences between evaporation and boiling**.(L1)**

Ans.i) Evaporation occurs at all temperatures while boiling occurs at boiling point.

ii) Evaporation is surface phenomenon while boiling occurs throughout the bulk of liquid.

iii) Evaporation is slow while boiling is rapid.

Q3. Give Vander Waal's equation of state for real gases? What is the significance of constants a and b in this equation?**(L3)**

Ans. $(P + an^2/V^2) (V – nb) = nRT$

a gives the idea of magnitude of attractive forces between the molecules of the gas while **b** is a measure of effective size of gas molecules.

UNDERSTANDING

One Mark questions

Q1. Explain how can gases be liquefied?**(L1)**

Ans. Gases can be liquefied by decrease of temperature and increase of pressure.

Q2.What is the effect of temperature on surface tension and viscosity of a liquid?**(L1)**

Ans. Both decrease by increasing temperature.

Q3..Name the property of liquids which i)causes internal resistance to flow
ii)causes capillary action. Give their units.**(L2)**

Ans. i) viscosity. Its unit is poise.
ii) surface tension. Its unit is Nm^{-1}.

Two marks questions

Q1. In the plot of Z(compressibility factor) vs P, Z attains a value of unity at a certain pressure. What does this signify?**(L3)**

Ans. It implies that at this value of pressure attractive and repulsive forces balance each other. Below this pressure attraction dominates and $Z < 1$. Above this pressure repulsion dominates and $Z > 1$.

Q2. Account for the following properties of gases on the basis of kinetic molecular theory of gases-
a) high compressibility b) gases occupy whole of the volume available to them.**(L2)**

Ans. a) High compressibility is due to large empty space between the gas molecules.
b) Due to absence of attractive forces between the molecules, they can easily separate from one another.

Q3. Explain the pressure and volume corrections in ideal gas equation?**(L2)**

Ans. At low temperature and high pressure intermolecular attractions cannot be neglected, the observed pressure P is smaller than the ideal pressure P_i.
Therefore, $P_i = P + p = P + an^2/V^2$
As volume of gas molecules is not negligible as compared to total volume of the gas the ideal volume V_i is smaller than the observed volume.
Therefore, $V_i = V + v = V - nb$

Three Marks questions

Q1.i) Can a gas with a = 0 be liquefied?**(L2)**

Ans. A gas with a = 0 means absence of intermolecular forces. Hence such a gas cannot be Liquified.

ii) Out of NH_3 and N_2 which will have **(L3)**
a) larger value of 'a'
b)larger value of ' b' .Explain.

Ans. a) NH_3 will have larger value of a because of H – bonding.
b) NH_3 will have larger value of b due to larger molecular size.

Q2. What is meant by compressibility factor of gases? How does its value deviate from that of an ideal gas in case of real gases and what does it indicate?**(L2)**

Ans. It is the ratio of the product PV to nRT.
$Z = PV/nRT$. For ideal gas its value is unity. $Z < 1$ indicates negative deviation i.e. gas is more compressible due predominance of attractive forces. $Z > 1$ indicates positive deviation i.e. gas is less compressible due predominance of repulsive forces.

Q3. Critical temperature for CO_2 is 30.98 ^oC. What does this mean? Explain other two critical constants.**(L2)**

Ans. It means that CO_2 cannot be liquefied above 30.98^oC which is its critical temperature(T_c).

Critical pressure(P_c) – it is the pressure required to liquefy the gas at critical temperature.

Critical volume(V_c) – it is the volume of one mole of the gas at T_c and P_c.

APPLICATION

One mark questions

Q1. How is the partial pressure of a gas related to the total pressure in a mixture of gases?**(L2)**

Ans. Partial pressure = mole fraction x total pressure. For gas A

$p_A = x_A \times P$

Q2. When do real gases deviate from ideality?**(L2)**

Ans. At high pressure and low temperature.

Q3. Why excluded volume 'b' is four times the actual volume of the molecules?**(L3)**

Ans. The two molecules cannot come closer than distance 2r and the volume of sphere with radius 2r is four times the volume of one molecule.

Two marks questions

Q1. Critical temperature of two gases A and B are 30^o and -50^o respectively. Which of them has strong intermolecular forces and why?**(L2)**

Ans. A will have stronger inter particle forces as it can be liquefied at a higher temperature.

Q2.Explain: **(L1)**

i)Vapour pressure increases with increase in temperature.

ii)Giycerine is more viscous than water.

Ans. i) At higher temperature inter particle attraction weakens and more number of mole cules escape to vapour.

ii) As interparticle forces are stronger in glycerine.

Q3. Derive relation between density and pressure of a gas.**(L2)**

Ans. Ideal gas equation PV= nRT

or n/V = P/RT

or m/MV = P/RT (as nm = m/M)

or d/M = P/RT

or P = dRT/M

Three marks questions:-

Q1.At what temperature 128 g of SO_2 confined in vessel of 5 dm^3 capacity will exhibit a pressure of 10.0 bar? Given a = 6.7 bar L^2 mol^{-2} and b= 0.0564 L mol^{-1}.**(L2)**

Ans. w = 128 g

V = 5 dm^3

P = 10.0 bar

M_{SO2} = 64 g n = w/M = 128/64 = 2

Putting values in equation : (P + an^2/V^2) (V – nb) = nRT We get T = 329 K

Q2. Calculate the pressure exerted by 8.5 g of NH_3 contained in a 0.5 L vessel at 300 K. For ammonia a = 4.0 atm L^2mol^{-2} and b = 0.036 L mol^{-1}.**(L2)**

Ans. V =0.5 L , T = 300 K

n= 8.5/17 = 0.5 mol

$(P + an^2/V^2) (V – nb) = nRT$

Putting values , we have

P = 21.51 atm

Q3. 20 mol of Chlorine gas occupies a volume of 800 mL at 300 K and 5 x 10^6 Pa pressure. Calculate the compressibility factor of the gas. Comment on the compressibility of the gas under these conditions(**.L3)**

Ans. P = 5 x 10^6 Pa = 5 x 10^6 / 10^5 bar

n = 20

T = 300 K

R = 0.083 L bar K^{-1} mol^{-1}

V_{real} = 800 mL

V_{ideal} = nRT/P

Putting values , we have

V_{ideal} = 1004 mL

$Z = V_{real}/ V_{ideal}$= 800/1004 = 0.796

As Z is less than 1, it means gas is more compressible under these conditions.

Q4. Explain the effect of increasing the temperature of a liquid, on intermolecular forces operating between its particles. What will happen to the viscosity of a liquid if its temperature is increased? Arrange the following in increasing order of viscosity-water, hexane, glycerine.**(L2)**

Ans. On increasing the temperature , the kinetic energy of liquid molecules increases so that it can overcome the attractive forces between the molecules and hence liquid can flow more easily i.e. viscosity decreases. Order of increasing viscosity : hexane < water < glycerine.

Q5. i) Derive ideal gas equation.

ii) At 25^o and 760 mm of Hg pressure a gas occupies 600 mL volume. What will be its pressure at a height where temperature is 10^o C and volume of the gas is 640 mL.**(L2)**

Ans. i)at constt. T and n ; $V \propto 1/P$ (Boyle's law)

at constt. P and n ; $V \propto T$ (Charle's law)

at constt. P and T; $V \propto n$ (Avogadro's law)

thus, $V \propto nT/P$

or $V = nRT/P$

or $PV = nRT$

ii) Given p_1 = 760 mm Hg V_1 = 600 mL

T_1 = 25 + 273 = 298 K

V_2 = 640 mL and T_2 = 10 + 273 = 283K

According to combined gas law : $p_1V_1/T_1 = p_2V_2/T_2$

or $p_2 = p_1V_1 T_2/T_1 V_2$

putting values and calculating, we have p_2 = 676.6 mm Hg

UNIT –6 CHEMICAL THERMODYNAMICS

Concept – State of System, State Functions & First law of Thermodynamics

KNOWLEDGE

One mark questions

Q1. First law of thermodynamics is a restatement of which law?**(L1)**

Ans. Law of conservation of energy.

Q2. Give relation between Cp and Cv.**(L1)**

Ans. Cp – Cv = R

Q3. State First law of thermodynamics. Give its mathematical expression.**(L1)**

Ans. Energy can neither be created nor destroyed but can be transformed from one form to another.

$\Delta U = q + w$

2 Marks questions

Q1 Define the term system and surroundings. Explain the different types of system.**(L1)**

Ans. System : The part of the Universe which is under investigation.

Surroundings: The remaining part of the Universe other than system.

The system and surroundings are separated by well defined boundary.

Types of system:

(i) Open system

(ii) Closed system

(iii) Isolated system

Q2. Differentiate between path fuction and state function. **(L2)**

Ans. Path Function : Those properties which depend upon path followed.e.g,work.

Sate Function : Those properties which depend upon the initial and final staes of the system and not upon the path followed. E.g, enthalpy.

Q3. State Hess's law of constant heat summation.Give its two applications.**(L2)**

Ans. Hess's law states that enthalpy change for a reaction is same whether the reaction occurs in single step or several steps.

OR If a reaction occurs in several steps then ,its standard enthalpy of reaction is equal to the sum of standard enthalpies of the intermediate reactions into which the overall reaction may be divided at the same temperature.

Applications:

(i) It is used to calculate enrhalpy of the formation of the compound

(ii) It is used to calculate Lattice enthalpy of an ionic solid.

3 Marks Questions

Q1. (i) Under what conditions is the heat absorbed by a system is equal to the work done by the system?

(ii)In a process, 802 J of heat is absorbed by a system and 294 J of work is done by the system. What is the change in internal energy for the process?**(L3)**

Ans. (i) When ΔU=0 i.e, for isothermal process q = w

(ii)ΔU = q + w

ΔU = 802 + (-294) =508J

Q2. (i)State why heat changes in physical and chemical processes are indicated by enthalpy changes and not by entropy changes? **(L2)**

(ii)What are the limitations of First Law of thermodynamics?

Ans. (i) Most of the processes are carried out in an open system i.e, at constant pressure.

(ii)(a) Can't explain the feasibility of the reaction.

(b)It poses no restriction on the direction of flow of heat.

(c)Practically it is not possible to convert the heat energy into an equivalent amount of work.

Q3. (i) The standard heat of formation of Fe_2O_3 (s) is 824.2kJ mol^{-1} . Calculate heat change for the reaction.$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$

(ii)Why potential energy is a state function while work is not?**(L3)**

Ans. (i)$\Delta_r H$ = 2x 824.2 = 1648.4kJ/mol.

(ii)Potential energy is the energy possessed by an object due to its position while work is the path function.

UNDERSTANDING

One mark questions

Q1. Which gas law governs Isothermal process ? **(L1)**

Ans. Boyle's law.

Q2. Name the state variables that remain constant in isobaric and isochoric process.**(L1)**

Ans. Pressure and Volume .

Q3. What is the value of internal energy for 1 mole of monoatomic gas?**(L2)**

Ans. U = $\frac{3RT}{2}$

Two marks questions

Q1. (i)What happens to the internal energy of the system. **(L2)**

(a) if work is done by the system.

(b)Work is done on the system.

(ii) Why enthalpy of neutralization of strong acid and base is consant?

Ans. (i).(a)ΔU Decreases. (ΔU = q - w)

(b)ΔU increases. (ΔU = q + w)

(ii) Strong acids and bases dissociate completely into ions in aqueous solution and form 1 mole of water.

Q2. Predict the relationship between ΔU and ΔH for the following reactions: **(L3)**

(i) $S(s) + O_{2(}g) \rightarrow SO_2(g)$

(ii) $PCl_5(g) \rightarrow PCl_3(g) + Cl_{2(}g)$

Ans. (i) $\Delta n_g = 0$ Therefore , $\Delta U = \Delta H + \Delta n_g RT$, $\Delta U = \Delta H$

(i) $\Delta n_g = 1$ Therefore , $\Delta U = \Delta H + \Delta n_g RT$, $\Delta U > \Delta H$.

Q3. If a system absorbs 500 cal of heat at the same time does 400J of work, find the change in internal energy of the system. **(L1)**

Ans. $\Delta U = q + w$ (1 Calorie =4.2 J)

$\Delta U = 2100+(-400) = 1700J$

Three Marks questions

Q1. (i)On which factors an internal energy of the system depends? **(L2)**

(ii)A gas is enclosed in a cylinder with a weighted piston as the top boundary. The gas is heated and expands from a volume of 0.04 m^3 to 0.10 m^3 at a constant pressure of 200 kPa. Find the work done on the system.

Ans. (i)Quantity of the gas or substance ; its chemical nature ; temperature, pressure and volume.

(ii)Work done (W) = $- P\Delta V = -200 X (0.10 – 0.04) = - 12kJ$

Q2. Calculate the standard enthalpy of formation of one mole of $C_6H_{12}O_6$ (s), if the combustion of one mole of glucose takes place at 298 K and 1 atm and after combustion CO_2 (g) and H_2O (l) are produced and 2816 kJ of heat is liberated. Assume that the standard enthalpies of formation of CO_2 (g) and H_2O (l) are - 393 kJ/mol and -286 kJ mol respectively. **(L2)**

Ans , $C_6H_{12}O_6(s) + 6O_{2(}g) \rightarrow 6CO_2(g) + 6H_20(l)$

$\Delta H = \sum enthalpies\ of\ products - \sum sum\ of\ enthalpies\ of\ reactants.$

$-2816 = \{6X (-393) + 6(-286)\} - \{\Delta H_f(C_6H_{12}O_6) + 6(0)\}$

$\Delta H_f(C_6H_{12}O_6) = - 1258\ kJmol^{-1}$

Q3. (i)What are sign conventions used for Heat and Work? **(L2)**

(ii).Neither 'q' nor 'w' is a state function but " q + w" is a state function. Assign reason.

Ans. (i)Heat absorbed by the system = +ve

Heat evolved by the system = -ve

Work done by the system = -ve

Work done on the system = +ve

(ii)$\Delta U = q + w$ and 'ΔU' is a state function, which depends upon initial and final states of the system and not upon its path.

APPLICATION

One mark questions

Q1. Classify the following properties as extensive and intensive properties: **(L1)**

Molar heat capacity, temperature, enthalpy and volume.

Ans. Extensive properties : Enthalpy and volume.

Intensive properties: Molar heat capacity, temperature.

Q2. Determine enthalpy of formation of water. **(L1)**

$2H_2(g) + O_2(g) \rightarrow 2H_20(l) + 572$ kJ/mol.

Ans. $\Delta H_f(H_2O) = -572/2 = -286$ kJ/mol.

Q3. Give an example of reaction in which $\Delta U = \Delta H$. **(L2)**

Ans. All those reactions in which $\Delta n_g = 0$

e.g, $C(s) + O_{2(g)} \rightarrow CO_2(g)$

Two Marks questions

Q1. $1m^3$ of C_2H_4 at STP is burnt in oxygen according to the thermochemical reaction: **(L3)**

$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l) + 1410$ kJ/mol

Assuming 70% efficiency, determine how much of useful heat is evolved in he reaction.

Ans. 22.4Lit of C_2H_4 at STP produces energy = - 1410kJ/mol

1000Lit of C_2H_4 at STP produces = (1410 X 1000)/22.4

Since efficiency is 70% = (1410000 X 70)/ 22400 = 44.06 kJ

Q2. Calculate the standard enthalpy of formation of CH_3OH (l) from the following data: **(L2)**

$CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; $\Delta_rH^0 = -726$ KJ/mol

$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta_cH^0 = -393$ KJ/mol

$H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$; $\Delta_f H^0 = -286$ KJ/mol

Ans. $CH_3OH(l) + 3/2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$; $\Delta_rH^0 = -726$ KJ/mol .....(1)

$C(s) + O_2(g) \rightarrow CO_2(g)$; $\Delta_cH^0 = -393$ KJ/mol.....(2)

$H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$; $\Delta_f H^0 = -286$ KJ/mol.....(3)

$C(s) + 2H_2(g) + ½\ O_2(g) \rightarrow CH_3OH(l)$; $\Delta_fH^0 = ?$

Multiplying eq.(3) by 2 and adding it to eq. (2) we get,

$C(s) + 3H_2(g) + 2O_2(g) \rightarrow CO_2(g) + 3H_2O(l)$; $\Delta_f H^0 = -393 + 2(-286) = -965$kJ/mol.....(4)

Subtracting eq. (1) from eq.(4) we get,

$C(s) + 2H_2(g) + ½\ O_2(g) \rightarrow CH_3OH(l)$; $\Delta_fH^0 = -965 - (-726) = -239$ kJ/mol.

Q3. It has been found that 221.4J is needed to heat 30g of ethanol from 15^0C to 18^0C. calculate (a) specific heat capacity, and (b) molar heat capacity of ethanol. **(L2)**

Ans. (a) heat(q) = mass x specific hea capacity x ΔT

221.4 = 30 x c x 3

c = 221.4/90 = 2.46 $Jg^{-1}K^{-1}$

(b) molar heat capacity = 2.4 x 46 = 110.4$Jmol^{-1}K^{-1}$.

Three marks questions

Q1. Express the change in internal energy of a system when:- **(L2)**

(a) No heat is absorbed by the system from the surroundings, but work (w) is done on the system. What type of wall does the system have?

(b) No work is done on the system, but 'q' amount of heat is taken out from the system and given to the surroundings. What type of wall does the system have?

(c) 'w' amount of work is done by the system and 'q' amount of heat is supplied to the system. What type of system would it be?

Ans. (i) $\Delta U = w$, wall is adiabatic

(ii) $\Delta U = -q$, thermally conducting walls

(iii)Δ U = q – w, closed system

Q2. Calculae Standard enthalpy change and standard internal energy change for the following reaction at 300K : OF_2 (g) + H_2O (g) -→ O_2(g) + 2HF(g) **(L3)**

Standard enthalpy of formation of various species are given as below in KJ/mol :

OF_2(g) = 23.0 ,H_2O (g) = -241.8 , HF(g) = -268.6 ,R=8.314J/K/mol

Ans. $\Delta H^o = \sum \{\Delta_f H^o \text{ (product)}\} - \sum\{\Delta_f H^o \text{ (reactants)}\}$

$\Delta H^o = \{0+2\times(-268.6)\} - \{23+(-241.8)\} = -318.8KJ$

$\Delta U^o = \Delta H^o - \Delta n_g RT$

$= -318800 - \{(3-2) \times 8.314 \times 300/1000\}$

$= -321.3$ KJ.

Q3. (i)Will the change in enthalpy of the system be zero in adiabatic process? **(L3)**

(ii)1gram of graphite is burnt in a bomb calorimeter in excess of oxygenat 298K and 1 atm pressure according to the equation : C (graphite) + O_2 (g) → CO_2 (g).During the reaction temperature rises from 298 to 299K. If the heat capacity of the bomb calorimeter is 20.7 kJ/K then what is the enthalpy change for the above reaction at 298K and 1 atm?

Ans. (i)Yes ,in adiabatic process enthalpy of the system is zero.

(ii) q= - Cv x ΔT =- 20.7/(300 – 298) = - 10.35kJ.

ΔH for combustion of one gram of Carbon = --10.35kJ

ΔH for combustion of mole of Carbon = --10.35 x 12=124.2kJmol^{-1}

Q4. (i) Define bond energy. **(L2)**

(ii)Calculate $\Delta_f H^0$ of HCl if bond energy of H-H bond is 437kJmol^{-1} Cl-Cl bond is 244kJmol^{-1} and

H-Cl is 433 kJmol^{-1}.

Ans. (i) Bond energy is the amount of energy released when bond is formed between t wo isolated atoms in ground state.

(ii) 1/2 H_2 (g) + 1/2Cl_2(g) → HCl(g) $\Delta_f H^0$ = ?

$\Delta_f H^0 = \sum bond\ enthalpies\ of\ reactants - \sum bond\ enthalpies\ of\ products$

$\Delta_f H^0$ = {1/2 x 437 + 1/2 x 244} -{433} = - 92.5kJmol^{-1}

Q5. (i) Classify the following processes as reversible or irreversible : **(L2)**

(a)Dissolution of NaCl.

(b)Evaporation of water at 373K and 1atm.

(c) Mixing of two gases by diffusion.

(d)Melting of ice without rise in temperature.

(ii)When an ideal gas expands in vacuum there is neither absorption nor evolution of heat.Why?

Ans. (i) (a)and (d) : Reversible ;

(b) and (c): Irreversible.

(ii)It is because no work is done i.e w = 0 ,

W = -P x ΔV = 0

ΔU = q + w , q= 0 because chamber is insulated. Therefore ΔU = 0.

Concept- Standard Enthalpies, ΔS & ΔG

KNOWLEDGE

One Mark Questions

Q.1. State First Law of thermodynamics. **(L-1)**

Ans. Energy can neither be created nor destroyed. The energy of an isolated system is constant.
ΔU=q+ w.

Q.2. What is a thermodynamic state function? **(L-1)**

Ans. A function whose value is independent of path. eg. P, V, E, H

Q.3. Give enthalpy (H) of all elements in their standard state. **(L-2)**

Ans. In standard state enthalpies of all elements is zero.

Q.4. From thermodynamic point to which system the animals and plants belong? **(L-2)**

Ans. Open system.

Q.5. Predict the sign of ΔS for the following reactions. **(L-3)**

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$+ heat

Ans. Δ S is positive (entropy increases)

Two Marks Question-

Q.1 Give relationship between entropy change and heat absorbed/evolved in a reversible reaction at temperature T. **(L-1)**

Ans. $\Delta S = q_{rev}/T$

Q.2 What is spontaneous change? Give one example. **(L-2)**

Ans. A process which can take place of its own or upon initiation under some condition.
eg. Common salt dissolves in water of its own.

Q.3 A real crystal has more entropy than an Ideal crystal. Why? **(L-2)**

Ans. A real crystal has some disorder due to presence of defects in their structural arrangement, and Ideal crystal does not have any disorder.

Q.4 Under what condition, the heat evolved/absorbed in a reaction is equal to its free energy change? **(L-3)**

Ans. In ΔG = ΔH – T. ΔS, when reaction is carried out at 0 K or ΔS = 0, then ΔG = ΔH.

Q.5 Predict the entropy change in- (i) A liquid crystallizes into solid (ii) Temperature of a crystalline solid raised from 0K to 115K. **(L-3)**

Ans. (i) Entropy decreases because molecules attain an ordered state.
(ii) Entropy increases because from 0K to 115K average kinetic of moleculesincreases.

Three Marks question

Q.1.Given the following thermo chemical equations **(L-2)**

(i) S(rhombic) + $O_2(g)$ → $SO_2(g)$, ΔH = - 297.5 kj mol-1

(ii) S(monoclinic) + O_2 → $SO_2(g)$,ΔH = - 300.0 kj mol-1

Calculate ΔH for the transformation of one gram atom of rhombic sulphur into monoclinic sulphur.

Ans. Required equation

S(rhombic) → S(monoclinic), ΔH = ?

Subtract equation (ii) from (i) it gives

S(rhombic) – S(monoclinic) →0, ΔH =297.5 – (-300.0) = 2.5 $KJmol^{-1}$

OR

S(rhombic)→ S(monoclinic), ΔH = +2.5 kj mol^{-1}

Thus for the transformation of one gram atom of rhombic sulphur into monoclinic sulphur, 2.5 kj mol^{-1} of heat is absorbed.

Q.2.Calculate the enthalpy of hydrogenation of ethylene, given that the enthalpy of combustion of ethylene, hydrogen and ethane are -1410, -286.2 and -1560.6 kj mol^{-1} respectively at 298 K. **(L-2)**

Ans. (i) $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(l)$, ΔH = -1410 $KJmol^{-1}$

(ii) $H_2(g) + ½\ O_2(g) \rightarrow H_2O(l)$, ΔH = -286.2 $KJmol^{-1}$

(iii) $C_2H_6(g) + 7/2\ O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$, ΔH = -1560.6 $KJmol^{-1}$

Required equation

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$,ΔH = ?

Equation(i) + equation (ii) – equation (iii) gives

$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$,ΔH = -1410 +(-286.2) – (1560.6)

= - 135.6 $KJmol^{-1}$

Q.3.What is meant by entropy driven reaction? How can the reaction with positive change of enthalpy and entropy be made entropy driven? **(L-1)**

Ans.The free energy change of a reaction is given by ΔG = ΔH – TΔS

For a reaction to be spontaneous, ΔG should be –ve.

If both ΔH and ΔS are positive ΔG can be –ve if TΔS>ΔH in magnitude. Thus, entropy factor should dominate over enthalpy factor. Such reactions are therefore, called entropy driven. This can happen in either of the following two ways:

(i)ΔS should be so large that even if T is low, TΔS should be greater than ΔH

(ii) If ΔS is small, T should be so large that TΔS>ΔH.

Q.4.Justify the following statements: **(L-2)**

(i) Reactions with $\Delta G^0 < 0$ always have an equilibrium constant greater than 1.

(ii) Many thermodynamically feasible reactions do not occur under ordinary conditions.

(iii) At low temperatures, enthalpy change dominates the ΔG expression and at high temperatures, it is the entropy which dominates the value of ΔG.

Ans.(i) $-\Delta G^0 = RT \ln K$. Thus, if ΔG^0 is less than zero, i.e. , it is –ve, then ln K will be +ve and hence K will be greater than 1.

(ii) Under ordinary conditions, the average energy of the reactants may be less than threshold energy. They require some activation energy to initiate the reaction.

(iii) $\Delta G = \Delta H - T\Delta S$. At low temperature, $T\Delta S$ is small .Hence, ΔH dominates. At high temperatures, $T\Delta S$ is large, i.e. , ΔS dominates the value of ΔG.

Q.5. Calculate the resonance energy of N_2O from the following data: **(L-3)**
$\Delta_f H^0$ of N_2O =82 KJ mol^{-1}, Bond energies of NΞN, N=N,O=O and N=O bonds are 946 ,418 ,498 and 607 kj mol^{-1} respectively.
Ans. The equation for the formation of one mole of N_2O will be

N≡N (g) + ½ O=O (g) → N=N=O

Calculated value of $\Delta_f H^0$ for this reaction will be
$\Delta_f H0$ = [B.E.(NΞN) + ½ B.E.(O=O)] – [B.E.(N=N) + B.E.(N=O)]
=[946 + ½ (498)] – [418 + 607] kj mol^{-1}
= 170kj mol^{-1}
Resonance energy = Observed $\Delta_f H^0$ – Calculated $\Delta_f H^0$ = 82 – 170
= - 88 kj mol^{-1}.

UNDERSTANDING

One Mark Questions

Q.1.Write an expression in the form of chemical equation for the standard enthalpy of formation (ΔH_f) of CO (g). **(L-1)**
Ans. C(s) +1/2 O_2(g) → CO (g)

Q.2.An exothermic reaction A→ B is spontaneous in the backward direction. What will be the sign of ΔS for the forward reaction? **(L-2)**
Ans. Backward reaction will be endothermic. Thus, energy factor opposes the backward reaction .As backward reaction is spontaneous, randomness factor must favour, i.e., ΔS will be +ve for backward reaction or it will be –ve for forward reaction.

Q.3.Under what condition, the heat evolved or absorbed in a reaction is equal to its free energy change? **(L-2)**
Ans. As $\Delta G = \Delta H - T\Delta S$. Thus, $\Delta G = \Delta H$ only when either the reaction is carried out at 0^0 K or the reaction is not accompanied by any entropy change, i.e., $\Delta S = 0$

Q.4.When $\Delta H > 0$ and $\Delta S < 0$, reaction is never spontaneous. Explain. **(L-2)**
Ans. When $\Delta H > 0$, energy factor opposes the reaction . When $\Delta S < 0$, i.e. randomness decreases, this factor also opposes the process. As both factors oppose the process, reaction is never spontaneous.

Q.5. Two ideal gases under same pressure and temperature are allowed to mix in an isolated system. What will be the sign of entropy change? **(L-1)**
Ans. Entropy change (ΔS) is positive. It is because disorder or degree of freedom increases on mixing.

Two Marks Questions

Q.1.Predict the sign of ΔS for (a) the process of evaporation (b) the process of freezing. **(L-1)**
Ans. (a) ΔS =+ve
(b) ΔS=-ve

Q.2. Out of carbon(diamond)and carbon (graphite) whose enthalpy of formation is taken as zero? (**L-2)**

Ans. Enthalpy of formation of carbon in the form of graphite is taken as zero because it is a more commonly found in stable form of carbon.

Q.3. The equilibrium constant for a reaction is 10. What will be the value of ΔG^0? R =8.314 $JK^{-1}mol^{-1}$,T = 300K. **(L-2)**

Ans.ΔG^0 = - 2.303 RT log K

= - 2.303X8.314 J K-1 mol-1 x 300K X log 10

=-5744.1 J.

Q.4.The standard free energy of a reaction is found to be zero. What is the value of its equilibrium constant? **(L-2)**

Ans. ΔG=-2.303RT log K

When ΔG^0=0, it means log K=0 or K =1, Value of equilibrium constant, K is unity.

Q.5. Which have more entropy real crystal or ideal crystal and why? **(L-2)**

Ans. Real crystal has more entropy because it has more disorderness.

Three Marks Questions

Q.1. At a certain temperature 'T', the endothermic reaction A→ B proceeds virtually to the end. Determine: **(L-2)**

(i) sign of ΔS for this reaction

(ii) sign of ΔG for the reaction B→ A at the temperature T, and

(iii) the possibility of reaction B→ A proceeding at a low temperature.

Ans.(i) Energy factor opposes .So enthalpy factor must favour , i.e. ,ΔS must be positive.

(ii) For A→ B , ΔG is –ve, therefore, for B→A, ΔG will be +ve.

(iii) For B→ A, ΔH = - ve and ΔS is also –ve , i.e. ,Δs opposes the process but at low temp., TΔS may be so low that ΔH is greater in magnitude then TΔS and the process will be spontaneous

Q.2.Calculate the free energy change for the complete combustion of one mole of methane, $CH_4(g)$, the main component of natural gas. Is this reaction spontaneous? **(L-3)**

Ans. We begin by writing the equation that represents this reaction. Recall that "complete combustion," or burning, is a reaction with oxygen from the atmosphere, forming carbon dioxide and water:

$CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$

$\Delta G° = (1\ mol)[\Delta Gf°\ for\ CO_2(g)] + (2\ mol)[\Delta Gf°\ for\ H_2O(l)] –$

$(1\ mol)[\Delta Gf°\ for\ CH_4(g)] – (2\ mol)[\Delta Gf°\ for\ O_2(g)] =$

(1 mol) (–394.4 kJ/mol) + (2 mol) (–237.0 kJ/mol) – (1 mol) (–50.8 kJ/mol) –

(2 mol) (0) = –817.6 kJ

The negative value of ΔG° indicates that the reaction is spontaneous. This matches ourexperiences in everyday life, where we have seen that natural gas burns spontaneously.

Q.3. Give reason: (i) Neither q nor w is a state function but q+w is a state function. **(L-1)**

(ii) The dissociation of ammonium chloride in water is endothermic still it dissolve in water.

(iii) Areal crystal has more entropy than an ideal crystal.

Ans. (i) q+w =ΔU. As ΔU is a state function, hence q+w is a state function.

(ii) On dissociation ,entropy increases, i.e. ,ΔS is +ve .Though ΔHis +ve but if TΔS>ΔH, then according to the equation, ΔG =ΔH - TΔS,ΔG will be –ve. Hence, the process is spontaneous.

(iii) A real crystal has some disorder due to presence of defects whereas ideal crystal has no disorder . Hence ,a real crystal has more entropy then ideal crystal.

Q.4.Calculate ΔG and ΔG^0 for the reaction : **(L-2)**

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

At 27^0C. Equilibrium constant (K) for this reaction =10^2.

Ans. ΔG =0 because the reaction is in equilibrium.

$\Delta G^0 = -2.303RT \log K$

$= -2.303 \times 8.314 JK^{-1}mol^{-1} \times 300K \log 10^2$

$= -11488 J\ mol^{-1}$

$= -11.488 kJmol^{-1}$.

Q.5.Enthalpies of formation of CO(g),CO_2(g),N_2O(g) and N_2O_4 (g) are -110, -393, 81 and 9.7kJmol -1 respectively. Find the value of ΔrH for the reaction : **(L-3)**

Ans. $N_2O_4(g) + 3CO(g) \rightarrow N_2O(g) + 3CO_2(g)$.

Ans. $\Delta_r H = \sum \Delta_f H(\text{Products}) - \sum \Delta_f H(\text{Reactants})$

$= [\Delta H(N_2O) + 3\,\Delta H(CO_2)] - [\Delta H(N_2O_4) + 3\,\Delta H(CO)]$

$= [81 + 3(-393)] - [9.7 + 3(-110)]$

$= -777.7$ kj.

APPLICATION

One Mark Questions

Q.1.What is the sign of enthalpy of formation of highly stable compound? **(L-1)**

Ans. Negative.

Q.2.What is the value of ΔG where ice and water are in equilibrium? **(L-1)**

Ans. ΔG=0

Q.3.Is the bond energy of all the four C-H bonds in CH_4 molecule equal? If not then why ? How is C-H bond energy then reported? **(L-2)**

Ans. No because after breaking of C-H bonds one by one, the electronic environments change. The reported value is the average of of the bond dissociation energies of the four C-H bonds.

Q.4. Water can be lifted into the water tanks at the top of the house with the help of a pump. Then why is not considered to be spontaneous? **(L-2)**

Ans. A spontaneous process should continue taking place by itself after initiation . But this is not so in the given case because water will go up so long as the pump is working.

Q.5.We are consuming a lot of electrical energy, solar energy etc Do you, therefore, conclude that energy of the universe is continuously decreasing? Explain. Which other thermodynamic quantity is continuously increasing or decreasing? **(L-2)**

Ans. No, energy of the universe remains constant (law of conservation of energy). Entropy of the universe is continuously increasing.

Two Marks Questions

Q.1.Explain Hess's law. **(L-1)**

Ans. It states that the enthalpy change of the reaction remains the same whether the reaction is carried out in one step or several steps, i.e.,

$\Delta H = \Delta H_1 + \Delta H_2 + \Delta H_3 + \ldots\ldots\ldots$

Q.2. The enthalpies of combustion of graphite and diamond are 393.5 kj and 395.4 kj respectively. Calculate the enthalpy change accompanying the transformation of 1 mole of graphite into diamond. **(L-2)**

Ans. $C\ (gr) + O_2\ (g) \rightarrow CO_2(g)$, $\Delta H = -393.5$ KJ mol-1

$C\ (dia) + O_2\ (g) \rightarrow CO_2(g)$, $\Delta H = -395.4$ KJ mol-1

Required equation

$C(gr) \rightarrow C\ (dia)$, $\Delta H = ?$

Subtract equation (ii) from (i)

$\Delta H = -393.5 - (-395.4)$

$= 1.9$ KJ mol-1

Q.3.Comment on the thermodynamic stability of NO(g), given: **(L-2)**

$\frac{1}{2} N_2(g) + \frac{1}{2} O_2\ (g) \rightarrow NO\ (g)$; $\Delta r H^0 = 90$ kj mol-1

$NO\ (g) + \frac{1}{2} O_2\ (g) \rightarrow NO_2\ (g)$; $\Delta r H^0 = -74$ kjmol-1

Ans. As energy is absorbed in the first reaction ,NO (g) is unstable. As energy is released in the second reaction, NO_2 (g) is stable. Thus, unstable NO (g) changes into the stable NO_2 (g).

Q.4.Calculate the entropy change in the surroundings when 1.00 mol of H_2O (l) is formed under standard conditions: Δ fH0 = - 286 kj mol-1. **(L-2)**

Ans. $H_2\ (g) + \frac{1}{2} O_2\ (g) \rightarrow H_2O\ (g)$, $\Delta_f H^0 = -286$kj mol-1

This means that when 1 mol of H_2O (l), is formed , 286 kj of heat is released. This heat is absorbed by the surroundings, i.e., q rev = +286 kj mol^{-1}.

So $\Delta S = q_{surr}/T = 286 KJmol^{-1}/298K$

$= 0.9597 kjK^{-1}mol^{-1}$

$= 959.7\ JK^{-1}\ mol^{-1}$.

Q.5.For the reaction at 298 K, $2A + B \rightarrow C$, $\Delta H = 400$ KJ mol^{-1} and $\Delta S = 0.2$KJ K^{-1} mol^{-1} .At what temperature will the reaction become spontaneous considering ΔH and ΔS to be constant over the temperature range. **(L-3)**

Ans. Let us first calculate the temperature at which the reaction will be in equilibrium i.e. $\Delta G = 0$

Now, $\Delta G = \Delta H - T\Delta S$

$0 = \Delta H - T\Delta S$ **OR** $T = \Delta H/\Delta S = 400 KJmol^{-1}/0.2 kj\ K^{-1}\ mol^{-1}$

= 2000 K

For reaction to be spontaneous, i. e., for ΔG to be –ve, T should be greater than 2000 K.

Three Marks Questions

Q.1.Determine the standard entropy change for the decomposition of one mole of solid calcium carbonate, forming solid calcium oxide and carbon dioxide gas**. (L-2)**

Ans. This is a straight-forward application of Equation 2, followed by substitution of the Appropriate values from a table.

$CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

ΔS° = (1 mol) [ΔS° for CaO (s)] + (1 mol) [ΔS° for CO_2(g)] –
(1 mol)[ΔS° for $CaCO_3$(s)] =
(1 mol) (39.8 J/mol K) + (1 mol) (213.7 J/mol K) – (1 mol) (92.9 J/mol K) =
160.6 J/K.

Q.2.Calculate ΔG° for the reaction in Example 1, the decomposition of calcium carbonate, from ΔH° and ΔS° values. **(L-3)**

Ans. We have already calculated ΔS° for the reaction $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$ as 160.6 J/K. We can find ΔH° for the reaction in a similar manner:

ΔH° = (1 mol)[ΔH° for CaO(s)] + (1 mol)[ΔH° for CO_2(g)] –
(1 mol)[ΔH° for $CaCO_3$(s)] =
(1 mol) (–635.3 kJ/mol) + (1 mol) (–393.5 kJ/mol) – (1 mol) (–1207.0 kJ/mol)
= 178.2 kJ

Now we use Equation 23.6 to find the value of ΔG°:

ΔG° = ΔH° – TΔS° = 178.2 kJ – 298.15 K ×160.6 JK×1 kJx1000 J
= 130.3 kJ

Notice that we used 298.15 K, or 25°C as the value of T. This is thermodynamic standard temperature. Also note how the ΔS° value was in joules per kelvin, while the ΔH° value was in kJ.

Q.3.Consider the reaction of nitrogen monoxide and chlorine to form nitrosyl chloride: **(L-3)**

$2\,NO(g) + Cl_2(g) \rightarrow 2\,NOCl(g)$

a) Calculate ΔG° for the reaction.

b) Calculate ΔG when pNO = 0.30 atm, pCl_2 = 0.10 atm, and pNOCl = 0.45 atm.

Ans. (a) ΔG° is found by applying Equation 23.1:

ΔG° = (2 mol)[ΔG_f° for NOCl(g)] – (2 mol)[ΔG_f° for NO(g)] –
(1 mol)[ΔG_f° for Cl_2(g)] =
(2 mol) (66.2 kJ/mol) – (2 mol) (86.6 kJ/mol) – (1 mol) (0) = –40.8 Kj

b) ΔG at nonstandard conditions (the pressures are not 1 atm in this case) is found by ΔG = ΔG° + RT ln Q. Let's begin by calculating Q:

$$Q = \frac{(pNOCl)2}{(pNO)^2\,(pCl_2)}$$

$$=\frac{(0.45)2}{(0.30)2\,(0.10)} = 23$$

Now we can find ΔG:

$$\Delta G = \Delta G° + 2.303\ RT \log Q$$

$$= –40.8 \times 1000\ J + 2.303 \times 8.314\ Jmol\ K \times 298.15\ K \times \log 23$$

$$= –33.0\ kJ.$$

Q.4. K_{sp} for the reaction $BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$ is 1.1×10^{-10}. Use thermodynamic data to determine ΔG° for this reaction, and then calculate K . How do the K values compare? **(L-3)**

Ans. ΔG° is found in the usual manner:

ΔG° = (1 mol) [ΔGf° for $Ba^{2+}(aq)$] + (1 mol)[ΔGf° for $SO_4^{2-}(aq)$] –(1 mol)[ΔGf° for $BaSO_4(s)$]

=(1 mol) (–560.8 kJ/mol) + (1 mol) (–744.5 kJ/mol) – (1 mol) (–1362.3 kJ/mol)

=57.0 kJ

ΔG° = –2.303RT log K

log K =–ΔG°/2.303RT

$$\text{Log K} = \frac{57 \times 1000}{2.303 \times 8.314 \times 298.15}$$

Log K = -9.98472

K = antilog (-9.98472)

$K = 1 \times 10^{-10}$

The K calculated from $\Delta G_f°$ values agrees with the tabulated Ksp value to ± 0.1 in the doubtful digit.

Q.5.Comment on the validity of the following statements, giving reason: **(L-2)**

(i) Thermodynamically, an exothermic reaction is sometimes not spontaneous.

(ii)The entropy of steam is more then that of water at its boiling point.

(iii) The equilibrium constant for a reaction is one or more if ΔrG^0 for it is less than zero.

Ans.

(i) Yes, the given statement is true. This is because ΔG=ΔH-TΔS. For exothermic reaction ,ΔH is –ve. If TΔS is +ve (i.e., entropy factor opposes the process) and TΔS>ΔH in magnitude, ΔG will be +ve and process will not be spontaneous.

(ii) Yes, the given statement is true .This is because at the same temperature, gaseous state is more disordered than the liquid state.

(iii) $-\Delta G^0 = RT \ln K$. Thus ,if ΔG^0 is less than zero, i.e. it is –ve, then ln K will be +ve and hence K will be greater than 1.

UNIT -7 EQUILIBRIUM

Concept: Laws & Factors affecting Equilibrium

KNOWLEDGE

One Mark Questions

Q1 what is Equilibrium? (**L- I)**

Ans : Equilibrium represents the state of process in which properties such as temperature, pressure ,concentration of the system do not show any change with the passage of time.

OR The state in which rate of forward reaction becomes equal to the rate of backward reaction.

Q.2 Define law of mass action. (**L- I)**

Ans. The rate of chemical reaction is directly proportional to the product of active masses of the reactant, each raise to the power equal to stoichiometric coefficient as represented by the balanced chemical equation.

$aA+bB \leftrightarrows$ product

Rate of reaction $\propto [A]^a [B]^b$

Q.3Write the relation between Kp &Kc. (**L- I)**

Ans $K_p=K_c(RT)\Delta^n$

Q4 What will be the value of K ,If reaction is reversed? (**L- I)**

Ans. The value of K will get inversed.

Q.5 Give example of Homogenous equilibrium. (**L- I)**

Ans. $H_2(g)+I_2(g) \leftrightarrows 2HI(g)$

Two Mark Questions

Q1 Write characteristics of Chemical equilibrium. (**L- I)**

Ans. (i) At equilibrium the rate of forward reaction becomes equal to rate of backward reaction.

(ii) A chemical equilibrium established only if none of the products are allowed to escape out.

(iii) Chemical equilibrium can be attained from either direction.

(iv) Catalyst does not alter the state of equilibrium.

Q2 Explain the law of chemical Equilibrium (**L- I)**

Ans. $a A+ b B \leftrightarrows x X + y Y$

$Kc= [X]^x [Y]^y / [A]^a [B]^b$

According to this law: Equilibrium constant is the Raito of product of molar concentration of the product to the product of molar concentration of the reactant with each concentration term raise to the power equal to their stoichiometric coefficient.

Q.3 what will be the value of equilibrium constant in each of the following case: (**L- I)**

(i) If the reaction is divided by 2

(ii) If the reaction is multiplied by 2.

(iii) If the reaction is reversed.

(iv)If the reaction is divided into two steps.

Ans. (i) $\sqrt{K}$
(ii)K^2
(iii) 1/K
(iv)K=K1 X K2

Q.4 Write Application of Equilibrium constant? **(L- I)**
Ans. (i) To predict the extent of the reaction.
(ii) To predict the direction of the reaction.
(iii) To calculate the equilibrium concentration.
Q.5 what do you mean by homogenous and heterogeneous equilibrium? **(L- I)**
Ans. Homogenous;-It is that equilibrium reaction in which all the reactants and the products are in the same phase.

$$N_2(g) + 3\,H_2(g) \leftrightarrows 2\,NH_3(g)$$

Heterogeneous equilibrium: - It is that equilibrium reaction in which all the reactants and the products are in two or more phases

$$CaCO_3(s) \leftrightarrows CaO(s) + CO_2(g)$$

Three marks questions
Q.1 what are the values of equilibrium constant for the following reactions: **(L- I)**
Ans. (i) The production of ammonia from nitrogen and hydrogen gases

$$N_2(g) + 3\,H_2(g) \leftrightarrows 2\,NH_3(g)$$

Ans:

$$K_c = \frac{[NH_3]^2}{[N_2][H_2]^3} \qquad K_p = \frac{P^2_{(NH3)}}{P_{(N2)}P^3_{(H2)}}$$

(ii)The thermal decomposition of calcium carbonate.

$$CaCO_3(s) \leftrightarrows CaO(s) + CO_2(g)$$

Ans. $K_c = [CO_2]$

$K_p = P_{(CO2)}$

Q.2 What will be the value of K_c at 373 K for the following reaction: **(L- I)**

$$2\,NO(g) + Br_2(g) \leftrightarrows 2\,NOBr(g) \qquad K_p = 2.40 \text{ @ } 373\ K$$

Ans. Calculate the change in the number of moles of gases, Δ^n.

Δ^n = (2 moles of gaseous products - 3 moles of gaseous reactants) = - 1

Substitute the values into the equation and calculate K_c. $K_p=K_c(RT)\Delta^n$

$2.40 = K_c[(0.0821)(373)]^{-1}$

$K_c = 73.5$

Q.3 Describe the effect of the following (**L- I)**
(i) Addition OfH_2 (ii) Addition of CH_3OH (iii) Removal of CO in the following equilibrium reaction:
$2H_2$ (g) +CO (g) $\leftrightarrows CH_3OH$ (l)
Ans. (i) equilibrium will shift in forward direction
(ii) Equilibrium will shift in backward direction.
(iii) Equilibrium will shift in backward direction.

Q.4 which of the following reactions will get affected by increasing pressure? Mention whether the change will cause the reaction to go into forward or backward direction. (**L- I)**
(i)$COCl_2$ (g) $\leftrightarrows$CO (g) + Cl_2(g)
(ii)CO_2 (g) +C(s) $\leftrightarrows$2CO (g)
(iii) $2H_2$ (g) +CO (g) $\leftrightarrows CH_3OH$ (l)
Ans.(i) np >nr Direction will be backward.
(ii) np >nr Direction will be backward.
(iii) np <nr Direction will be Forward

Q.5 what is the effect of adding an inert gas a) at constant volume b) at constant pressure on the following equation: (**L- I)**
PCl5 (g) $\leftrightarrows$PCl3(g) +Cl2(g)
Ans a) At constant vol. the total pressure would increase due to inert gas addition but the conc. of the reactants and products will do not change hence no effect on equilibrium
b) At const. pressure the vol. of the system would increase. This results in decrease in no. of the moles of reactants per unit vol. Hence, reaction will shift in forward direction.

UNDERSTANDING

One Mark Questions

Q.1 Which measurable property become constant in Water $\leftrightarrows$ Water vapors equilibrium at constant temperature (**L- II)**
Ans. Vapour pressure.

Q.2 What is the value of Δ^n for the given reaction(**L- II)**
2NOCl (g) $\leftrightarrows$2NO (g) + Cl_2 (g)
Ans . $\Delta^n = n_p - n_r = 1$

Q.3 if the equilibrium constant for the reaction is 4.0, what will be the equilibrium constant for the reverse reaction. (**L- II)**
Ans. Kc=1/4

Q.4 What happens to the dissociation of PCl_5 in a closed vessel if He gas is introduced into it at the same temperature? (**L- II)**
Ans. No effect.

Q.5 What are the conditions for getting maximum yield of NH3 by Haber's process? (**L- II)**
Ans. High conc. Of N_2 &H_2, Low Temp. & High Pressure.

Two Marks Question

Q.1Write the significance of equilibrium constant? **(L- II)**

Ans.The numerical value of equilibrium constant is a measure of the extent to which the reactants have been converted into products. A large value of K indicates large amount of reactants converted into products while its low value indicates less amount of reactants converted into products before achieving the equilibrium state.

Q.2 Applying Le- Chatelier's principle, predict the effect of temperature and pressure on evaporation of water. **(L- II)**

Ans Evaporation of water can be represented as water + heat $\leftrightarrows$ water vapours:

i) With increase in pressure- the equilibrium tend to shift in direction where there is decrease in the vol. i.e. towards left.

ii) with increase in temperature- the equilibrium shifts to right as it is an endothermic reaction.

Q3 Explain why the gas fizzes out when soda water bottle is opened? **(L- II)**

Ans. In soda water bottle carbon dioxide gas is dissolved under pressure. As soon as the bottle is opened, the pressure inside the bottle tends to decrease, so the solubility decreases and gas escapes out.

Q.4What will be the effect on equilibrium if

(i) a catalyst is added to it

(ii) An inert gas is added at constant volume **(L- II)**

Ans. (i) The state of equilibrium is not disturbed on adding catalyst rather it is attained quickly.

(ii) No effect on state of equilibrium

Q.5 Kp for the reaction $N_2(g)+3H_{2(}g) \leftrightarrow 2NH_3$ is 49 at certain temperature. Calculate the value of Kp at the same temperature for the following reaction:

$NH_3 \leftrightarrows 1/2N2\ (g) +3/2\ H2\ (g)$ **(L- II)**

Ans: Given: $N2(g)+3H2(g) \leftrightarrows 2NH3(g)$ Kp= 49

$2NH3(g) \leftrightarrows N2(g)+3H2(g)$ Kp=1/49

$NH3 \leftrightarrows 1/2N2\ (g) +3/2\ H2\ (g)$ Kp= $\sqrt{1/49}$= 1/7

Three Marks Question

Q.1 Match the following: **(L- II)**

Column1	Column II
(A)Reaction is reversed	(p) $\sqrt{K}$
(B)Reaction is divided by 2	(q) K^2
(C)Reaction is multiplied by2	(r) 1/K

Ans .A-r B-p C-q

Q.2 The value of Kc for the reaction $2A \leftrightarrows B+C$ is 2.0×10^{-3} At a given time the composition of reaction mixture is $[A]=[B]=[C]=3\times10^{-4}$M in which direction the reaction will proceed? **(L- II)**

Ans. $Qc=[B][C]/[A]^2 = (3X10\text{-}4)\ (3X10\text{-}4)/(3X10\text{-}4)^2=1$

$Q_c > K_c$. the reaction will proceed in backward direction.

Q.3 For a hypothetical reaction: **(L- II)**

$A+B \leftrightarrows C+D;\ \Delta$ =-X KJ What will be the effect of:

(i) Decrease of temperature
(ii) Decrease in conc. Of C
(iii) Decrease in conc. of A

Ans (i) Forward
(ii) Forward
(iii)Backward

Q.4 For a reaction X ⇆Y the value of Kc is 1.8 $X10^{-7}$ at 298 K. Calculate the standard free energy change for the reaction. (**L- II)**

Ans ΔG^0=-RT ln Kc =-2.303RTlog K_c

-2.303X 8.314 X 298 Xlog(1.8 $X10^{-7}$) =38484.4 J/mol

Q.5 Give reasons for these: (**L- II)**

(i) Clothes dry quicker when there is breeze.

(ii) on humid day we sweat more.

Ans (i) Because the water vapours of nearby air are removed & the clothes loses water vapours to re-establish the equilibrium.

(ii) Because surrounding air has large amount of water vapours& our body can not lose water as water vapours.

APPLICATION

One Mark Questions

Q.1The equilibrium constant of a reaction at 27^oc is1.6 and at 127^oc is 7.6 respectively. Is the reaction exothermic or endothermic? (**L- III)**

Ans. As the value of equilibrium constant increases with increase in temperature so, the reaction is endothermic in nature.

Q.2Why the Equilibrium constant is taken as dimensionless? (**L- III)**

Ans. Activities are used in place of molar Conc. These represent the concentration or pressure with respect to standard state.

Q3 The value of equilibrium constant is4.1X 10^{-48} for a reaction. What will be the extent of reaction? (**L- III)**

Ans It shows that backward reaction is favoured or the reaction proceeds to very small extent.

Q.4Why does Ice melts slowly at higher altitudes? (**L- III)**

Ans. Melting of ice is endothermic process. At altitude temp.& pressure are low

At Equilibrium: ICE- ⇆Water. Both factors favoured backward process.

Q.5 A------ Equilibrium is reached when the forward & backward reaction occur at the same rate. (**L- III)**

Ans. Dynamic

Two Marks Questions

Q.1 Write the effect of temperature on Equilibrium constant. (**L- III)**

Ans. The value of Equilibrium constant changes with the temperature. The increase in rate depends upon activation energy .As the activation energy are different for forward & backward direction .So temperature will increase the rate to different extent in forward & backward direction. As K= Kf/ Kb ,so the state of equilibrium will be altered.

Q.2 how can we predict the extent of the reaction from the value of equilibrium constant? **(L- III)**
Ans.If value of K is $>10^3$ the reaction go almost to completion: forward reaction is favored.
If Value of K is $<10^{-3}$: The reaction proceeds to very small extent. Backward reaction is favored.
If value of K is in between 10^{-3} to 10^3: it shows that concentration of reactants & products are comparable.

Q.3 What will be the value of K_c at 373 K for the following reaction: **(L- III)**

$$2\,NO(g) + Br_2(g) \leftrightarrows 2\,NOBr(g) \qquad K_p = 2.40 \text{ @ } 373\ K$$

Ans. Calculate the change in the number of moles of gases, $\Delta^{n.}$

Δ^n = (2 moles of gaseous products - 3 moles of gaseous reactants) = - 1

Substitute the values into the equation and calculate K_c

$K_p = K_c(RT)\Delta^n$

$2.40 = K_c[(0.0821)(373)]^{-1}$

$K_c = 73.5$

Q.4 . Calculate the value of K_c for the reaction: $2\,NO(g) + Br_2(g) \leftrightarrows 2\,NOBr(g)$ using the following information. **(L- III)**

$2\,NO(g) \leftrightarrows N_2(g) + O_2(g)$ $\qquad K_{c1} = 1 \times 10^{30}$

$N_2(g) + Br_2(g) + O_2(g) \leftrightarrows 2\,NOBr(g)$ $\qquad K_{c2} = 2 \times 10^{-27}$

The two equations can be added to yield the desired equation. The value of K_c for the reaction will be the product of the other two.

$$K'_c = K_{c1} \times K_{c2} = (1 \times 10^{30})(1 \times 10^{-27}) = 2 \times 10^3$$

Q.5 What is the value of the equilibrium constant for the reaction $2\,NO_2(g) \leftrightarrows N_2O_4(g)$ at 100^o C? **(L-III)**

$N_2O_4(g) \leftrightarrows 2\,NO_2(g)$ $\quad K_c = 0.212$ @ 100^oC?

The desired reaction is the reverse of the reaction for which the K_c is known. The equilibrium expression is the reciprocal of that given.

$$K'_c = 1/K_c = 1/0.212 = 4.72$$

Three Marks Questions

Q1 Calculate the value of the equilibrium constant, K_c , for the system shown, if 0.1908 moles of CO_2, 0.0908 moles of H_2, 0.0092 moles of CO, and 0.0092 moles of H_2O vapor were present in a 2.00 L reaction vessel were present at equilibrium. **(L- III)**

$$CO_2(g) + H_2(g) \leftrightarrows CO(g) + H_2O(g)$$

Ans:

$$K_c = \frac{[CO][H_2O]}{[CO_2][H_2]}$$

Since K_c is being determined, check to see if the given equilibrium amounts are expressed in moles per liter In this example they are not; conversion of each is requried.

$[CO_2]$ = 0.1908 mol CO_2/2.00 L = 0.0954 M

$[H_2]$ = 0.0454 M

[CO] = 0.0046 M

$[H_2O]$ = 0.0046 M

Substitute each concentration into the equilibrium expression and calculate the value of the equilibrium constant.

$$K_c = \frac{[0.0046][0.0046]}{[0.0954][0.0454]} = 0.0049 \text{ or } 4.9 \times 10^{-3}$$

Q.2 A flask is charged with 3.00 atm of dinitrogen tetroxide gas and 2.00 atm of nitrogen dioxide gas at 25°C and allowed to reach equilibrium. It was found that the pressure of the nitrogen dioxide decreased by 0.952 atm. Estimate the value of K_p for this system: **(L- III)**

$$N_2O_4(g) \leftrightarrows 2\ NO_2(g)$$

- Write the equilibrium expression to find K_p.

$$K_p = \frac{P^2_{(NO2)}}{P_{(N2O4)}}$$

- Check to see that the given amounts are measured in appropriate pressure units since K_p is to be . In this example they are (atmospheres).
- Create an ice chart and calculate the changes in pressure and equilibrium pressures for each species.

	N_2O_4	NO_2
Initial Pressure (atm)	**3.00**	**2.00**
Change in Pressure (atm)	**+ 0.476**	**- 0.952**
Equilibrium Pressure (atm)	**3.476**	**1.048**

- Substitute the equilibrium pressures into the expression for K_p and solve for K_p.

$$K_p = \frac{(1.048)^2}{(3.476)} = 0.3160$$

Q.3 Initially, a mixture of 0.100 M NO, 0.050 M H_2, 0.100 M H_2 O was allowed to reach equilibrium (initially there was no N_2). At equilibrium the concentration of NO was found to be 0.062 M. Determine the value of the equilibrium constant, K_c , for the reaction: **(L- III)**

$$2\ NO(g) + 2\ H_2(g) \leftrightarrows N_2(g) + 2\ H_2O(g)$$

- Write the expression of KC for the reaction.

$$K_c = \frac{[N_2][H_2O]^2}{[NO]^2[H_2]^2}$$

- Check to see if the amounts are expressed in moles per liter (molarity) since K_c is being . In this example they are.

- Create an ice chart that expresses the initial concentration, the change in concentration, and the equilibrium concentration for each species in the reaction. From the chart you can determine the changes in the concentrations of each species and the equilibrium concentrations. From the example, we start with the folowing information.

	NO	H_2	N_2	H_2O
Initial Concentration (M)	0.100	0.0500	0	0.100
Change in Concentration (M)	- 2 x	- 2 x	+ x	+ 2 x
Equilibrium Concentration (M)	0.062			

The change in concentration of the NO was (0.062 M - 0.100M) = - 0.038 M. Thus -2 x = - 0.038 and x = 0.019. Note: the negative sign indicates a decreasing concentration, not a negative concentration. The changes in the other species must agree with the stoichiometry dictated by the balance equation. The hydrogen will also change by - 0.038 M, while the nitrogen will increase by + 0.019 M and the water will increase by + 0.038 M. From these changes we can complete the chart to find the equilibrium concentrations for each species.

	NO	H_2	N_2	H_2O
Initial Concentration (M)	0.100	0.0500	0	0.100
Change in Concentration (M)	- 0.038	- 0.038	+ 0.019	+ 0.038
Equilibrium Concentration (M)	0.062	0.012	0.019	0.138

- Substitute the equilibrium concentrations into the equilibrium expression and solve for K_c.

$$K_c = \frac{[0.019][0.138]^2}{[0.062]^2[0.012]^2} = 650 \text{ or } 6.5 \times 10^2$$

Q.4 0.035 moles of SO_2, 0.500 moles of SO_2Cl_2, and 0.080 moles of Cl_2 are combined in an evacuated 5.00 L flask and heated to 100°C. What is Q before the reaction begins? Which direction will the reaction proceed in order to establish equilibrium? **(L- III)**

$$SO_2Cl_2(g) \leftrightarrows SO_2(g) + Cl_2(g) \qquad K_c = 0.078 \text{ at } 100^oC$$

- Write the expression to find the reaction quotient, Q.

$$Q_c = \frac{[SO_2][Cl_2]}{[SO_2Cl_2]}$$

- Since K_c is given, the amounts must be expressed as moles per liter. The amounts are in moles so a conversion is required.

  0.500 mole SO_2Cl_2/5.00 L = 0.100 M SO_2Cl_2

  0.035 mole SO_2/5.00 L = 0.070 M SO_2

  0.080 mole Cl_2/5.00 L = 0.016 M Cl_2

- Substitute the values in to the expression and solve for Q.

$$Q_c = \frac{(0.070)(0.016)}{(0.100)} = 0.011$$

- Compare the answer to the value for the equilibrium constant and predict the shift.

  0.078 (K) > 0.011 (Q)

Since K >Q, the reaction will proceed in the forward direction in order to increase the concentrations of both SO_2 and Cl_2 and decrease that of SO_2Cl_2 until Q = K.

Q.5 0.050 mol of H_2 and 0.050 mol of Br_2 are placed in an evacuated 5.0 L flask and heated to 700 K. What is the concentration of each species in the flask when equilibrium has been established? The equation for the reaction is as follows: **(L- III)**

$$H_2(g) + Br_2(g) \leftrightarrows 2\ HBr(g) \qquad K_c = 64 \text{ @ } 700\ K$$

- Write the expression for K_c for the reaction.

$$K_c = \frac{[HBr]^2}{[H_2][Br_2]} = 64$$

- Since K_c is used in this problem, check to see if the given quantities are in moles per liter In this example they are not. A conversion is required.

  $[H_2]$ = 0.050 mole H_2/5.0 L = 0.010 M

  $[Br_2]$ = 0.010 M

  [HBr] = 0 M

- The only direction that this reaction can proceed is forward due to the fact that initially there are only H_2 and Br_2 in the flask. The reverse reaction cannot begin to occur until some HBr is formed.

- Make an ice chart with "x" representing the change in the concentration of the H_2 (or Br_2) as the system moves towards equilibrium. All of the other changes are expressed in terms of x.

	H_2	Br_2	HBr
Initial Concentration (M)	0.010	0.010	0
Change in Concentration (M)	- x	- x	+ 2 x
Equilibrium Concentration (M)	0.010 - x	0.010 - x	0 + 2 x

- Substitute the expressions for the equilibrium concentrations into the equilibrium expression and solve for "x".

$$64 = \frac{(2x)^2}{(0.010 - x)(0.010 - x)} = \frac{(2x)^2}{(0.010 - x)^2}$$

x = 0.008 M

- Calculate the equilibrium concentration for each species from the initial concentrations and the changes.

$[H_2] = [Br_2] = 0.010 - x = 0.010 - 0.008 = 0.002$ M for each

[HBr] = 2x = 2(0.008) = 0.016 M

- Check your answer by substituting the equilibrium concentrations into the equilibrium expression and see if the result is the same as the equilibrium constant.

$$\frac{(0.016)^2}{(0.002)(0.002)} = 64$$

Concept: Ionisation Of Electrolytes & Hydrolysis of Salt

KNOWLEDGE

One Mark Questions

Q1.What type of substances are generally called 'electrolyte'? L1

Ans: Acid, bases and salts

Q2. What is the molarity of pure water? L1

Ans: 55.5M

Q3.How much is the percentage ionization of an electrolyte to classified is as 'weak electrolyte'? L2

Ans: <5%

Q4.What is the ionic product of water at 298K? L1

Ans: 1.0×10^{-14}

Q5.Two acids 'A' and 'B' with Pka value 6.3 and 5.1 , which one is the stronger acid? L3

Ans: Pka = -logKa, So hiher is the value Ka lower is its Pka greater is the acidic strength.

Two Marks Questions

Q1. What will the conjugate bases for the following Bronsted acids:

HF , H_2SO_4 HCO_3^- and NH_4^+ L2

Ans: F^- ,HSO_4^- ,CO_3^{2-} and NH_3

Q2. What is the PH of 0.01M NaOH solution? L2

Ans: POH = - log(OH^-)

= - log 10^{-2}

=-(-2)log 10 log10 =1

=2

As PH+POH = 14

So, PH=12

Q3. . What will the conjugate acids for the following Bronsted bases?

NH_2^- , NH_3 and $HCOO^-$ L3

Ans: NH_3 ,NH_4^+ and HCOOH

Q4. Calculate the PH of 0.05M H_2SO_4 solution.L1

Ans: $H_2SO_4 \rightleftharpoons 2H^+ + SO_4^{2-}$

$[H^+] = 2 \times [H_2SO_4]$

$= 2X0.05$

$=0.1= 10^{-1}$

$PH = - \log(H^+)$

$= -\log (10^{-1})$

$=-(-1)\log 10$

$=1$

Q5.Calculate the PH of the resultant mixture: 10 Ml of 0.1M H_2SO_4 + 10 Ml 0.1M KOH L3

Ans: Number of moles of H+ ion = 2 x number of moles of H2SO4

$=2 \times M(V/1000)$

$= 2 \times 0.1x10/1000 = 2x\ 10^{-3}$

Number of moles of OH^- ion = number of moles of NaOH

$= M(V/1000)$

$= 0.1x10/1000 =1 \times 10^{-3}$

Number of moles of H^+ ion after neutralization=$2 \times 10^{-3} - 1x\ 10^{-3}$

$= 1x\ 10^{-3}$

Molarity of H^+ ion= n x1000/V

$= 1x\ 10^{-3}$ x1000/20

$=0.05$

$PH = - \log(H^+)$

$= -\log (0.05)$

$= 1.301$

Three Marks Questions

Q1. PH of a solution is 5.0 .What will be the PH of solution after diluting the solution a 100 times? L3

Ans: PH= 5

$- \log(H^+) = 5$

$\log(H^+)= -5$

$[H^+]=10^{-5}$

New $[H^+]=10^{-5}/100$

$[H^+] = 10^{-7}$

Total $[H^+] = [H^+]_{water}+[H^+]_{acid}$

$[H^+]=10^{-7} +10^{-7} =2x10^{-7}$

$PH=- \log(2x10^{-7})$

$PH = 6.6989$

Q2.What will the PH of a solution formed by mixing equal volumes of two solutions A and B having PH=6 and PH=4 .L3

Ans: PH=6

$[H^+] = 10^{-6}M$

PH=2

$[H^+] = 10^{-2}M$

Resultant $[H^+]$

$M_1xV_1+M_2xV_2=M_3\ xV_3$

10^{-6} x1 +10^{-6}x1=M_3x2

M3=101x10^{-6}/2 = 50.5 x 10^{-6}

PH=- log(50.5x10^{-7})

=4.296

Q3. Calculate the PH of solution in which 0.37 g of $Ca(OH)_2$ dissolve into water to give 500ml of solution.L2

Ans: moality of $Ca(OH)_2$ = 0.37/74x1000/500

= 0.05M

PH = - log(H^+)

=- log(0.05)

=0.301

Q4. What will be the PH , when 200 ml of an aqueous solution of HCl (PH=2.0) is mixed with300 ml an aqueous solution of NaOH (PH= 12.0) L3

Ans: Hcl + NaOH → NaCl + H_2O

Before reaction	200x10^{-2}	300x10^{-2}	0	0
After reaction	0	100x10^{-2}	200x10^{-2}	200x10^{-2}

$[OH^-]$ = 100 x 10^{-2}/500 = 2x10^{-3}

POH=2.70

PH=11.30

UNDERSTANDING

One Mark Questions

Q1. What is the conjugate acid and conjugate base of HCO_3^- ion ? L1

Ans: Conjugate acid is H_2CO_3 a conjugate acid is CO_3^{2-}

Q2.Give one example of amphoteric substance. L2

Ans: HCO_3^- it can act as acid as well base

Q3. Which one of the following is not the Lewis acid:

BF_3 ,NH_3, PCl_5 and SO_2 L2

Ans: NH_3

Q4. Why is the PH of blood remains almost constant?L3

Ans: Blood is a buffer solution and resist the change in PH

Q5. Will the PH of water is same at 277K and 298K?L3

Ans: No ,As the temperature increases ,dissociation of water take place to greater extent H+ ion concentration PH decreases

Two Marks Questions

Q1. Derive the expression Ka = $[H^+][X^-]$ / [HX] for dissociation of a weak acid HX in water , which is undergo complete dissociation in the solution.L2

Ans: $HX \rightleftharpoons H^+ + X^-$

Initial conc	Cx1	0	0
	C-Cα	Cα	Cα

$Ka = [H^+][X^-] / [HX]$

$= C\alpha x\ C\alpha / C - C\alpha$

$= C^2\alpha^2 / C(1-\alpha)$

$Ka = C\alpha^2 / 1-\alpha$

Q2. How is the acidic , basic character of acids and bases varies with respect to neutral water . Show these variations on the PH scale.L2

Ans: The PH of neutral water is 7 ,As the PH of solution deceases from 7 the acid characteristic of the solution increase so the acids having values 1 and 2 are strong acids and when the PH of solution increases from 7 the basic characteristic of the solution increase so the acids having values 11and 12 are strong bases.

Q3. Explain with an example that strong acids have very weak conjugate bases and a strong base have a very weak conjugate acid.L2

Ans: $HCl + HOH \rightleftharpoons Cl^- + H_3O^+$

$CH_3COOH + HOH \rightleftharpoons CH_3COO^- + H_3O^+$

HCl is strong acid but chloride ion is a weak base similarly CH_3COOH is weak acid but CH_3COO- ion is a strong base, these example shows that every strong acid has a weak conjugate base and weak acid has a strong conjugate acid.

Q4. Explain with the help of an example, how an electrolyte undergo dissociation in water. what is the role play by water in formation of an aqueous solution of an electrolyte?L2

Ans: When strong electrolyte like NaCl is dissolve ion water, the negative part of the water molecule start attracting the Na^+ ion and positive part start attracting the Cl^- ion , as these interaction are stronger than lattice enthalpy of sodium chloride ,so sodium chloride get broken into ions in solution and formed aqueous solution of the electrolyte.

$NaCl \rightleftharpoons Na^+ + Cl^-$

Q5. Derive the expression Kb = $[M^+][OH^-]$ / [MOH] for dissociation of a weak base MOH in water , which is undergo complete dissociation in the solution.L2

: $MOH \rightleftharpoons M^+ + OH^-$

Initial conc	Cx1	0	0
	C-Cα	Cα	Cα

$Kb = [H^+][X^-] / [HX]$

$= C\alpha x\ C\alpha/C - C\alpha$

$=C^2\alpha^2/C(1-\alpha)$

$Kb=C\alpha^2/1-\alpha$

UNDERSTANDING

Three Marks Questions

Q1.What is the difference between conjugate acid and the conjugate base.L1

Ans : These differ from each other by proton.

Acid $\rightleftharpoons$ Conjugate base + proton

Base $\rightleftharpoons$ Conjugate acid+ proton

Q2. Explain why anhydrous HCl is a bad conductor electricity while aqueous HCl is a good conductor of electricity. L2

Ans: Hcl is a covalent compound and has no ion but when dissolve into solution it under go dissociation and produce ions in the solution and hence conduct electricity.

Q3.Derive the formula PH + POH =14 L2

Ans: $H^+ + OH^- = K_w$

$10^{-7} + 10^{-7} = 10^{-14}$

Taking log both side

$\log(H^+) + \log(OH^-) = \log(K_w)$

$\log(H^+) + \log(OH^-) = \log(10^{-14})$

Taking '-' sign both sides

$-\log(H^+) - \log(OH^-) = -\log(10^{-14})$

$PH+POH = -(-14)\log(10)$

$PH+POH = 14$

Q4. The ionization constant at 298K is 1.8×10^{-4}. Calculate the ionization constant of the corresponding conjugate base.

$Ka \times Kb = Kw$

$Kb = Kw/Ka$

$=1 \times 10^{-14}/1.8 \times 10^{-8}$

$=5.55 \times 10^{-7}$

Q5. Ionic product of water at 363K is 10^{-12}. What will be the PH? Will it be the acidic?

$[H^+] + [OH^-] = 10^{-12}$

$[H^+] = 10^{-12}/10^{-7} = 10^{-5}$

$PH = -\log(H^+)$

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

$PH=5$ Acid

APPLICATION

One Mark Questions

Q1.Out of following pair , point out the stronger Lewis acid and assign the reason:

(a) BF_3 and BH_3 (b) Sn^{+2} and Sn^{+4} L2

Ans: (a) BF3 due to greater electronegativity of fluorine it withdraws more electrons from central 'B' atom (b) Sn^{+4} Greater is the charge on the ion greater is its Lewis acidic strength

Q2.What happens to the ionic product of the water when some amount of acid is added into the water? L2

Ans: It will remain constant

Q3. What is the structure of H_3O^+ ion? L2

Ans: Three are three O-H bond pairs and one lone pair on oxygen atom in H_3O^+ ion so the ion has pyramidal shape.

Q4. Ionization of HCl is given below:

$HCl + HOH \rightleftharpoons Cl^- + H_3O^+$

label the two conjugate acid- base pairs in the ionization. L2

Ans : Cl^- ion Conjugate base H_3O^+ ion Conjugate base,

Q5. The PH of a sample of vinegar is 4. Calculate the concentration of hydrogen ion in it. L2

Ans: It is 10^{-4}

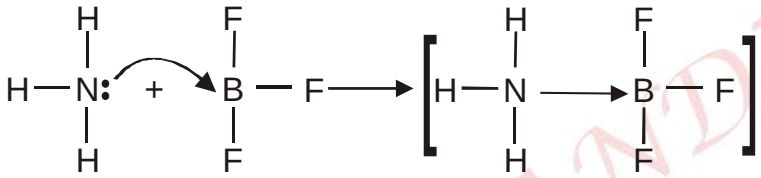
2 **Marks Question**

Q1.classify the following as strong acids, strong bases and weak acids, weak bases:

Solution:	P	Q	R	S	T	U	
PH :	7.8	0.1	5.2	14.0	0.0	12.1	L2

Ans: P= weak base , Q=Strong acid, R=weak acid S= strong base , T= Strong acid , U=strong base

Q2. A reaction between ammonia and boron tri fluoride is given by:



Identify the acid and base in this reaction. Which theory explain it?

Ans: Ammonia donate the lone pair of electron so it is a Lewis base and boron trifluoride accept the lone pair of electron so it is a Lewis acid .This is Lewis acid base concept.

Q3.Indicate whether the following compounds are Arrhenius , Bronsted or Lews acids and bases:

$NH_3(g)$, HCl (aq) , $CH_3COOH(aq)$, $CO_2(g)$, BF_3 ,Ag^+ and HCO_3^{-1} L3

Ans: $NH_3(g)$ = Lewis base, $CH_3COOH(aq)$= Arrhenius acid , $CO_2(g)$, BF_3 ,Ag^+ = Lewis acid and HCO_3^{-1} is a Bronsted acid

Q4. What is the difference between dissociation and ionization? L2

Ans: The term ionization is used for the compounds which are covalent and when dissolve in the solution undergo dissociation where as for the ionic compounds which are in ionic form in the compound when dissolve into the solution undergo dissociation.

Q5. A solution is found to contain 0.63 g of nitric acid per 100ml of solution. What is the PH of solution if acid is completely dissociated? L3

$M=n/V$

$=w_2/M_2 \times V$

$= 0.63x1000/63$ mol-1L-1

$=0.01$ molL^{-1}

$[H^+] = [HNO_3] = 10^{-2}$

$PH = - \log(H^+)$

$= - \log(10^{-2})$

$= -(-2)\log 10$

$PH = 2$

Three Marks Questions

Q1. 2 g of NaOH has been dissolved into 500 ml of solution.

Find: (a) Molarity of the solution

(b) OH- ion concentration

(c) PH of the solutionL2

Ans (a) M = Wx1000/MxV

= 2x1000/40x500

$[OH^-]$=0.1M

(b) $[H^+]] = 10^{-13}$

(c) PH= 13

Q2. The PH of 0.1M monobasic acid is 4.50. Calculate concentration of species H^+ ion A^- and HA at equilibrium. Also determine the value of Ka and Pka of the monobasic acid.L2

Ans: pH = – log [H+]

Therefore, [H+] = 10

$-pH = 10^{-4.50}$

$= 3.16 \times 10–5$

[H+] = [A–] = 3.16 × 10–5

Thus, *K*a = [H+][A-] / [HA]

[HA]eqlbm = 0.1 – (3.16×10^{-5}) Ä 0.1

*K*a = $(3.16 \times 10^{-5})^2 / 0.1 = 1.0 \times 10^{-8}$

p*K*a = – log(10^{-8}) = 8

Q3. Calculate the PH of 1 x 10^{-8}M solution of HCl.

Ans: Total $[H^+]$= $[H^+]$acid + $[H^+]$water

= $1x10^{-7} + 1x10^{-8}$

=[1+0.1] $x10^{-7}$

PH = $-\log(1.1 X10^{-7})$

= -[0.0414-7.0] =

pH=6.9586

Q4. Four species: H_2O HCO_3^{-1} HSO_4^{-1} and NH_3 can act as both Bronsted acids and bases. For each case give the corresponding conjugate acid and conjugate base. L2

Ans:H_2O =Conjugate acid -H_3O^+ ; Conjugate base -OH^-

HCO_3^{-1} =Conjugate acid –H_2O^+ ; Conjugate base -OH^-

Q5 Calculate the pH of 0.08M solution of hypochlorous acid, HOCl. The ionization constant of the acid is 2.5 × 10^{-5}. Determine the percent dissociation of HOCl.

Ans: HOCl(aq) + H2O (l) $\rightleftharpoons$ H3O+(aq) + ClO–(aq)

Initial conc. (M) 0.08 0 0

Change to conc – x + x +x

equilibrium conc. 0.08 – x x x

*K*a = {[H3O+][ClO–] / [HOCl]}

= x2 / (0.08 –x)

As x << 0.08, therefore 0.08 – x Ä 0.08

x2 / 0.08 = 2.5 × 10^{-5}

x2 = $2.0 \times 10^{-6,}$ thus, x = 1.41×10^{-3}
[H+] = 1.41×10^{-3} M
Percent dissociation= {[HOCl]dissociated / [HOCl]undissociated }× 100
= 1.41 × 10–3 / 0.08 = 1.76 %.
pH = –log(1.41 × 10–3) = 2.85.

Concept: Common Ion Effect & Solubility Product

KNOWLEDGE

One Mark Questions

Q 1. What happens HCl gas passed through saturated NaCl solution? (L-I)
Ans. NaCl will be precipitated out.

Q2. What is the function of adding NH_4 OH in group file? (L-II)
Ans. It convert ammonium bicarbonate into ammonium carbonate.

Q3. Define solubility product? (L-III)
Ans. It is defined as the product of the concentrations of the ions of the salt in its saturated solution at a given temperature raised to the power the number of ions produced by the dissociation of one mole of the salt.

Two marks Questions

Q1. How does solubility product differ from ionic product? (L-I)
Ans. Solubility product:- the product of the concentrations of the ions of the salt in its saturated solution at a given temperature raised to the power the number of ions produced by the dissociation of one mole of the salt.
Ionic product :- It is the product of concentration of the ions of the electrolyte, each raised to the power of their coefficients in the balanced chemical equation in solution at any concentration.

Q2. NaCl solution is added to a saturated solution of $PbCl_2$. What will happen to the concentration of Pb^{2+} ions ? (L-II)
Ans. Pb^{2+} ion concentration will decrease to keep K_{sp} constant>**Q3 what** happens when solutions of $BaCl_{2\ and}$ Na_2SO_4 are mixed? (L-III)
Ans. A precipitate is formed when in the final solution after mixing, the ionic product (Ba^{2+}) ($SO^{2-}_{4)}$ >K_{sp} for $BaSO_4$.

Three marks questions

Q1. What is common ion effect and how it can be used to purifies impure sodium chloride? (L-I)
Ans: to an ionic equilibrium, AB---→ A+ +B+,a salt containing a common ion (AC or BD is added, the equilibrium shifts in the backward direction. This is called common ion effect. On passing hydrogen chloride gas through a saturated solution o sodium chloride, the concentration of chloride ions will be increased. This increases the ionic product of NaCl and the solid salt will be precipitated.

Q2. The solubility of AgCl in water at 25^0C is found to be $1.06*10^{-5}$ moles per litre. Calculate the solubility product of AgCl at this temperature. (L-II)
Ans: AgCl ionizes completely in the solution as AgCl--→Ag+ $+Cl^-$
One mole of AgCl in the solution gives 1 mole of Ag+ ions and 1 mole of Cl^-ions.

Now as the solubility of AgCl= $1.06*10^{-5}$ moles per litre.
Therefore [Ag+]=$1.06*10^{-5}$ moles per litre and [Cl^{-}] = $1.06*10^{-5}$ moles per litre.
Ksp for AgCl=[Ag+] [Cl^{-}]=$1.06*10^{-5}$ *$1.06*10^{-5}$=$1.1*10^{-10}$

Q3. What is the maximum concentration of equimolar solution of ferrous sulphate and sodium sulphide so that when mixed in equal volums, there is no precipitation of iron sulphide? For iron sulphide Ksp=$6.3*10^{-18}$ (L-III)
Ans: suppose the concentration of each of FeSO4 and Na2S is s mol L-1. Then mixing equal volums, [FeSO4]=[Na2S]=x/2 M, i.e. [Fe2+]= [S2-]=x/2 M
Ksp for FeS= [Fe2+][S2-],i,e. $6.3*10^{-18}$= x/2*x/2 or x2=$25.2*10^{-18}$

, or x= $5.02*10^{-9}$ m.

UNDERSTANDING

One Mark Questions

Q1. Give an example of sparingly soluble salt? (L-I)
Ans. AgCl

Q2. Under what conditions precipitation takes place in ionic reactions? (L-II)
Ans. When ionic product is greater than solubility product.

Q3. Calculate the solubility of silver chloride in the water at room temperature if the solubility product of AgCl is $1.6*10^{-10.}$ (L-III)
Ans. Ksp=S^2
$1.6*10^{-10.}$= S^2
S= $1.26*10^{-5}$

Two Marks Questions

Q1. Will AgCl be more soluble in water or in NaCl solution and Why? (L-I)
Ans. In NaCl solution (Cl^-) will increase.As (Ag^+) (Cl^-) = K_{sp} remains constant, (Ag^+) Will decrease ,i,e, the solubility will be less in the NaCl solution than in water.

Q2. Why solid NaCl starts separating out from a saturated solution of NaCl if HCl gas is passed through it? (L-II)
Ans. HCl in the solution provides Cl^- ions. This increases the ionic product in NaCl and so the solid NaCl starts separating out.

Q3**.** What common salt is added to precipitate out soap from the solution during its manufacture? (L-III)
Ans. Soap is sodium salt of higher fatty acids (RCOONa). On adding common salt, Na^+ion concentration increased. Hence, the equilibrium RCOONa (s) ----- $RCOO^-$ + Na^+ shifts in the backward dirction, i,e, soap precipitates out.

Three marks questions

Q1**.** Discuss the Application of Solubility Product and common ion Effect?(L-I)
Ans. (1) Calculation of solubility of sparingly soluble salts.
(2) Predicting ionic or precipitation reaction.

(3)In explaining salting out or precipitation of soluble salts.
(4) In qualitative analysis.
(5) In fractional precipitation.

Q2.Calculate the molar solubility of Ni(OH)2 in 0.10 M NaOH. The product of Ni (OH)2 is $2.0*10^{-15}$?(L-II)
Ans: Suppose the solubility of Ni (OH)2 in 0.10 M NaOH= s mol L-1
Ni(OH)2 in the solution dissociates as : Ni (OH)2 ---→ $Ni2^{+}$ + 2 OH^{-}
Thus , s mol L-1 of Ni(OH)2 in the solution gives s mol L-1 of Ni^{+2} ion and 2 s mol L-1 of OH-1 ions. But OH-1 ions are also produced from NaOH dissociates completely, OH- from NaOH=0.1 M.
Hence,[Ni^{2+}]= s mol L-1 and [OH-]=2 s +0.1 mol L-1 =0.1 mol L-1
Ksp= if Ni(OH)2= $[Ni^{2+}][OH-]^2$
Therefore $s(0.1)2= 2.0*10^{-15}$ or $s= 2.0*10^{-13}$ mol L^{-1}

Q3. The solubility product for silver chloride is $1.2*10^{-10}$ at 298 k. Calculate the solubility of solver chloride at 298K. (L-III)
Ans: Silver chloride dissociates according to the equation:
AgCl (s)-----→AgCl(aq)------→ Ag+(aq)+ Cl- (aq)
Let s be the solubility of AgCl in moles per litre.
Consequently, the molar concentration of Ag+ and Cl- will also be s each. Substituting in the expression for solubility product of AgCl,
Ksp=[Ag+][Cl-]=s*s =s^2
Ksp= $1.2*10^{-10}$(given) therefore $s^2= 1.2*10^{-10}$
S= $(1.2*10^{-19})$ ½= $1.1*10^{-5}$ mol L^{--1}

APPLICATION

One mark Questions

Q1. What would be the expression for solubility product of calcium phosphate in terms of its molar solubility, S. (L-I)
Ans. $K_{sp} = (3 S)^2 (2 S)^3= 72 S^5$

Q2:-Write the expression for Ksp for AB type salt With solubility s
Ans:- Ksp:-S^2

Q3:-Write the expression for Ksp for AB_3type salt With solubility s
Ans:- Ksp:-$27S^4$

Two Marks Questions

Q1. Through a solution containing $Cu^{2+}$and Ni^{2+},H_2S gas is passed after adding dill HCl, which will precipitate out and why?
Ans. Cu^{2+} will precipitate out because in acidic medium, only ionic product $[Cu^{2=}][S^{2-}]$ exceeds the solubility product of CuS.

Q2. Why is Group V of qualitative analysis, sufficient NH_4 OH solution be added before adding $(NH_4)_2$ CO_3 solution?

Ans. This is done to convert NH_4HCO_3 usually present in large amounts along with $(NH_4)_2CO_3$ to $(NH_4)_2Co_3NH_4HCO_3 + NH_4OH$_------> $(NH_4)CO_3H_2O$

Q3. This sparingly soluble salts AB and XY_2 have the same solubility product. Which salt will be more soluble? Explain.

Ans. Suppose solubility of AB =a mol L^{-1}. Then AB ------→ $A^+ + B^-$, $K_{sp} = [A^+][B^{--}] = a*a = a^2$

Therefore a= under root K_{sp}

Suppose solubility of salt XY_2 = b mol L^{-1}. Then

XY_2---→ X^{2+} 2 Y^- ,$K_{sp} = [X^{2+}][Y^-]^2 = b(2b)^2$ i,e., $4b^3 = K_{sp}$ or $b = (K_{sp}/4)^{1/3}$

Obviously b>a (as K_{sp} have values with negative powers of 10). Hense, salt XY_2 is more soluble.

Three Marks Questions

Q1.Give reason for the following: (L-III)

(1) Zinc is not precipitated as Zn (OH)2 on adding NH4 OH to a zinc salt solution containing NH4Cl.

(2) Baso4 precipitate is washed with water containing a small amount of H2 SO4 in gravimetric analysis.

(3) Co2 is more soluble in aqueous NaOH solution than in water.

Ans(1) NH4CL suppresses the ionization of NH4OH due to common ion effect. Hence, concentration of OH- decreases such that the ionic product [Zn2+] [OH-]2 does not exceed solubility product. Hence, $Zn()H)_2$ is not precipitated.

(2) $BaSO_4$ dissociates as : $BaSO_4(s) \xrightarrow{aq} Ba^{2+}(aq) + SO^2{}_4^-(aq)$. Addition of H_2SO_4 gives common $SO^2{}_4^-$ ions dissociation of Ba SO_4 and thus helps in the complete precipitation.

(3) In water, CO_2 dissolves to form carbonic acid(H_2CO_3):

$CO_2(g) + H_2O(l)$----→ $H_2CO_3(aq)$

As the reaction is reversible, the solubility is low.

In aqueous NaOH, H_2CO_3 reacts with sodium hydroxide as follows:

2 NaOH(aq)+ H_2CO_3---→ $Na_2CO_3(aq) + H_2O(l)$

As a result, the equilibrium involving dissolution of CO_2 in H_2O shifts forward, i.e. solubility increases.

Q2. The solubliyt of $Pb(OH)_2$ in water is $6.7*10^{-6}$ M. Calculate the following of $Pb(OH)_2$ in a buffer solution of pH=8 (L-II)

Ans: $Pb(OH)_2$------→ $Pb^{2+} + 2\ OH^-$

$K_{sp} = [Pb^{2+}][OH^-]^2 = s*(2s)^2 = 4s^3 = 4*(6.7*10^{-6})^3 = 1.20*10^{-15}$

In a solution with pH= 8,$[H^+] = 10^{--8}$ and $[OH]^{--} = 10^{-6}$

$1.2*10^{-15} = [Pb^{2+}]*(10^{-6})^2$ or $= 1.2*10^{-15}/(10^{--6})^2 = 1.2*10^{-3}$ M

Q3. Equal volumes of 0.002 M solution of sodium iodade and copper chlorate are mixed together. Will it lead to precipitation of copper iodate? For copper iodate, $K_{sp} = 7.4 * 10^{-8.}$(L-I)

Ans. 2 $NaIO_3$ + Cu CrO_4-----→ Na_2CrO_4 + Cu $(IO_3)_2$

After mixing, $[NaIO_3] = [IO_3^-] = 2*10^-3/2 = 10^{-3}$ M

$[CuCrO_4] = [Cu^{2+}] = 2*10^-3/2 = 10^{-3}$ M

Ionic product of $Cu(IO_3)_2 = [Cu^{2+}][IO_3^{--}]^2 = (10^{-3})(10^{-3})^2 = 10^{-9}$

UNIT 8- REDOX REACTIONS

Concept- Types Of Chemical Reactions & Oxidation Number

KNOWLEDGE

ONE MARK QUESTIONS

Q1. Define oxidation number (O.N). (L1)

Ans. Oxidation number denotes the oxidation state of an element in a compound ascertained according to a set of rules formulated on the basis that electron pair in a covalent bond belongs entirely to more electronegative element.

Q2. What is the oxidation number of an atom in the elemental state? (L2)

Ans.zero

Q3. What are the minimum and maximum Oxidation Number of Cl in its compounds?(L3)

Ans. Minimum -0, maximum- +7.

Q4. Give an example of photodecomposition reaction?(L3)

Ans.Decomposition of silver bromide in the presence of light.

Q5. What is the oxidation number of Cr in $Cr_2O_7^{2-}$?(L2)

Ans. +6.

TWO MARKS QUESTIONS

Q1. The compound AgF_2 is unstable. However, if formed, the compound acts as a very strong oxidizing agent. Why? (L3)

Ans. The +2 oxidation state of Ag is unstable in nature, so the compound (Ag^{2+}) tend to gain an electron to possess the +1 oxidation state of silver.

Q2. Suggest a scheme of classification of the following redox reactions. (L2)

(a) $N_2(g) + O_2(g) \longrightarrow 2\,NO(g)$

(b) $2Pb(NO_3)_2(s) \longrightarrow 2PbO(s) + 2\,NO_2(g) + \frac{1}{2}\,O_2(g)$

Ans. (a), the compound nitric oxide is formed by the combination of the elemental substances , nitrogen and oxygen; therefore, this is an example of combination redox reactions .

(b)The reaction involves the breaking down of lead nitrate into three components;

Therefore, this is categorized under decomposition redox reaction

Q3. Justify the fractional oxidation number in C_3O_2? (L3)

Ans. +2 0 +2

O = C = C*= C = O

The oxidation number of C in C_3O_2 is fractional as it is average of oxidation number of all C atoms in the molecule. Therefore fractional O.N. of C is 4/3=1.3

THREE MARKS QUESTIONS

Q1. Describe how are alkali and alkaline earth metals good reductants? (L2)

Ans. All alkali metals and some alkaline earth metals (Ca, Sr, and Ba) which are very good reductants, will displace hydrogen from cold water.

0 +1 –2 +1 –2 +1 0

$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

0 +1 –2 +2 -1 0

$Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

Q2. Why do the following reactions proceed differently? (L3)

$Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + 4H_2O$ and

$Pb_3O_4 + 4HNO_3 \longrightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

Ans. Pb_3O_4 is actually a stoichiometric mixture of 2 mol of PbO and 1 mol of PbO_2. In PbO_2, lead is present in +4 oxidation state , whereas the stable oxidation state of lead in PbO is +2. PbO_2thus can act as an oxidant (oxidizing agent) and, therefore, can oxidiseCl^- ion ofHCl into chlorine ,.AsPbO is a basic oxide. So, the reaction

$Pb_3O_4 + 8HCl \longrightarrow 3PbCl_2 + Cl_2 + 4H_2O$

can be splitted into two reactions namely:

$2PbO + 4HCl \longrightarrow 2PbCl_2 + 2H_2O$

$PbO2 + 4HCl \longrightarrow PbCl2 + Cl2 + 2H2O$

Since HNO_3 itself is an oxidizing agent therefore, it is unlikely that the reaction mayoccur between PbO_2 and HNO_3. However, the acid-base reaction occurs between PbO and HNO_3as:

$2PbO + 4HNO_3 \longrightarrow 2Pb(NO_3)_2 + 2H2O$

It is the passive nature of PbO_2 against HNO_3 that makes the reaction different from the one that follows with HCl.

Q3. Assign oxidation number to the underlined elements in each of the following(L1)

Species: (a) $NaH_2\underline{P}O_4$ (b) $NaH\underline{S}O_4$ (c) $H_4\underline{P}_2O_7$ (d) $K_2\underline{Mn}O_4$ (e) $\underline{Ca}O$ (f) $Na\underline{B}H_4$

Ans. (a) NaH_2PO_4= +5 (b) 6 (c) 5 (d) 6 (e) 2 (f) 3

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Fluorine reacts with ice and results in the change. (L2)

$H_2O(s) + F_2(g) \longrightarrow HF(g) + HOF(g)$

Justify that this reaction is a redox reaction

Ans. The oxidation number of F isbeing changed from 0 to -1 &+ 1. So it is a redox reaction.

Q2.MnO_4^{2-} undergoes disproportionation reaction butMnO_4^- does not. Explain. (L3)

Ans. MnO_4^- possessMn in highest oxidation state (+7) But in MnO_4^{2-} ,Mn shows +6 oxidation state Hence MnO_4^{2-} undergoes disproportionation reaction but MnO_4^- does not.

Q3. Show that F cannot undergo Disproportionation reaction? (L2)

Ans. F is most electronegative element and cannot possess three oxidation states. Hence it cannot undergo disproportionation reactions.

Q4.Indicate how the color of KI solution containing starch turns blue when it is shaken with cold Cl_2 water.Explain why?(L2)

Ans.I^- reacts with Cl_2 to form I_2 which form blue colouredcomplex with starch.

Q5.Out of dil. HNO3 &dilHCl ,in which Cu gets dissolve?(L3)

Ans.Cu gets dissolved indil HNO_3 due to oxidation of Cu by NO_3^-ions.

TWO MARKS QUESTIONS

Q1.Explain the fallacy of oxidation state in Fe_3O_4? (L2)

Ans. As per rule, the oxidation state of Fe comes out to be 8/3 Which is not possible. So,here the oxidation state of Fe is +2 & +3since it is mixed oxide of FeO and Fe_2O_3

Q2. Justify that the reaction:

$2Cu_2O(s) + Cu_2S(s)$ ---------→ $6Cu(s) + SO_2(g)$

is a redox reaction. Identify the species oxidised/ reduced, oxidant and /reductant.(L1)

Ans. Cu_2O helps sulphur in Cu_2S to increase its oxidation number, therefore, Cu(I) is an oxidant; and sulphur of Cu_2S helps copper both in Cu_2S itself and $Cu_2O$to decrease its oxidation number; therefore, sulphur of Cu_2S is reductant

THREE MARKS QUESTIONS

Q1.Which of the following species, do not show disproportionation reaction and why ?(L2)

ClO^-, ClO_2^-, $ClO_3^-$and ClO_4^-.Also write reaction for each of the species that disproportionates.

Ans. Among the Oxoanions of chlorine listed above, ClO_4^- does not dis proportionate because in this Oxo anion chlorine is present in its highest oxidation state that is, +7.

The disproportionation reactions for the other three Oxo anions of chlorine

are as follows:

$3ClO^- 2Cl^-$ ---------→ClO^-_3

$6\ ClO2^-$----------→ $4ClO3^- + 2Cl^-$

$4ClO^-_3$ ---------→$Cl^- + 3\ ClO_4^-$

Q2.Indicate three differences between valence and oxidation number?(L1)

Ans (i) Valency of an element cannot not be zero but oxidation number can be.

(ii) Valency is just a number but oxidation number can be negative or positive.

(iii) Valency is the combining capacity whereas oxidation number refers to charge which an atom carry when present in the combined state.

Q3. Justify the oxidation number of Cl in bleaching powder?(L2)

Ans By stoichiometry the composition of bleaching powder is $Ca^{2+}(OCl^-)Cl^-$. Here O.N. of Cl in OCl^- is +1 while that in Cl^- is -1 .So that the average of O.N. is zero.

APPLICATION

ONE MARK QUESTIONS

Q1.Predict,what would happen if $CuSO_4$ is stored in a zinc vessel?(L2)

Ans.No, as $CuSO_4$ reacts with Zn.

Q2.Identify the result of chemical reaction between permanganate ion and Br^-? (L2)

Ans. MnO_2 and BrO_3^- are formed.

Q3. Explain the fallacy in O.N. of KI_3? (L1)

Ans. Three I atoms are present in 0,0& -1 oxidation state.

Q4. Explain the disproportionation nature of decomposition of Hydrogen peroxide?(L2)
Ans. Decomposition of hydrogen peroxide produces water and oxygen. O.N Increases as well as decreases.

Q5.How is decomposition reactions are the opposite of combination reactions?(L1)
Ans Combination reactions involve the combination of more than one substance where as decomposition reactions involve the breakdown of substance.

TWO MARKS QUESTIONS

Q1.Explain the oxidation number of lead in Pb_3O_4. (L2)
Ans. Pb_3O_4 is considered to be mixture of $2PbO.PbO_2$O.N.ofPb in PbO is +2 while in PbO_2 is +4 so that the average O.N.is 8/3.

Q2.Tell what would happen if phosphorous undergoes disproportionation in basic medium? (L2)
Ans. $P_4(s) + 3OH^-(aq)$ ----------→$3H_2O(l)$ $PH_3(g) + 3H_2PO_2^-$.

Q3.Tell how can household bleaching agent be formed? (L3)
Ans. $Cl_2(g) + 2\ OH^-(aq)$ ---------→$ClO^-(aq) + Cl^-(aq) + H_2O(l)$
So, Household bleaching agent can be formed by dissolving chlorine in the base.

THREE MARKS QUESTIONS

Q1.Give the chemical reaction used CS_2 layer test? (L3)
Ans. $Cl_2(g) + 2Br^-(aq$ ----------→$)2Cl^-(aq) + Br_2(l)$
$Cl_2(g) + 2I^-(aq)$ --------→ $2Cl^-(aq) + I_2(s)$
These reactions form the basis of Layer test.

Q2.Can the reaction $Cr_2O_7^{2-} + H_2O\ 2CrO_4^{2-} + 2H^+$ beregarded as a redox reaction?(L2)
Ans. O.N of Cr in $Cr_2O_7^{2-}$ = +6
O.N of Cr in $Cr_2O_7^{2-}$ = +6
Since the oxidation number of Cr has neither decrease nor increased, the above reaction is not a redox reaction.

Q3.Whenever a reaction b/w an oxidizing reagent and a reducing agent is carried out , a compound of lower oxidation state is formed if the reducing agent is in excess and a compound of higher oxidation state is formed if the oxidizing agent is in excess . Justify this statement giving three illustrations. (L3)
Ans. (i) $2C(s) + O_2$ ----------→ $2CO$
$C(s) + O_2$----------→ CO_2
(ii) $P_4 + 6Cl_2$ ----------→ $4PCl_3$
$P_4 + 10Cl_2$ ----------→ $4PCl_5$
(iii) $4Na(s) + O_2(g)$ ⟶ Na_2O
$2Na(s) + 2O_2(g)$ ⟶ Na_2O_2

Concept: Balancing Of Redox Reactions &Appliciations

KNOWLEDGE

ONE MARK QUESTIONS

Q1. Define oxidation in terms of oxidation number .(L-I)

Ans. :- The process which involves increase in oxidation number .

Q2. What is the principle of electrochemical cell ?(L-II)

Ans .:- The cell works on the principle of redox reactions . One of the reactant undergoes oxidation while another undergoes reduction

Q3. What do you mean by redox couple .(L-III)

Ans.:- Having together oxidised and reduced forms of a substance taking part in oxidation or reduction half reaction .

TWO MARKS QUESTIONS

Q1. What is meant by Electrochemical cell . Why is it called as galvanic cell and Voltaic cell ?(L-I)

Ans. :- The cell which converts chemical energy into electrical energy . It is called as galvanic cell and Voltaic cell after the name of scientists who first tried to convert chemical energy into electrical energy .

Q2. .Discuss the functions of salt bridge . (L-II)

Ans . :- (i) To maintain electrical neutrality of the two solution .

(ii) To complete the circuit .

(iii)It allows the flow of current .

Q3.Identify the oxidising and reducing agent in the following reaction . Also write the change in oxidation number .

$Cr(OH)_3 + Br_2 \rightarrow CrO_4^{2-} + Br^-$ (L -III)

Ans. :- As O.N. of Cr changes from +3 to +6 so it acts as reducing agent .

On the other hand O.N. of Br changes from 0 to -1 so it acts oxidisingagent .

THREE MARKS QUESTIONS

Q1.Match the items in Column I with relevant items in Co**lumn II**

	Column I	Column II
(i)	Ions having positive charge	(a) +7
(ii)	The sum of oxidation number of all atoms in a neutral molecule	(b) –1 (c) +1
(iii)	Oxidation number of hydrogen ion (H^+)	(d) 0
(iv)	Oxidation number of fluorine in NaF	(e) Cation
(v)	Ions having negative charge	(f) Anion

Ans . :- (i) - (e) , (ii) - (d) , (iii) - (c) , (iv) - (b) , (v) - (f)

Q2.(i) Write short note on working of SHE .
(ii) Give one example of a metal oxide which is reduced by coke (L-II)
Ans. (I)It can behave as anode and cathode depending upon another electrode taken.
(a) When it acts as anode reaction will be :-
H_2 ---→ $2H^+ + 2e^-$
Representation will be :-Pt, H_2 (1atm.) / H^+ (1M)
(b) $2H^+ + 2e^-$ -----→ H_2
Representation will be :- / H^+ (1M) / H_2 (1atm.), Pt
(ii) Fe_2O_3

Q3. (i) Define electrochemical series .
(ii) Write down the reaction occurring in Daniel cell . What is the direction of flow of current in it ? (L-III)
Ans. :- The arrangement of elements in the order of increasing standard reduction potential is known as electrochemical series .
(i) At Anode :- Zn ------→ $Zn^{+2} + 2e^-$
(ii) At Cathode :- $Cu^{+2} + 2e^-$ ------→ Cu
The current will flow from Cu electrode to Zn electrode .

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Give one example of disproportionation reaction .(L-I)
Ans.:- $P_4 + NaOH$ ------→ $PH_3 + H_2PO_2^-$

Q2. Classify the following into double displacement, and decomposition reactions :-
$CaCO_3$ ----------→$CaO + CO_2$
$AgNO_3 + KCl$ -------→$AgCl + KNO_3$ (L– II)
Ans. :- (i) Decomposition reaction
(ii)Double decomposition reaction

Q3. What would happen if salt bridge is not used in electrochemical cell ? (L– III)
Ans. :- The cell works for short time .After that electrons stop flowing from anode to cathode due to accumulation of +ve ions at anode and no reduction will occur at cathode . The result is that current stops flowing and cell will not work .

TWO MARKS QUESTIONS

Q1. Arrange the following in order of increasing reactivity with suitable explanation :-
Cu, Fe, Zn, Ag, Ca, Au (level – I)

Ans .:- Au, Ag, Cu, Fe, Zn, Ca
This is based on standard reduction potential . From Ca to Au value of E^0cell goes on increasing. Greater the E^0 value lesser is the reactivity of a metal .

Q2. In the following cell : -

Cu / Cu^{+2} (1M) // Ag^{+} (1M) / Ag

Write down each half cell reaction and overall reaction . (level – II)

Ans. :- At anode :- Cu ------→Cu^{+2} + $2e^{-}$

At Cathode :- 2 Ag^{+} + $2e^{-}$ ----→ 2Ag

Overall reaction :- Cu + 2 Ag^{+} ------→ Cu^{+2} + 2Ag

Q 3.(i) The reaction

Cl2 (g) + 2OH– (aq) –→ ClO– (aq) + Cl– (aq) + H2O(l)represents the process of bleaching. Identify and name the species that bleaches the substances due to its oxidising action.

(ii)MnO42– undergoes disproportionation reaction in acidic medium but MnO4– does not. Give reason.(Level – III)

Ans. :- (i) Cl_2

(ii)Mn has +7 O.S. which is maximum O.S. so MnO_4^- can undergo reduction only while MnO_4^{2-} has +6 O.S. of Mn so it can undergo oxidation as well as reduction .

THREE MARKS QUESTIONS

Q1. .On the basis of standard electrode potential values, suggest which of the following reactions would take place? (Consult the book for E⊖ value).

(i) $Cu + Zn^{2+} \longrightarrow Cu^{2+} + Zn$

(ii) $Mg + Fe^{2+} \longrightarrow Mg^{2+} + Fe$

(iii) $Br_2 + 2Cl^- \longrightarrow Cl_2 + 2Br^-$

(iv) $Fe + Cd^{2+} \longrightarrow Cd + Fe^{2+}$

Q2.Write redox couples involved in the reactions (i) to (iv) given in question L-1

(i)Cu^{2+} /Cu and Zn^{2+} / Zn

(ii)Mg^{2+} / Mg and Fe^{2+} /Fe

(iii)Br_2 /Br^- andCl^- /Cl_2

iv) Fe^{2+} /Fe and Cd^{2+} /Cd

APPLICATION

ONE MARK QUESTIONS

Q1. Why does fluorine not show disporportionation reaction?(Level – I)

Ans. :- Because F Can show only -1 oxidation state and not +ve O.S. due to highest electronegativity .

Q2.In the following reaction write down the redox couples :-

Fe + Sn+2 -------→ Fe+2 + Sn

Ans. :- Fe+2 / Fe and Sn+2 / Sn

Q3. Mn^{+3} ion is unstable in solution and undergoes disproportionation to give Mn^{+2}, MnO_2 and H^+ ion . Write a balanced ionic equation for the reaction . (Level –II)
Ans. :- Because Mn is not stable in +3 O.S. so it changes to more stable +2 and +4 O.S.

TWO MARKS QUESTION

Q1.Calculate E^o cell of the following cell :- (Level – I)
Zn / Zn^{+2} (1M) // Cu^{2+} (1M) / Cu
$E^o_{Zn2+/Zn} = -0.76$ V ,$E^o_{Cu+2 / Cu} = 0.34$ V
Ans. : - E^o Cell = Eo Cathode - Eo Anode
E^o Cell = $E^o_{Cu+2 / Cu}$ - $E^o_{Zn2+/Zn}$
E^o Cell = 0.34 - (- 0.76)
E^o Cell = 1.10 V

Q2.Using the given standard electrode potentials predict if the reaction between the following is feasible : (Level – II)

(ii) Br_2 and Fe^{2+}
$E^o_{Cu+2 / Cu} = 0.34$ V, $E^o_{Fe+3 / Fe2+} = 0.77$ V $E^o_{Fe+2 / Fe} = 0.44$ V, $E^o_{Br2 / Br-} = 1.09$ V
Ans. :- (i) Fe^{3+} + Cu -------→ Fe^{2+} + Cu^{2+}
E^o Cell = $E^o_{Fe+3 / Fe2+}$ - $E^o_{Cu2+/Cu}$

E^o Cell = 0.77 - 0.34 = 0.43 V

As E^o Cell comes out to be +ve so reaction between Fe^{3+} and Cu is feasible .
(ii) Fe^{3+} + 2 Br^- -------→ Fe^{3+} + Br_2
E^o Cell = $E^o_{Fe+3 / Fe2+}$ - $E^o_{2/Br-/Br}$
E^o Cell = 0.77 - 1.09 = - 0.22 V
As E^o Cell comes out to be - ve so reaction between Fe^{3+} and Cu is notfeasible .

THREE MARK QUESTIONS
Q1.Balance the following equation in acidic medium :- .
MnO−4(*aq*)+*I*−(*aq*)→*Mn*2+(*aq*)+*I*2(*s*) (Level – I)

The first step is to identify which element(s) is being oxidized and which element(s) is being reduced. Manganese(Mn) goes from a charge of +7 to a charge of +2. Since it gains five electrons, it is reduced. Because it is reduced, it is considered the ***oxidizing agent*** of the reaction.

Iodine (I) goes from a charge of -1 to 0. Thus it loses electrons, and is oxidized. Iodine (I) is therefore considered to be the **reducing agent** of this reaction.
The next step is to break the equation down into two half equations, one each for the reduction and oxidation reactions. At a later stage, the equations will be recombined into a balanced overall equation.
The first half reaction is for the reduction: MnO_4^- (aq) → Mn^{2+} (aq)
The other describes the oxidation:
I^- (aq) →I_2 (s)
MnO_4^- (aq) + $8H^+$ (aq) + $5e^-$ → Mn^{2+} (aq) +$4H_2O$ (l)

The reduction half reaction is now sufficiently balanced.
The only element in the oxidation half reaction is iodine. This is easily balanced by doubling the iodide ions on the reactant side and adding electrons to the product side to balance the negative charge:
$2I^-(aq) \rightarrow I_2(s) + 2e^-$
Now that both parts of the reaction are balanced, it is time to reform the overall reaction equation. Consider the electrons in each reaction. There are currently five electrons on the left in the reduction half reaction, and two on the right in the oxidation half reaction. The least common multiple of five and two is ten, so the reduction reaction is multiplied by two and the oxidation reaction is multiplied by five:
$2MnO_4^-(aq) + 16H^+(aq) + 10e^-$\(\rightarrow\) $2Mn^{2+}(aq) + 8H_2O(l)$

$10I^-(aq) \rightarrow 5I_2(s) + 10e^-$.

The two reactions are added together, and common terms on either side of the reaction arrow are eliminated (in this case, only the electrons) to add the two parts together and cancel out anything that is on both sides, in this case, only the electrons can be cancelled out:
$2MnO_4^-(aq) + 16H^+(aq) + 10e^- \rightarrow 2Mn^{2+}(aq) + 8H_2O(l)$
$10I^-(aq) \rightarrow 5I_2(s) + 10e^-$
_____
$10I^-(aq) + 2MnO_4^-(aq) + 16H^+(aq) \rightarrow 5I_2(s) + 2Mn^{2+}(aq) + 8H_2O(l)$
This is the balanced reaction equation in acidic solution.

Q2. Balance the following equation in basic medium :-. (L-III)
$MnO_4^-(aq) + SO_3^{2-}(aq) \dashrightarrow MnO_2(s) + SO_4^{2-}(aq)$
Ans. First, they are separated into the half-equations:
$MnO_4^-(aq) \dashrightarrow MnO_2(s)$ (the reduction, because oxygen is LOST) and
$SO_3^{2-}(aq) \dashrightarrow SO_4^{2-}(aq)$ (the oxidation, because oxygen is GAINED)

Now, to balance the oxygen atoms, we must add two water molecules to the right side of the first equation, and one water molecule to the left side of the second equation:
$MnO_4^-(aq) \dashrightarrow MnO_2(s) + 2H_2O(l)$
$H_2O(l) + SO_3^{2-}(aq) \dashrightarrow SO_4^{2-}(aq)$

To balance the hydrogen atoms (those the original equation as well as those added in the last step), we must add four H^+ ions to the left side of the first equation, and two H^+ ions to the right side of the second equation.
$4H^+ + MnO_4^-(aq) \dashrightarrow MnO_2(s) + 2H_2O(l)$
$H_2O(l) + SO_3^{2-}(aq) \dashrightarrow SO_4^{2-}(aq) + 2H^+$

Now we must balance the charges. In the first equation, the charge is +3 on the left and 0 on the right, so we must add three electrons to the left side to make the charges the same. In the second equation, the charge is -2 on the left and 0 on the right, so we must add two electrons to the right.

$3e^- + 4H^+ + MnO_4^-(aq) \dashrightarrow MnO_2(s) + 2H_2O(l)$
$H_2O(l) + SO_3^{2-}(aq) \dashrightarrow SO_4^{2-}(aq) + 2H^+ + 2e^-$

Now we must make the electrons equal eachother, so we multiply each equation by the appropriate number to get the common multiple (in this case, by 2 for the first equation, and by 3 for the second).

$2(3e^- + 4H^+ + MnO_4^-(aq) \rightarrow MnO_2(s) + 2H_2O(l))$
$3(H_2O(l) + SO_3^{2-}(aq) \rightarrow SO_4^{2-}(aq) + 2H^+ + 2e^-)$

With the result:
$6e^- + 8H^+ + 2MnO_4^-(aq) \rightarrow 2MnO_2(s) + 4H_2O(l)$
$3H_2O(l) + 3SO_3^{2-}(aq) \rightarrow 3SO_4^{2-}(aq) + 6H^+ + 6e^-$
$2MnO_4^-(aq) + 2H^+ + 3SO_3^{2-}(aq) \rightarrow H_2O(l) + 2MnO_2(s) + 3SO_4^{2-}(aq)$

The equation is now balanced in an acidic environment. If necessary, we can balance in a basic environment by adding OH^- to turn the H^+ into water molecules as follows:
$2MnO_4^-(aq) + H_2O + 3SO_3^{2-}(aq) \rightarrow H_2O(l) + 2MnO_2(s) + 3SO_4^{2-}(aq) + 2OH^-$
The equation is now balanced in a basic environment.

Q3 . Balance the following equation by oxidation no. method. (L-II)
$HNO_3(aq) + H_3AsO_3(aq) \rightarrow NO(g) + H_3AsO_4(aq) + H_2O(l)$
Identify the oxidation number of every atom.
Left hand side: H= +1; N= +5; O = -2; As = +3
Right hand side: N = +2; O = -2; H = +1; As = +5
Determine the change in oxidation number for each atom that changes.
N: +5 → +2; Change = -3
As: +3 → +5; Change = +2

Make the total increase in oxidation number equal to the total decrease in oxidation number.
We need 2 atoms of N for every 3 atoms of As. This gives us total changes of -6 and +6.

Place these numbers as coefficients in front of the formulas containing those atoms.
$2HNO_3 + 3H_3AsO_3(aq) \rightarrow 2NO(g) + 3H_3AsO_4(aq)$

Q4 . Balance the following equation by oxidation no. method (L-1)
$MnO_2(s) + Al(s) \rightarrow Mn(s) + Al_2O_3(s)$
Ans.First assign oxidation states.
$MnO_2(s) + Al(s) \rightarrow Mn(s) + Al_2O_3(s)$

Left side:
Mn = +4 O = -2 (each O) Al = 0
Right side: Mn = 0 Al = +3 (each Al) O = -2 (each O)

Each Mn atom undergoes a decrease in oxidation state of 4 (from +4 to O), whereas each Al atom undergoes an increase of 3 (from 0 to +3).
Thus we need three Mn atoms for every four Al atoms to balance the increase and decrease in oxidation states.
Increase = 4(3) = decrease = 3(4)**$3MnO_2(s) + 4Al(s)$) --------→ →$3Mn(s) + 2Al_2O_3(s)$**

UNIT 9-HYDROGEN

Concept: Hydrogen: preparation, its properties & hydrides

KNOWLEDGE

ONE MARK QUESTIONS

Q.1 What is the position of Hydrogen in the periodic table? (L-I)
Ans. Group I, Period I

Q.2 Give one example of electron deficient Hydrides. (L-I)
Ans.BH_3

Q.3 which is the most stable isotope of Hydrogen? (L-I)
Ans. Protium

Q.4 what is the Syn gas? (L-I)
Ans. CO +H_2.

Q.5 Write one property of Hydrogen common to alkali metal. (L-I)
Ans. Both have +1 oxidation state.

TWO MARKS QUESTIONS

Q.1 Give one example for each: reaction of hydrogen with metal & Non metal(L-I)
Ans. 2Na +H_2--→ 2 NaH
H_2 + Cl_2-→ 2HCl (in the presence of light)

Q.2 what is Hydrogenation? Give example. (L-I)
Ans. The addition of H_2 to unsaturated compound in the presence of Ni or Pt is called Hydrogenation.
CH_2=CH_2+H_2---Ni-→CH_3-CH_3

Q.3 Why Hydrogen is inert at room temperature? (L-I)
Ans. Because of high bond dissociation energy of H-H bond.

Q. 4 Give point of resemblance of hydrogen with alkali metal. (L-I)
Ans: 1 like alkali metals hydrogen also has one electron in its valence shell
2 like alkali metals hydrogen loses its only electron to form proton(H+)
3 like alkalis metals hydrogen exhibits an oxidation state of +1 in its compounds
4 When an aqueous solution of HCl is electrolysed H2 is librated at the cathode in the same way as alkali metals are librated at the cathode during the electrolysis of their fused halides

Q.5 How is dihydrogen prepared? (L-I)
Ans. 1. By reacting highly reactive metal like Na with H2O.
2Na +2 H2O --→ 2 NaOH +H2
2. In laboratory prepared by treating Zn granules with dil. H2SO4
Zn+ H_2SO_4--→ $ZnSO_4$ +H_2

THREE MARKS QUESTIONS

Q.1 What do you understand by (1) electron-deficient,(ii) electron-précise and (iii) electron precise hydrides. Provide justification with suitable examples (L-I)

Ans: Electron-deficient: the hydrides which contain less than eight electron in their outmost shell are called electron- deficient for exam B_2H_6

Electron- precise: These hydrides contain exact number of electron to form covalent bonds and hence are called as electron-precise hydrides for example: CH_4, SIH4,GeH4,SnH4

Electron-rich: these have more electron than required to form nomal covalent bond and are called as electron rich hydrides. For example NH_3,PH_3,H_2O,H_2S.

Q.2 Write three physical & three chemical properties of Hydrogen. (L-I)

Ans. Physical Properties:

(i) Colorless & Odorless gas
(ii) Not soluble in water
(iii) Low density than air

Chemical Properties:

(i) Reacts with active metal to form Hydrides
(ii) Reacts with nonmetals to form different compound.
(iii) Inert at room temperature.

Q.3 Name the classes of Hydrides to which H_2O, B_2H_6 & NaH belong (L-I)

Ans. H_2O—Covalent

B_2H_6- Covalent

NaH- Ionic

UNDERSTANDING

ONE MARK QUESTIONS

Q.1 The electrolysis of molten sodium hydride librates hydrogen gas at the ---------- . (L-II)

Ans. Anode

Q.2 The radioactive isotope of hydrogen is called--------- and its nucleus contains --------proton and ----neutron. (L-II)

Ans: Tritium, one and two

Q.3 The binary compound of Hydrogen with S block elements are called as ---------- (L-II)

Ans: ionic hydride

Q.4 The oxidation state exhibited by hydrogen in its various compound ares----------(L-II)

Ans: +1.-1 and Zero

Q.5 Name the classes of hydride to which H_2O, B_2H_6, and NaH belong (L-II)

Ans: H_2O(Covalent, electron rich) , B_2H_6 (Covalent Hydride, electron deficient),NaH(ionic hydride)

TWO MARKS QUESTIONS

Q.1 Give two examples of Interstitial Hydrides. (L-II)

Ans-Transition metal hydrides are called Interstitial Hydrides

$T_1H_{1.8}$ & T_1H_2(non –stoichiometric hydrides)

Q2 Write one laboratory method of preparation of hydrogen gas. (L-II)
Ans-Generally prepared by the reaction of granulated zinc with dilute hydrochloric acid as under
$Zn(s)+2HCl \dashrightarrow ZnCl_2 + H_2(g)$

Q3 Identify the isotopes of hydrogen. (L-II)
(a) Has no neutron.
(b) Radioactive in nature.
Ans-(a) Protium $_1H^1$ $e^-=1$, $p^+=1$,$n^0=0$
(b) Tritium $_1H^3$ $e^-=1$, $p^+=1$,$n^0=2$ Hence n/p>1.25

THREE MARKS QUESTIONS

Q.1 what do you understand by "Non stoichiometric hydrides"? Do you think this type of hydrides to be formed by alkali metals? Justify your answer. (L-II)
Ans: Hydrides which are deficient in hydrogen and in which the ratio of hydrogen to metal is fractional are called non-stoichiometric hydrides. This type of hydrides are formed by d-and f-block element
Since alkali metals are highly reducing, they transfer their own electron to H atom thereby forming H- ion. Therefore the ratio of metal to hydrogen is always fixed and they form only stoichiometric hydrides. In other words alkali metals do not form non-stoichiometric hydrides.

Q.2 Describe the commercial preparation methods for the manufacture of hydrogen? (L-II)
Ans. 1 by electrolysis of water:

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

At cathode: $H^+ + e \dashrightarrow H$

$$H + H \dashrightarrow H_2$$

At anode: $4OH^- \dashrightarrow 2H_2O + O_2$

Thus by this method Hydrogen is produced at cathode and oxygen is produced at anode.

Q.3 Give reasons for these: (L-II)
(i) Inert nature of Hydrogen at room temperature
(ii) Oxy- Hydrogen torch is used for cutting & welding purpose
(iii) LiH is least ionic among Alkali Metal Hydrides
(i) High bond dissociation energy of H-H bond
(ii) Hydrogen molecule dissociate into atomic hydrogen at very high temperature (4000K)
(iii) Because of least electronegativity difference.

APPLICATION

ONE MARK QUESTIONS

Q.1 Give two examples of Interstitial Hydrides. (L-III)
Ans-Transition metal hydrides are called Interstitial Hydrides
$T_1H_{1.8}$ & T_1H_2 (non –stoichiometric hydrides)

Q.2 which spin isomer would be 100% at OK? (L-III)
Ans. PARA H2

Q.3 Name the hydrogen ion which resembles anions of group 17. (L-III)
A (H^-) Hydride ion

Q.4 how much energy is required to ionize the H-atom? (L-III)
Ans-1311.8 KJ/ mole Or $2.18X10^{-18}$J/atom

Q.5 Name the compound formed on combination of CO & H_2 (L-III)
Ans. CH_3OH

TWO MARKS QUESTIONS

Q.1 how can the production of hydrogen from water gas be increased by using water shift reaction? (L-III)
Ans: Water shift reaction is given as

$$C(s) + H_2O(g) \xrightarrow[1270K/Ni]{} CO(g) + H_2(g) \quad -121.3kj$$

It is difficult to obtain pure hydrogen from water gas ($CO+H_2$) since CO is difficult to remove. Therefore to increase the production of H_2 form water gas CO is oxidized to CO_2 by mixing it with more steam and passing over $FeCrO_4$ catalyst at 673K

Q.2 which isotope of hydrogen is used as a tracer in organic compound. (L-III)
Ans: The Hydrogen has three isotopes viz H.D and T. Due to difference in masses, the rate constant of these isotopes with the same substrate are different. In other words Both D and T show isotope effect, but since T is not only radioactive in nature but is also least abundant hydrogen isotope, therefore D is used as tracer to study the mechanism of organic reaction.

Q.3 Name one example of reaction in which dihydrogen acts (1) as an oxidizing agent (ii) as a reducing agent. (L-III)
Ans: in the reaction of dihydrogen with metals to form metal hydride it acts as an oxidizing agent

$$2Na(s) + H_2(g) \longrightarrow 2Na^+H^-$$

Here Na has oxidized to Na^+ and Dihydrogen is reduced to hydride (H^-) ion
(II) In the reaction of heated cupric oxide with dihydrogen to form H_2O and copper metal dihydrogen acts as a reducing agent

$$CuO(s) + H_2(g) \longrightarrow Cu(s) + H_2O$$

Q.4 Do you expect the carbon hydride of the type (CnH2n+2) to acts as Lewis acid or bases? Justify your answer (L-III)
Ans: carbon hydride of the types(CnH2n+2)are electron-precise hydrides. In other words they have exact number of electron to form covalent bonds therefore they do not show any tendency to either gain or lose electron hence they are neither Lewis acid or Lewis bases.

THREE MARKS QUESTIONS

Q.1 complete the following reaction: (L-III)

(1) $CO + 2H_2$ $\xrightarrow{Co(CATALYST)}$

(2) $C_3H_8(g) + 3H_2O$ $\xrightarrow{Ni\ 1270K}$

(3) $Zn(s) + 2NaOH\ (aq)$ $\xrightarrow{\text{heat}}$

Ans: 1) $CO + 2H_2$ $\xrightarrow{Co(CATALYST)}$ $CH_3OH(l)$

2) $C_3H_8\ (g) + 3H_2O$ $\xrightarrow{Ni\ 1270K}$ $3CO + 7H_2(g)$

3) $Zn(s) + 2NaOH\ (aq)$ $\longrightarrow$ $Na_2ZnO_2 + 7H_2(g)$

Q.2 How can the production of dihydrogen obtained from coal gasification, be increased? (L-III)

Ans: the process of producing syngas or synthesis gas from coal is called coal gasification

$$C(s) + H_2O(g) \xrightarrow{Ni\ 1270K} \underset{\text{Syn gas}}{CO(g) + H_2(g)}$$

The production of hydrogen can be increased by reacting carbon monoxide of syngas with the steam in presence of iron chromate as catalyst at 673K. This is called water shift reaction

$$CO\ (g) + H_2O\ (g) \xrightarrow{FeCrO_4,\ 673K} CO_2\ (g) + H_2\ (g)$$

The CO_2 thus produced can be removed either by scrubbing with a solution of sodium arsenite or by passing the mixture through water under 30atm. Pressure when CO_2 dissolves leaving behind H_2 which is collected

Q. 3 what is meant by the term "Cold Combustion"? Explain. (L-III)

Ans. In space crafts, H_2 gas is used in fuel cells for generating electrical energy and for providing clean drinking water to the Astronauts'. The electrical energy is generated by the reaction of H_2 and O_2 without evolution of any heat called "Cold combustion"

With alkaline electrolyte the half-cell reactions are:

$H_2 + 2OH^- \rightarrow 2H_2O + 2e^-$ $\quad H_2O + 1/2\ O_2 \rightarrow 2OH^-$

$H_2 + ½\ O_2 \rightarrow H_2O \qquad E^0 = 1.23\ V$

Efficiency is up to 85% which in rechargeable secondary cells is about 40%

Concept –Water & Hydrogen Peroxide

KNOWLEDGE

ONE MARK QUESTIONS

Q1. Which compounds are responsible for permanent hardness of water? (L 2)

Ans- Chlorides and sulphates of calcium and magnesium

Q2. Define 'autoprotolysis' of water. (L-2)

Ans- Reaction between two moles of water to form one mole of hydroxide ion and one mole of hydronium ion.

Q3. Name the method used to remove temporary hardness of water? (L1)

Ans-Clark s method OR By Boiling

TWO MARKS QUESTIONS

Q1 What is coal gasification? Write chemical equation involved. (L-1)

Ans-The process of producing syn gas from coal

$C(s) + H_2O(g)$----1270 k Catalyst--------$\rightarrow CO(g) + H_2(g)$

Q2 How many hydrogen-bonded water molecule(s) are present in CuSO4.5H2O ? Draw its structure to show formation of hydrogen bond. (L-3)
Ans- one molecule of water is bonded by hydrogen bond and is deeply embedded in the lattice, While four molecules are bonded with coordinate bond.
$[Cu(H_2O)_4]SO_4.H_2O$

Q3 Which compounds are responsible for permanent and temporary hardness of water? (L-1)
Ans-Permanent hardness is due to chlorides and sulphates of calcium and magnesium
While temporary hardness is due to bicarbonates of calcium and magessium.

THREE MARKS QUESTIONS

Q1. Complete the following reactions: (L-2)
(a) Na_2O_2 (*s*) + H2O ----------→
(b) $Ca_3N_2 + D_2O$ ----------→
(c) P4O10 (*s*) + 6H2O----------→
Ans-

a) $NaOH+H_2O_2$
b) $Ca(OD)_2+ND_3$
c) H_3PO_4

Q2. Write ionic equations for each of the following reactions: (L-3)
(a) H2O2 reduces acidified potassium permanganate solution to colorless Manganese sulphate.
(b) H2O2 oxidises ferrous sulphate to ferric sulphate in acidic medium.
Ans-a)

$$2MnO_4^- + 6H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 8H_2O + 5O_2$$

b) $2Fe^{2+} + H_2O_2$ ----------→ $2Fe^{3+} + 2OH^-$

Q3. Write chemical equation involved in the preparation of hydrogen peroxide from(L-3)
(a) Barium peroxide
(b) Peroxide sulphate
(c) 2-Ethyl anthraquinol
Ans-a)

$$BaO_2.8H_2O(s) + H_2SO_4(aq) \rightarrow BaSO_4(s) + H_2O_2(aq) + 8H_2O(l)$$

b)

$$2HSO_4^-(aq) \xrightarrow{\text{Electrolysis}} HO_3SOOSO_3H(aq) \xrightarrow{\text{Hydrolysis}} 2HSO_4^-(aq) + 2H^+(aq) + H_2O_2(aq)$$

c)

$$2-\text{ethylanthraquinol} \underset{H_2/Pd}{\overset{O_2(air)}{\rightleftharpoons}} H_2O_2 + (\text{oxidised product})$$

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Which compound is used as oxidizing agent for lead sulphide to restore the color of lead paintings? (L-2)
Ans-H_2O_2

Q2 Which property of Zeolites make it suitable to soften hard water? (L-3)
Ans-Sodium ions are exchanged by calcium and magnesium ions

Q3. In laboratory preparation of H_2O_2 from hydrated barium peroxide with sulphuric acid , anhydrous barium peroxide is not used Why ? (L-3)
Ans-Because it forms a protective layer of barium sulphate over anhydrous barium peroxide

TWO MARKS QUESTIONS

Q1 What properties of water make it useful as a solvent? What types of compound can it dissolve and hydrolyse? (L-2)
Ans-Water is a universal solvent because of its polar nature and ability to form hydrogen bonds

a) It hydrolyses many ionic compounds and certain covalent compound by chemically reacting with them
b) It form hydrogen bonds with some covalent compounds and dissolve them

Q2. What do you understand by terms hydrolysis and hydration? Give examples. (L-2)
Ans-Due to high dielectric constant, it has a very strong hydrating tendency. It dissolves many ionic compounds. However, certain covalent and some ionic compounds are hydrolysed in water.Examples-

$P_4O_{10}(s) + 6H_2O \longrightarrow 4H_3PO_4(aq)$

$SiCl_4 + 2H_2O \longrightarrow SiO_2(s) + 4HCl$

Q3. Why hydrogen peroxide is kept in wax lined glass or plastic vessels in dark? (L-3)
Ans-In the presence of metal surfaces or traces of alkali (present in glass containers), the above reaction is catalyzed. It is, therefore, stored in wax-lined glass or plastic vessels in dark. Urea can be added as a stabilizer. It is kept away from dust because dust can induce explosive decomposition of the compound.

THREE MARKS QUESTIONS

Q1. Assign the reason for the following: (L-3)
(a) Enthalpy of fusion of water is higher as compared to the hydrides of Sulphur & Selenium.
(b) Water is quite stable and does not dissociate in to its elements even at high temperature.
Ans-a) Due hydrogen bond it has high latent heat of fusion
b) Water is a stable compound and its decomposition is not thermodynamically feasible

Q2 Calculate the strength of 20 volume solution of hydrogen peroxide (L-3)
Ans-10 volume solution of H_2O_2 means that
1L of this H_2O_2 will give 10 L of oxygen at STP

$2H_2O_2(l) \rightarrow O_2(g) + 2H_2O(l)$

2×34 g 22.4 L at STP
22.4 L of O_2 at STP is produced from H_2O_2 = 68 g
20 L of O_2 at STP is produced from H_2O_2 =68X20/22.4 = 60.72 g

Therefore, strength of H_2O_2 in 20 volume H_2O_2 = 60.72 g/L

Q3. Assign the reason for the following observations: (L-2)

(a) The temporary hardness of water is removed by boiling.

(b) In the Clark's method, only calculated amount of lime is added to hard Water for removal of hardness.

(c) Regeneration of sodium zeolite is essential by brine.

Ans-a) because calcium and magnesium bicarbonates decomposes on heating or boiling

b) It precipitates out calcium carbonate and magnesium hydroxide which can be filtered off.

c) Permutit/Zeolite is said to be exhausted when all the sodium in it is used up. It is regenerated for further use by treating with an aqueous sodium chloride solution.

APPLICATION

ONE MARK QUESTIONS

Q1 What is the significance of autoprotolysis of water ? (L-1)

Ans- It has amphoteric behaviour

Q2.How does H_2O_2 reacts with KMnO4 in alkaline medium?((L-3)

Ans-

$$2MnO_4^- + 3H_2O_2 \rightarrow 2MnO_2 + 3O_2 + 2H_2O + 2OH^-$$

Q3.How is heavy water prepared? (L-2)

Ans-By prolonged electrolysis of normal water

TWO MARKS QUESTIONS

Q1. Give uses of heavy water. Can heavy water be used for drinking? (L-2)

Ans-It is used as moderator and to study the reaction mechanism.

Q2. Out of hard water and soft water which would you like to use for washing of clothes and why? (L-2)

Ans-Soft water because it does not contain salts of calcium and magnesium (which form precipitate with soaps) and hence give more froth with soap solution.

Q3. Explain why hard water produces less lather with soap? (L-1)

Ans- Hard water forms scum/precipitate with soap. Soap containing sodium stearate ($C_{17}H_{35}COONa$) reacts with hard water to precipitate out Ca/Mg stearate.

THREE MARKS QUESTIONS

Q1..H_2O_2 act both as oxidising and reducing agent, Justify it with the help of one examples of each along with suitable chemical equations. (L-3)

Ans-The oxidation state of oxygen in hydrogen peroxide is -1 which can change into -2 in water and it act oxidizing agent but when it act as reducing agent oxidation state of oxygen changes from -1 to 0 in O2

a)Oxidising action -

$$PbS(s) + 4H_2O_2(aq) \rightarrow PbSO_4(s) + 4H_2O(l)$$

b)Reducing action-

$$HOCl + H_2O_2 \rightarrow H_3O^+ + Cl^- + O_2$$

Q2. Account for the following : (L-2)
(a) H_3PO_4 is preferred to H_2SO_4 in preparation of H_2O_2 from $BaO_2.8H_2O$
(b) Water is responsible for moderation of the climate and the body temperature of living beings
(c) Melting point of D_2O is higher than normal water .
Ans-a)Because H_3PO_4 act as negative catalyst and prevent the decomposition of H_2O_2
b).Water has high heat of vapourisation and freezing due to hydrogen bond
c)Deuterium is larger than hydrogen and hence strong hydrogen bonding

Q3. Complete the following reactions : (L-2)
(a) $Ca_3N_2 + H_2O$ -------→
(b) $AlCl_3$ (*g*) + H_2O ----------→
(c) $CaCl_2$ + $C_{17}H_{35}COONa$ ----------→
Ans-a) $Ca(OH)_2 + NH_3$
b)$Al(OH)_3 + HCl$
c)$(C_{17}H_{35}COO)_2Ca$ + NaCl

Q4 Explain the following (L-2)
(a) The density of ice is less than that of liquid water?
(b) The boiling point of water is less than that of H2S.
(c) NaH has higher reducing character than H2O.
Ans-a) In structure of ice , Oxygen atom is tetrahedrally surrouneded by four hydrogen (with two hydrogen by hydrogen bond and with two hydrogen by covalent bond) and have vacant spaces in which air is trapped
b)Due to extensive hydrogen bonding in water
c)NaH is ionic compound while water is a covalent compound

Q5 Describe the following in brief (L-1)
a)Hydrogen economy
b) Fuel cell
c) Uses of Hydrogen peroxide
Ans a) The storage and transportation of liquid hydrogen as a fuel is hydrogen economy
b)Those cells in which the energy of combustion is converted into electricity are called fuel cells e g-H_2-O_2 fuel cell
c)In bleaching, as antiseptic ,as oxidizing and reducing agent.

UNIT 10- s-BLOCK ELEMENTS

Concept: Alkali Metals

KNOWLEDGE

ONE MARK QUESTIONS

Q.1 What happens when KO_2 reacts with water ? (L-1)

Ans. $2\ KO_2 + 2H_2O$ ------> $2\ KOH + H_2O_2 + O_2$

Q2Name the chief factor responsible for the anomalous behavior of lithium.(L-2)

Ans. High polarizing power (charge/size ratio).

Q3 What are the raw material used for the manufacture of washing soda by solvay process ?(L-1)

Ans. Nacl, $CaCO_3$ and NH_3

Q.4 Why is sodium metal kept under kerosene oil ?(L-1)

Ans. Sodium metal is highly reactive and combines with air forming sodium oxide.

Q.5 Name the alkali metal which shows diagonal relationship with Mg? (L-2)

Ans.Li

Q.6. Name the alkali metal which forms only the normal oxide on heating with air ? (L-2)

Ans. Li.

TWO MARKS QUESTIONS

Q.1 When a cation is highly polarizing ? Which alkali metal cation has the highest polarizing power ? (L-3)

Ans. A cation is highly polarizing if its charge/size ratio is very high.Li^+ has the highest polarizing power .

Q.2 why sodium is less reactive than potassium? (L-1)

Ans. The ionization enthalpy of potassium is less than that of sodium and the electrode potential of Potassium (-2.95 V) is more negative than that of sodium (-2.71 V) and hence sodium is less reactive than potassium.

Q.3 Why are potassium and caesium, rather than lithium used in photoelectric cells ?(L-1)

Ans. Potassium and caesium have much lower ionization enthalpy than that of lithium. As a result, these metals on exposure to light, easily emit electrons but lithium does not. Therefore, K and Cs rather than Li are used in photoelectric cells

THREE MARKS QUESTIONS

Q.1 Discuss the various reactions that occur in the Solvay process.(L-2)

Ans. In Solvay process , CO_2 is passed through brine saturated with ammonia .when $NaHCO_3$ being sparingly soluble gets precipitated.

NaCl + NH3 + CO2 ------->$NaHCO_3$ + NH4Cl (i)

Sodium bicarbonate thus formed is filtered, dried and then heated when sodium carbonate is

Obtained.

$2\ NaHCO_3$ ------> $Na_2CO_3 + CO_2 + H_2O$

CO_2 needed for the reaction shown in eq.(i) is prepared by heating calcium carbonate and the quick lime, CaO thus formed is dissolved in water to form slaked lime, $Ca(OH)_2$. NH_3 needed for the purpose is prepared by heating NH_4Cl

Q.2 what are the common physical features of alkali metals? (L-1)

Ans. Large Atomic and ionic radii, Low ionization enthalpies, metallic character, low melting and boiling Point, form ionic bond, low density,show flame coloration ,photoelectric effect.

Q.3. In what ways lithium shows similarities to magnesium in its chemical behavior? (L-2)

Ans. (a) the hydroxides of both lithium and Mg decompose on heating

(b) Both form ionic nitrides when heated in an atmosphere of nitrogen.

(C) The carbonates of both Li and Mg decompose on heating

Q4.Write the chemical features of alkali metals. (L-1)

Ans.(I)All alkali metals react with water,liberating H_2 and forming their hydroxides.

$2M + 2H_2O$ ---------->$2MOH + H_2$

(II) Alkali metals tarnish in air due to formation of an oxide or hydroxide on their surface.

$4Li + O_2$-------->$2Li_2O$

$2Na + O_2$--------->Na_2O_2

(iii)All alkali metals react with hydrogen to form ionic hydrides.

$2M + H_2$---------->$2MH$

Q5.Write two important uses of each of the following: (i)Sodium carbonate (II)Sodium Hydroxide (iii)Sodium hydrogen carbonate (L-1)

Ans.(I)Sodium carbonate :for softening of hard water ,laboratory reagent.

(II)Sodium hydroxide: in the manufacture of soap, in the purification of bauxite.

(iii) Sodium hydrogen carbonate: as a mild antiseptic, as an antacid.

UNDERSTANDING

ONE MARK QUESTIONS

Q1.Which alkali metal will have highest hydration enthalpy ? (L-1)

Ans. Li

Q.2. K_2CO_3 Cannot be prepared by solvay process ? (L-3)

Ans. Because $KHCO_3$ is highly soluble in water

TWO MARKS QUESTIONS

Q 1(I) Which alkali metal has the highest ionic radii ? (L-1)

Ans.Cs.

(ii)A Solution of sodium in liquid ammonia is strongly reducing in nature.Why? (L-2)

Ans Due to presence of ammoniated electrons.

Q.2 Why does table salt get wet in rainy season? (L-2)

Ans. NaCl is not hygroscopic but impurities like $MgSO_4$, $CaSO_4$, $MgCl_2$ and $CaCl_2$, present in it are hygroscopic and absorb moisture from air.

Q.3 why alkali metals impart color to the flame? (L-1)

Ans. Alkali metals have low ionization enththalpies. Their valence electrons get excited by absorbing energy from the flame. When these electrons return to the ground state, the energy is emitted In the form of light.

Q.4. Why can caesium be used in photoelectric cell while lithium cannot ? (L-2)

Ans. Caesium has the lowest while lithium has the highest ionization enthalpy. Hence Cs can lose electrons very easily while lithium cannot.

Q.5 Sodium fire in laboratory should not be extinguished by pouring water.Why? (L-1)

Ans. Sodium reacts violently with water producing hydrogen gas which also catches fire.Instead of water pyrene should be used.

Q6.Why is that on being heated in excess supply of air K,Rb and Cs forms superoxide's instead of Oxides & peroxides? (L-3)

Ans.K^+,Rb+ and Cs^+ are large cations and superoxide ion is larger than oxide and peroxide ions. Since due to higher lattice energies,a large cation stabilizes a large anion,therefore these metals form Superoxides.

Q.7.Potassium carbonate cannot be prepared by Solvay process. Why? (L-3)

Ans. Potassium carbonate cannot be prepared by Solvay process because potassium bicarbonate being more soluble than sodium bicarbonate does not get precipitated when CO_2 is passed through a Conc. Solution of KCl saturated with ammonium.

THREE MARKS QUESTIONS

Q1 State as to why: (L-2)

(a) A solution of Na_2CO_3 is alkaline?

(b)alkali metals are prepared by electrolysis of their fused chlorides ?

(c)sodium is found to be more useful than potassium ?

Ans.

(a) It undergoes hydrolysis to produce a strong base NaOH .

(b) When the aq. Solution of any alkali metal is subjected to electrolysis ,H_2 instead of the alkali metal is produced at the cathode. Therfore alkali metals are prepared by electrolysis of their fused chlorides.

(c) Sodium ions are formed primarily in the blood plasma and in the interstitial fluid which surrounds The cell while potassium ions are primarily present within the cell fluids. Sodium ions are help in the transmission of nerve signals, in regulating the flow of water across cell membranes and in the transport of sugars and amino acids into the cells. Thus, sodium is found to be more useful than potassium.

Q2.Give reason for the following: (L-3)

(a)LiCl is more covalent than KCl.

(b)LiF has lower melting point than NaCl.

(c)CuCl is more covalent than NaCl.

Ans(a).Due to smaller size and high poalrising power of Li+ ion ,LiCl is more covalent than KCl.

(b)Small cation Li+ ion highly polarizes large anion I^-, LiI is more covalent and hence has lower melting point.

©Due to pseudo inert gas configuration, Cu^+ is more polarizing than Na^+ and hence CuCl is more Covalent NaCl.

Q.3 when an alkali metal dissolves in liquid ammonia, the solution can acquire different colors. Explain .(L-3)

Ans. The dilute solutions of alkali metals in liquid ammonia exhibit dark blue color because ammoniated electrons absorb energy corresponding the red region of the visible light. However, If the concentration increases above 3M, the color changes to copper-bronze and the solution acquires metallic luster due to the formation of metal ion clusters.

Q4.Give reason for the following: (L-2)

(i)alkali metals do not occur free in nature.

(ii)alkali metals have low I .E.

(iii)LiI is more soluble than KI in ethanol.

Ans.(i)They are highly reactive in natur

(ii) Because of large atomic size.

(III)LiI is more covalent in character than KI

APPLICATION

ONE MARK QUESTIONS

Q.1 Arrange the following in order of the increasing covalent character : MCl,MBr,MF,MI (Where M=alkali metal) (L-2)

Ans. MF < MCl < MB < MI

Q.2 Predict giving reason the outcome of the reaction, LiI +KF -----> (L-3)

ANS.LiI +KF ------→LiF +KI;Larger cation stabilizes larger anion. App

Q.3. How the reaction between sodium and water can be made less vigorous? (L-3)

Ans. By amalgamating sodium.

Q4. Which of the following compounds is most stable : LiF ,LiBr,LiCl,LiI ?(L-2)

Ans. LiF.

TWO MARKS QUESTIONS

Q.1. What is the oxidation state of K in KO_2^- ? Why is KO_2 paramagnetic ? (L-2)

Ans. The oxidation state of K in KO_2^- is +1. It has 1 unpaired electron in π*2p MO. Therefore it is Paramagnetic.

Q.2.Starting with sodium chloride how would you proceed to prepare sodium hydroxide ?(L-2)
Ans. Sodium hydroxide is obtained by electrolysis of an aq.solution of NaCl in castner kellner cell using Mercury cathode and carbon anode .Sodium metal which is discharged at cathode combines with Mercury to form sodium amalgam.Cl2 is evolved at anode. The sodium amalgam thus obtained is treated with water to form sodium hydroxide and hydrogen gas.

Q.3.Why Li_2CO_3 decomposes at a lower temperature whereas Na_2CO_3 at higher temperature ?(L-3)
Ans.Li_2CO_3 is a salt of a weak acid (CO_2) and a weak base (LiOH). Since the weak base cannot attract CO_2 Strongly, therefore, Li_2CO_3 decomposes at a lower temperature.On the other hand ,NaOH is a Much stronger base than LiOH and hence can attract CO_2 more strongly.

THREE MARKS QUESTIONS

Q1. What happens when (L-2)
(i) Sodium metal is dropped in water ?
(ii) Sodium metal is heated in free supply of air ?
(iii) Sodium peroxide dissolves in water ?
Ans. (I) $2\ Na(s) + 2\ H_2O$ ------> $2\ NaOH + H_2$
(II) Na_2O_2 is formed
$2\ Na + O_2$ ------> Na_2O_2
(iii) H_2O_2 is formed
$Na_2O_2 + 2\ H_2O$ ------> $2\ NaOH + H_2O_2$

Q.2Write balanced equation for the reaction between (L-2)
(a)Na_2O_2 and water
(b)KO_2 and water
(c)Na_2O and CO_2
Ans(a).$Na_2O + 2\ H_2O$--------->$2NaOH + H_2O_2$
(b)$2KO_2 + 2H_2O$.--------->$2KOH + H_2O_2 + O_2$
(c) $Na_2O + CO_2$---------->Na_2CO_3

Q.3 How do you account for the strong reducing power of lithium in aqueous solution? (L-3)
Ans.Electrode potential is a measure of the tendency of an element to lose electrons in the aq.solution .It depends upon following factors :
(i)Sublimation enthalpy.
(II)Ionisation enthalpy
(iii)Hydration enthalpy
Since Li has the smallest size,Its enthalpy of hydration is the highest among alkali metals .Although ionization enthalpy of Li is the highest among alkali metals,it is more than compensated by the high High enthalpy of hydration.Thus Li has the most negative E^0 Value and hence lithium is the strongest reducing agent.

Q.4.Mention the oxides formed by Li,Na and K. (L-1)
Ans.$4Li + O_2$--------->$2Li_2O$
$2Na + O_2$---------->Na_2O_2
$K + O_2$---------->KO_2

Concept: Alkaline Earth Metals ; Anomalous Behaviour & Diagonal Relationship

KNOWLEDGE

ONE MARK QUESTIONS

Q 1 In second gp which element shows Anomalous Behaviour ?**(L1)**
Ans Be

Q 2 with which element Beryllium shows diagonal relation ship? **(L1)**
Ans : Al

Q3 Name the elements present in the 2nd Group of the Periodic Table: **(L1)**
Ans beryllium, magnesium, calcium, strontium, barium and radium

TWO MARKS QUESTIONS

Q 1 Elements present in the 2nd Group of the Periodic Table are also called ? **(L1)**
Ans alkaline earth metals

Q 2. Write electronic Configuration of Be &Mg**(L1)**
Ans Be $1s^2\ 2s^2\ 2p^2$
Mg $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^2$

Q 3What is the diagonal relationship ? **(L1)**
Ans : A close similarity is observed in certain cases between the first element of a group with the second element of the following group. This is referred to as the diagonal relationship and is observed in the following pairs..Li & Mg
Be & Al

THREE MARKS QUESTIONS

Q 1Write any three uses of Calcium Hydroxide (Slaked lime)**(L2)**
Ans i) It is used in the preparation of mortar, a building material.
(ii) It is used in white wash due to its disinfectant nature.
(iii) It is used in glass making, in tanning industry, for the preparation of bleaching powder and for purification of sugar.

Q 2 How does the setting of cement takes place & what is the role of gypsum in setting of cement ? **(L2)**
Ans When mixed with water, the setting of cement takes place to give a hard mass. This is due to the hydration of the molecules of the constituents and their Rearrangement. The purpose of adding gypsum is only to slow down the process of setting of the cement so that it gets sufficiently hardened.

Q 3 Complete the following**(L1)**
1 Be: $1s^2$……..
2 Aluminium shows similar properties with …….
3…… shows some properties different than other alkaline earth metals

Ans 1 $1s^2$ $2s^2$

2 Beryllium

3 Beryllium

UNDERSTANDING

ONE MARK QUESTIONS

Q 1 What is the reason for the diagonal relationship ? **(L1)**

Ans Diagonal relationship is due to the similarity in ionic sizes and /or charge/radius ratio of the elements.

Q 2 Beryllium forms covalent compound Why? **(L1)**

Ans Due to high Ionisation Enthalpy

Q 3 Beryllium does not show coordination more than four, Why ? **(L2)**

Ans Due absence of d Orbitals

Q 4 Beryllium, the first member of the Group 2 metals, shows different behaviour as compared to magnesium and rest of the members what is this properties **(L1)**

Ans Anomalous Behaviour

Q 5 Name the alkaline earth metal used in radio therapy**. (L1)**

Ans : Radium salts are used in radiotherapy, for example, in the treatment of cancer.

TWO MARKS QUESTIONS

Q 1 Why Be and Mg do not impart colour to the flame ? **(L2)**

Ans : The electrons in beryllium and magnesium are too strongly bound to get excited by flame. Hence, these elements do not impart any colour to the flame.

Q 2Which gas is liberated when Calcium carbonate is reacted with dil acid ? **(L2)**

Ans : It reacts with dilute acid to liberate carbon dioxide.

$CaCO_3 + 2HCl \rightarrow CaCl_2 + CO_2 + H_2O$

Q3.What happens when CaO is exposed to atmospheric air? **(L2)**

Ans On exposure to atmosphere, it absorbs moisture and carbon dioxide to form Calcium hydroxide and Calcium carbonate.

$CaO + CO_2 \rightarrow CaCO_3$

$CaO + H_2O \rightarrow Ca(OH)_2$

Note; The addition of limited amount of water breaks the lump of lime. This process is called **slaking of lime**.

Q 4 Give reason . the sulphate of Be & Mg are soluble in water **. (L2)**

Ans The sulphates of the alkaline earth metals are all white solids and **stable to heat.** BeSO4, and MgSO4 are readily soluble in water; the solubility decreases from CaSO4 to BaSO4. The greater

hydration enthalpies of Be^{2+} and Mg^{2+} ions overcome the lattice enthalpy factor and therefore their sulphates are soluble in water.

Q5.What happens when nitrates of alkaline earth metal is heated**? (L2)**

Ans The nitrates are made by dissolution of the carbonates in dilute nitric acid. Magnesium nitrate crystallises with six molecules of water, whereas barium nitrate crystallises as the anhydrous salt. This again shows a decreasing tendency to form hydrates with increasing size and decreasing hydration enthalpy. All of them decompose on heating to give the oxide like lithium nitrate.

THREE MARKS QUESTIONS

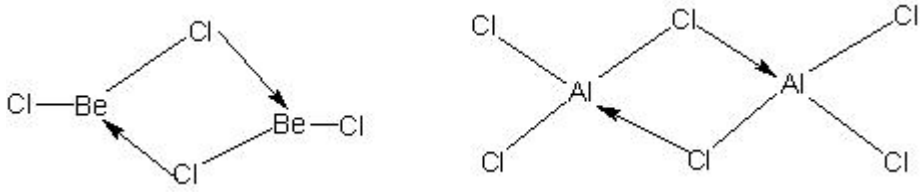
Q 1 What is the Reason for the anomalous behaviour of beryllium ?**(L1)**

Ans The properties of berrylium the first member of the alkaline earth metal, differ from the rest of the member. Its is mainly because of

- Its small size and high polarizing power.
- Relatively high electro negativity and ionization energy as compared to other members.
- Absence of vacant d – orbitals in its valence shell.

Q 2 Give resemblance in structure of chloride of Be & Al .**(L2)**

Ans $BeCl_2$ and $AlCl_3$ have bridged chloride polymeric structure.



Q 3 What is the similarity between carbide of Be & Al? (L2)

Ans Carbides of both the metal reacts with water liberating methane gas.

$$Be_2C + 4H_2O \rightarrow 2Be(OH)_2 + CH_4 \uparrow$$

$$Al_4C_3 + 12H_2O \rightarrow 4Al(OH)_3 + 3CH_4 \uparrow$$

Q 4 Give reaction for the amphoteric nature of Be & Al. (L2)

Ans the oxides and hydroxides of both Be and Al are amphoteric and dissolve in sodium hydroxide as well as in hydrochloric acid.

$$BeO + 2HCl \rightarrow BeCl_2 + H_2O$$

$$BeO + 2NaOH \rightarrow Na_2BeO_2 + H_2O$$

$$Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + H_2O$$

Q 5 Write a note on the manufacture of Cement: **(L2)**

Ans ; Cement is an important building material. It was first introduced in England in 1824 by Joseph Asphdin. It is also called Portland cement because it resembles with the natural limestone quarried in the Isle of Portland, England. Cement is a product obtained by combining a material rich in lime, CaO with other material such as clay which contains silica, SiO2 along with the oxides of aluminium, iron and magnesium. The average composition of Portland cement is : CaO, 50- 60%; SiO2, 20-25%; Al2O3, 5-10%; MgO, 2- 3%; Fe2O3, 1-2% and SO3, 1-2%. For a good quality cement, the ratio of silica

(SiO2) to alumina (Al2O3) should be between 2.5 and 4 and the ratio of lime (CaO) to the total of the oxides

of silicon (SiO2) aluminium (Al2O3) and iron (Fe2O3) should be as close as possible to 2. The raw materials for the manufacture of cement are limestone and clay. When clay and lime are strongly heated together they fuse and react to form 'cement clinker'. This clinker is mixed with 2-3% by weight of gypsum (CaSO4·2H2O) to form cement. Thus important ingredients present in Portland cement are dicalcium silicate (Ca2SiO4) 26%, tricalcium silicate (Ca3SiO5) 51% and tricalcium aluminate

(Ca3Al2O6) 11%.

APPLICATION

ONE MARK QUESTIONS

Q 1 Aluminium, Beryllium is not readily attacked by acids, Why ?**(L3)**
Ans :Because of the presence of an oxide film.

Q 2 The chlorides of both beryllium and aluminium are Lewis acid Why ? **(L2)**
Ans Incomplete octate.

Q 3 Name the gas liberated when alkaline metals react with dil acid? **(L2)**
Ans ; The alkaline earth metals readily react with acids liberating dihydrogen gas .

M + 2HCl _→MCl2 + H2

Q 4 Beryllium chloride, $BeCl_2$, melts at 405°C and boils at 520°C. That compares with 714°C and 1412°C for magnesium chloride.Give reason ?
Ans Be forms covalent compounds

Q 5 Give reason .the compounds of alkaline earth metals are less ionic than alkali metals**(L2)**
Ans This is due to increased nuclear charge and smaller size.

TWO MARKS QUESTIONS

Q 1 Beryllium shows covalent Character in its compounds ,Why? **(L3)**
Ans Due to the small size, high ionization **energy**, and high sublimation energy of beryllium, its lattice and hydration energies are insufficient to provide complete charge separation and the formation of simple Be^{2+} ions. In all compounds therefore, even BeO and BeF_2, there is substantial covalent character in the bonding.

Q 2 Account for the reducing nature of Be **(L3)**
Ans Beryllium has less negative value compared to other alkaline earth metals. However, its reducing nature is due to large hydration energy associated with the small size of Be2+ ion and relatively large value of the atomization enthalpy of the metal.

Q 3 How does the atomic and Ionic Radii of alkaline earth metals vary in comparison to alkali metals**(L3)**

Ans The atomic and ionic radii of the alkaline earth metals are smaller than those of the corresponding alkali metals in the same periods. This is due to the increased nuclear charge in these elements. Within the group, the atomic and ionic radii increase with increase in atomic number.

Q 4 How does the of Ionization Enthalpy of alkaline earth metals vary in comparison to alkali metals
Ans The alkaline earth metals have low ionization enthalpies due to fairly large size of the atoms. Since the atomic size increases down the group, their ionization enthalpy decreases The first ionisation enthalpies of the alkaline earth metals are higher than those of the corresponding Group 1 metals. This is due to their small size as compared to the corresponding alkali metals. It is interesting to note that the second ionisation enthalpies of the alkaline earth metals are smaller than those of the corresponding alkali metals.

Q 5 . How does the of Hydration Enthalpy of alkaline earth metals vary & compare it with alkali metals**(L2)**
Ans The hydration enthalpies of alkaline earth metal ions decrease with increase in ionic size down the group. $Be^{2+} > Mg^{2+} > Ca^{2+} > Sr^{2+} > Ba^{2+}$ The hydration enthalpies of alkaline earth metal ions are larger than those of alkali metal ions. Thus, compounds of alkaline earth metals are more extensively hydrated than those of alkali metals, e.g., $MgCl_2$ and $CaCl_2$ exist as $MgCl_2.6H_2O$ and $CaCl_2 \cdot 6H_2O$ while NaCl and KCl do not form such hydrates.

THREE MARKS QUESTIONS

Q 1 Mention the anomalous behaviour of beryllium**(L3)**
Ans Beryllium, the first member of the Group 2 metals, shows anomalous behaviour as compared to magnesium and rest of the members

i) Beryllium has exceptionally small atomic and ionic sizes and thus does not compare well with other members of the group. Because of high ionisation enthalpy and small size it forms compounds which are largely covalent and get easily hydrolysed.
ii) Beryllium does not exhibit coordination number more than four as in its valence shell there are only four orbitals. The remaining members of the group can have a coordination number of six by making use of d-orbitals.
iii) The oxide and hydroxide of beryllium, unlike the hydroxides of oother elements in the group, are amphoteric in nature.

Q 2 Mention the Diagonal Relationship between Beryllium and Aluminium**(L3)**
The ionic radius of Be^{2+} is estimated to be 31 pm; the charge/radius ratio is nearly the same as that of the Al^{3+} ion. Hence beryllium resembles aluminium in some ways. Some of the similarities are:

(i) Like aluminium, beryllium is not readily attacked by acids because of the presence of an oxide film on the surface of the metal.
(ii) Beryllium hydroxide dissolves in excess of alkali to give a beryllate ion, $[Be(OH)_4]^{2-}$ just as aluminium hydroxide gives aluminate ion, $[Al(OH)_4]^-$.
(iii) The chlorides of both beryllium and aluminium have Cl^- bridged chloride structure in vapour phase. Both the chlorides are soluble in organic solvents and are strong Lewis acids. They are used as Friedel Craft catalysts.
(iv) Beryllium and aluminium ions have strong tendency to form complexes, BeF_4^{2-}, AlF_6^{3-} .

Q 3 What is the colour imparted to the flame by Calcium,Strantium and Barium? **(L2)**

Ans Calcium, strontium and barium impart characteristic brick red, crimson and apple green colours respectively to the flame. In flame the electrons are excited to higher energy levels and when they drop back to the ground state, energy is emitted in the form of visible light.

Q 4 Why are Be & Mg inert to O_2& H_2O? **(L3)**

Ans Beryllium and magnesium are chemically inert to oxygen and water because of the formation of an oxide film on their surface. However, powdered beryllium burns brilliantly on ignition in air to give BeO and Be_3N_2.

Magnesium is more electropositive and burns with dazzling brilliance in air to give MgO and Mg_3N_2. Calcium, strontium and barium are readily attacked by air to form the oxide and nitride. They also react with water with increasing vigour even in cold to form hydroxides.

Q 5 Explain the Reaction of Beryllium chloride with water **(L3)**

Ans Beryllium chloride reacts vigorously and exothermically with water with the evolution of acidic, steamy hydrogen chloride gas. This is typical of covalent chlorides.In the first instance, it reacts to give hydrated beryllium ions, $[Be(H_2O)_4]^{2+}$, and chloride ions. But the hydrated beryllium ions (called tetraaquaberyllium ions) are quite strongly acidic. The small beryllium ion at the centre attracts the electrons in the bonds towards itself, and that makes the hydrogen atoms in the water even more positive than they usually are. If the solution is hot and concentrated (as it is likely to be if water is added to solid beryllium chloride - a very exothermic reaction), chloride ions can remove one or more of these hydrogen ions to produce hydrogen chloride gas.

UNIT 11- p-BLOCK ELEMENTS

(BORON FAMILY)

KNOWLEDGE

ONE MARK QUESTIONS

Q1. What are some uses of Boron Compound? [L1]
Ans.Adhesives, cement, disinfectants, fertilizers, etc.

Q2.What is the electronic configuration of Thallium? [L2]
Ans.$[Xe]4f^{14}5d^{10}6s^{2}6p^{1}$

Q3.Which element of Boron Family is used to prevent oxidation? [L1]
Ans.Aluminum

Q4.Which element of Boron family is a metalloid? [L1]
Ans. Boron

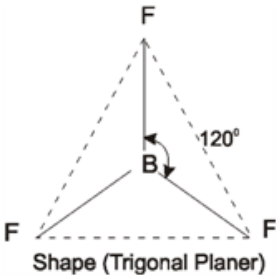
Q5.Why Al and Ga have the same covalent radius? [L-3]
Ans. Poor shielding of d-electrons

TWO MARKS QUESTIONS

Q1.Duralumin is an alloy of? [L1]
Ans. Al+Cu+Mg+Mn

Q2.What accounts for the formation of Boron Hydrides?[L1]
Ans. Because of small size of both B & H forms stable compound called Boron Hydrides.

Q3.Draw the structure of BF_3. [L1]
Ans



Shape (Trigonal Planer)

Q4How to prepare Boric Acid ? what is Colemanite? [L-III]
Ans. Hot solution of Borax when mixed with acids like HCl or H_2SO_4gives Boric is Acid.
Colemanite ($Ca_2B_6O_{11}$) is a compound which prepares Ortho Boric Acid.

Q5Write any two Properties of B_2H_6? [L1]
Ans5.a) Diborane is a colorless, highly toxic gas with a Boiling Point of 180K.
b) Diborane catches fire spontaneously upon exposure to air.

THREE MARKS QUESTIONS

Q1.Find thetotal number of B-O bonds in peroxoborate..[L1]

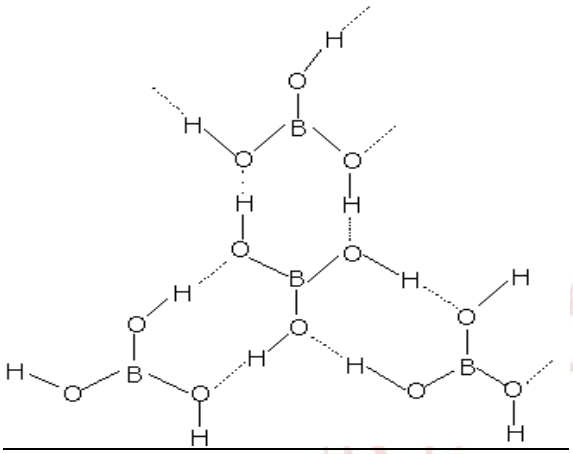
Ans. 8 covalent bonds

Q2.The order of Ionization enthalpy between following atoms is?[L1]

B, Tl, Ga, Al and In.

Ans.B>Tl>Ga> Al> In.

Q3.Draw the structure of Orthoboric Acid and write uses of Boric Acid.[HOTS]



Generally Boric acid is used as an Antiseptic, in enamel and glass industries

Q4.Write the Oxidation state of the following elements: [L2]

Boron

Gallium

Indium

Ans.a) -3 & +3

b) +3 & +1

c) +3 & +1

Q5.Write the three crystalline forms in which Boron exist. [L1]

Ans.a) Prismatic Borax ($Na_2B_4O_7.10H_2O$)

b) Octahedral Borax ($Na_2B_4O_7.5H_2O$)

c) Anhydrous Sodium tetra borate ($Na_2B_4O_7$

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Give example of group-13 elements. And give their symbols also[L1]

Ans. Boron (B) ,Aluminium (Al), Gallium (Ga) , Indium(In) and Thallium (Tl).

Q2.What are two isotopic forms of boron? [L1]

Ans: B(10,5) and B(11,5).

Q3.Name non-metal of Boron Family .What is the reason for its non-metallic behavior? [L1]
Ans Boron. Because of its small size ,high ionization enthalpy and comparatively high electronegativity.

Q4. What are the constituents of bead formed in borax bead test? [L1I]
Ans: Sodium metaborate and boric anhydride

Q5.Which of the following has highest melting point :TI,B,Ga,Al? [L1]
Ans:TI

TWO MARKS QUESTIONS

Q1: What is/are oxidation states of gallium? Give its reason also. [L1]
Ans:+1 and +3 ,due to inert pair effect

Q2.Which of the following is more acidic: TI_2O and B_2O_3? [L2]
Ans: B_2O_3 because down the group acidic character decreases because ionization enthalpy decreases.

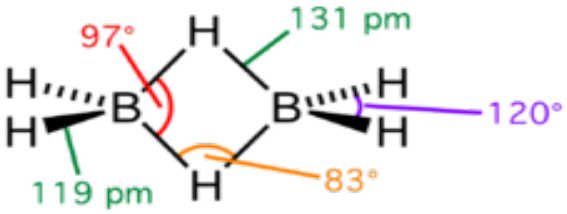
Q3.Which of the following is more basic: TI_2O and N_2O_3? [L2]
Ans: TI_2O because down the group basic character increases because ionization enthalpy decreases

Q4.What is tincal? [L1]
Ans: Naturally occurring Borax is called Tincal . It is obtained from dried up lakes contains about 50% of borax.It is boiled with water and filtered to remove insoluable impurities of clay,sand etc. This filtrate is concentrated when crystals of borax separate out.

Q5.What areLewis acids? (L-III]
Ans .Lewis acids accept an electron pair. Lewis Acids are Electrophilic meaning that they are electron attracting. When bonding with a base the acid uses its lowest unoccupied molecular orbital or LUMO.An atom, ion, or molecule with an incomplete octet of electrons can act as an Lewis acid (e.g., BF_3, AlF_3).

THREE MARKS QUESTIONS

Q1. Explain what is diborane and also show bond lengths and bonding in it. [L1]
Ans1:Diborane is the chemical compound consisting of Boronand Hydrogen with the formula B_2H_6. It is a colorless and highly unstable gas at room temperature with a repulsively sweet odor. Diborane mixes well with air, easily forming explosive mixtures. Diborane will ignite spontaneously in moist air at room temperature.



Q2.What is amphoterism? [L2]

AnsThe ability of water to do this makes it an amphoteric molecule. Water can act as an acid by donating its proton to the base and thus becoming its conjugate acid, OH-. However, water can also act as a base by accepting a proton from an acid to become its conjugate base, H_3O^+.

Water acting as an Acid:

$H_2O+NH_3 \rightarrow NH_4^+ + OH^-$

Water acting as a Base:

$H_2O+HCl \rightarrow Cl^- + H_3O^+$

The degree to which a molecule acts depends on the medium in which the molecule has been placed in. Water does not act as an acid in an acid medium and does not act as a base in a basic medium. Thus, the medium which a molecule is placed in has an effect on the properties of that molecule. Other molecules can also act as either an acid or a base. For example,

$Al(OH)_3 + 3H^+ \rightarrow Al^{3+} + 3H2O$

Where$Al(OH)_3$ is acting as a Lewis Base.

$Al(OH)_3 + OH^- \rightarrow Al(OH)_4^-$

where $Al(OH)_3$ is acting as an Lewis Acid.

Q3. Explain chemical properties of boron. [L2]

Ans. **Action of air and O_2**

Amorphous Boron is very reactive. When it is heated at 700 C in the air or O_2, it burns with a reddish flame forming a mixture of oxide and nitrate.

$4B + 3O_2 \rightarrow 2B_2O_3$

$2B + N_2 \rightarrow 2BN$

Action of acids

Halogen acids have no action on boron but it is attacked by oxidizing acids like HNO_3 and H_2SO_4.

$B + 3HNO_3 \rightarrow H_3BO_3 + 3NO_2$

$2B + 3H_2SO_4 \rightarrow 2H_3BO_3 + 3SO_2$

As reducing agents

`Boron is a powerful reducing agent, since it can replace carbon from CO_2, silicon from SiO_2, and nitrogen from NO.

$4B + 3CO_2 \rightarrow 2B_2O_3 + 3C$

$4B + 3SiO_2 \rightarrow 2B_2O_3 + 3Si$

$4B + 6NO \rightarrow 2B_2O_3 + 3N_2$

Action of Alkalies

It is vigorously attacked by fused alkalies or by fusion with oxidizing fusion mixture.

$2B + 6NaOH \rightarrow 2Na_3BO_3 + 3H_2$

Q4.Show Boron Nature with metals,nonmetals and steam. [HOTS]

Ans. **Action of metals**

Except for Cu, Ag and Au, Boron combines with other metals at high temperatures to form borides. These borides are extremely hard substances. Mg_3B_2 and Be_3B_2 are attacked by acids to form boron hydrides.

Action Of Non Metals

Boron also reacts with non-metals. For example: Boron combines with N_2 at temperatures greater than 900 C to form boron nitride, BN. Boron forms boron sulphide B_2S_3 when heated with S. On heating with Carbon in an electric furnace an extremely hard substance namely boron carbide, B_4C is formed.

Action Of Steam

Boron reacts with steam at red heat liberating H_2.

$2B + 3H_2O \rightarrow B_2O_3 + 3H_2$

Q5.What are the real world applications of boron family? [L2]

Ans. Boron compounds are being evaluated for treating arthritis.

The alloys of aluminum are used in the construction of aircraft and rockets.

Gallium is used to dope semiconductors and for producing solid-state devices.

Indium is used in low melting point alloys, making bearing alloys, transistors, thermistors, photoconductors, and rectifiers.

Thallium is used in selenium rectifiers, gamma radiation detection equipment, and infrared radiation detection and transmission equipment.

APPLICATION

ONE MARK QUESTIONS

Q1-why is boron used in nuclear reactions? [L- I]

Ansbecause boron can absorb neutrons.

Q2-why does boron form stable electron deficient compounds? [L- I]

Ansboron has three electrons in its valance shell that boron show three electrons with other element and form an electron deficient compound

Q3-By giving a balance equation show how $B(OH)_3$ behaves as an acid in water? [L- I]

Ans. $B(OH)_3 + 2HOH \longrightarrow [B(OH)_4]^- + H3O^+$

Q4- what is dry ice? Why is it so called? [L I]

Ans carbon dioxide can be obtained as a solid in the form of dry ice by allowing the liquefied CO2 to expand rapidly changes in to gas without changing in liquid.

Q5-Name the element of group 14 which exhibits maximum tendency for catenation? [L- I]

Ans –Carbon.

TWO MARKS QUESTIONS

Q1-what do you mean by Catenation? Why does 'C' show the property of catenation to maximum extent? (L-II)

Ans. It is the phenomenon of an atom to form a strong covalent bond with the atom of itself .Carbon shares the property of catenation to maximum extent because it is small and can form multiple bond to itself.

Q2- Give reason for the following observation (L-III)

(a)- The tendency for catenation decreases down the group in group 14

(b)- The decreasing stability of+3 oxidation state with increasing atomic no. in group 13.

(c)- Molten aluminum bromide is a poor conductor of electricity.

Ans. -(a) it is due to decrease in bond dissociation energy which is due to increase in atomic size

C-C > Si-Si >Ge-Ge>Sn-Sn>Pb-Pb.

(b)- It is due to inert pair effect.

(c)- Molten AlBr3 is poor conductor of electricity because it is covalent compound.

Q3-What are Fullerenes? How are they prepared? [L- II]

Ans. Fullerenes are the allotropes of carbon. Its structure is like a soccer ball .They is prepared by heating graphite in electric arc in presence of inert gases such as helium or argon.

Q4-Give reason [L-III]

(a)C and Si are always tetravalent but Ge, Sn, and Pb show divalency.

(b)Gallium has higher ionization enthalpy than Al.Explain.

Ans.(a) Ge, Sn and Pb show divalency due to inert pair effect, $Pb^{2+}$is more stable than Pb^{4+}.

(b)Due to poor shielding effect of d-electrons in Ga, effective nuclear charge increases as compared to Al. Thus the I.E of Ga is higher than Al.

Q5- Give reason why boron and aluminum tend of form covalent compounds.[LEVEL II]

Ans. Sum of the three ionization enthalpies of both the elements are very high. Thus they have no tendency to lose electrons to form ionic compound. Instead they form covalent compounds.

THREE MARKS QUESTIONS

Q1.-What are electron deficient compounds? AreBCl_3 and $SiCl_4$ electron deficient species? Explain. [L -II]

Ans. Electron deficient species are those in which the central atom in their molecules as the tendency to accept on or more electron pairs. They are also known as Lewis acids .BCl_3 and $SiCl_4$ both are electron deficient species. Since, in BCl_3 and B atom as only 6 electrons therefore, it is an electron deficient compound. In $SiCl_4$ the central atom as 8 electrons but it can expand it covalence beyond 4 due to the presence of d-orbital. Thus .$SiCl_4$ should also be considered as electron deficient spaces.

Q2-Give reasons [L- II]

(a)Why do boron halides form addition compound with NH_3?

(b)The tendency for catenation decreases down the group in Group 14.

(c)PbO_2 is a stronger oxidizing agent than SnO_2.

(a) it is because BX_3 is an electron deficient compound and NH_3 is an electron rich compound and acts as a base.

(b) As we move down the group 14, the atomic size increases thus the strength of the element decreases down the group thus the bond dissociation enthalpy decreases steadily consequently the tendency for catenation decreases down the group.

(c)PbO_2 and SnO_2 both are present +4 oxidation state but due to stronger inert pair effect Pb^{2+}ion is more stable than Sn^{2+} ion. In other way Pb_{4+} ions is more easily reduced to Pb^{2+} ions thus PbO_2 act as stronger

Q3-Expalin the difference in the properties of diamond and graphite based upon their structure.[L-II]

Ans3

Diamond	Graphite
Diamond is the hardest substance on earth.	Graphite is soft and slippery
In diamond carbon is sp^3-hybridised	In graphite carbon is sp^2-hybridized.
Since all the electrons in diamond are firmly In c-c, 6 bonds there are no free electrons in diamond crystal. Therefore diamond is bad conductor of electricity.	Since only three electrons of each carbon are used in making hexagonal rings of graphite, fourth valence electron is free to move thus graphite is a good conductor of electricity
Because of high refractive index diamond can reflect and refract the light.	Graphite is a black substance and posses a metallic luster.

Q4- Give reasons (I-III)

(a)Conc. HNO_3 can be transported in Al container.

(b)A mixture of diluted NaOH and Al pieces is used to open drain.

(c)Graphite is used as lubricant.

Ans.(a) Al reaches with conc.HNO_3 to form a very thin film of Al oxide on its surface which protects it from further reaction

$$2Al(S) + b\ 6HNO_3\ (conc.) - Al_2O_3\ (s) + 6NO_2(g) + 3H_2o(l)$$

(b)NaOH reacts with Al to evolve Hydrogen gas. Thus the pressure of the gas produced can be used for clogged drain

$$2Al(s) + 2NaOH\ (aq) + 2\ H_2O\ (l) \text{ ----------}\rightarrow - 2NaAlO_2\ (aq) + 3\ H_2\ (g)$$

(c) Graphite has layered structures which are held by weak van der waals forces. Thus, graphite cleaves easily b/w the layer; therefore it is very soft and slippery. That's why it is used as lubricant.

Q5 (a)Diamond is used as an abrasive. [L- II]

(b)Al alloy are used to make aircraft body.

Ans.(a) Diamond is used as an – abrasive because it is an extremely hard substance.

(b)Alloy of aluminum like duralumin is used to make aircraft body due to some of its property like toughness, lightness and resistant to corrosion

CARBON FAMILY

KNOWLEDGE

ONE MARK QUESTIONS

Q.1How carbon differ from rest of the elements of group 14?(L2)

Ans. Catenation and tetra valency.

Q2 Define Allotropes? (L1)
Ans. Substances showing similar chemical properties but different physical properties.

Q.3 What are zeolites?(L1)
Ans. They are the alumino silicates and used as shape selective catalysts. Eg.ZSM-5

Q.4Draw the Structure of Co_2?(L2)
Ans. O=C=O

Q.5 From which family does Ge Belongs to?(L1)
Ans. Carbon family.

TWO MARKS QUESTIONS

Q1 Write any two Allotropes of Carbon with one characterstic? (L1)
Ans. Graphite-soft and slippery
Diamond: Very Hard & Poor Conductor of electricity

Q2 Why Diamond shines?
Ans. Diamond-hard and brilliant glow due to highest refractive index.

Q.3 Write any two uses of silicones?(L2)
Ans. They are used artificial implants and in crockery.

Q.4 Although Diamond is Covalent, yet it has high melting point. Why? (L3)
Ans. All the four valencies are satisfied by carbon.

Q5 What is the state of hybridisation of Carbon in $CaCo_3$ and Diamond? (L2)
Ans. sp^2 &sp^3

Q.6Classify Following oxides as Neutral, Acidic, Basic, and Amphoteric? (L3)
CO - neutral
Sio_2-acidic
Pbo_2-amphoteric

THREE MARKS QUESTIONS

Q.1 Give reason for these: (L-III)
(I) Suggest a reason as to why CO is Poisonous
(II)How is Excessive Content of CO_2 responsible for global warming?
Ans (i) it combines with hemoglobin to form car boxyhemoglobin.
(ii)CO_2 traps the infrared heat radiations and forms a heat blanket and cause global warming

Q.2 Explain the difference in properties of diamond and graphite on the basis of their Structure?(L2)
Ans.1. Diamond has three dimensional network whereas graphite has two successive layers.
2. Diamond has high density while graphite has low.
3. Diamond has sp^3 and graphite has sp^2hybridised carbon atom.

UNDERSTANDING

ONE MARK QUESTIONS

Q.1Give one use of Dry ice?(L2)

Ans. As a freezing agent

Q2Which element of Group 14 exhibits maximum tendency for catenation? (L1)

Ans. Carbon

Q3Why Carbon Compounds are relatively inert? (L2)

Ans. Because of complete octet of Carbon in its compound.

Q4What is the basic building unit of all silicates? (L2)

Ans. SiO_4^{-4}linkage

TWO MARKS QUESTIONS

Q.1 $PbCl_4$ is less stable than $SnCl_4$ but $PbCl_2$ is more stable than $SnCl_2$. Justify? (L3)

Ans. due to inert pair effect +4 valency is less stable than +2 in case of Pb.

Q2 Write the equation for the production of Water Gas and producer gas from Coke? (L2)

Ans. $C + H_2O \rightarrow CO + H_2$(WATER GAS)

$2C + O_2 + N_2 \xrightarrow{1273K} 2CO + N_2$(PRODUCER GAS)

Q3 Give two Characteristics difference between C and Si?(L2)

Ans. 1. C does not has a vacant d orbital but Si has.

2. C is more electronegative than Si.

Q.4What are fullerenes? What type of structures do they have? (L3)

Ans. - Fullerenes are bucky balls with 60-120 carbon atoms. They are soccer like with pentagonal and hexagonal like.

THREEE MARKS QUESTIONS

Q.1 What are silicones? How are they prepared?(L2)

Ans -Silicones are a mixture of mono, di, and tri chlorosilanes along with tetra methyl silanes. Silicones are formed by the reaction between methyl chloride and silicon

$CH_3Cl + Si \rightarrow CH_3SiCl_3 + (CH_3)_2SiCl_2 + (CH_3)_3SiCl + (CH_3)_4Si$

Q.2 Discuss the anomalous behaviour of carbon in group 14?(L -2)

Ans. Absence of d orbital,

small size and formation of $p\Pi - p\Pi$ bonding

catenation.

Q3 Explain why-(L3)

(i)C and Si are Tetravalent but Ge, Si and Pb show divalency?

(ii)CCl_4 is resistant to hydrolysis?

Ans. due to inert pair effect

Ans. vacant d orbital is absent in C and due to small size.

APPLICATION

ONE MARK QUESTIONS

Q.1 Write a Use of Silicon?(L1)

Ans. silicon is used in making abrasives.

Q.2 Which elements of C-family does not dissolve in NaCl?(L3)

Ans. Si

Q.3 What is the most common use of Graphite ?(L1)

Ans. as lubricant.

Q.4 Name One natural Silicate?(L2)

Ans. Quartz

Q5 What compounds are used as Catalyst in Petrochemical industry?(L3)

Ans. Zeolites are shape selective catalysts and used to convert alcohol into petroleum

TWO MARKS QUESTIONS

Q.1 What are the Uses of Zeolites?(L-3)

Ans. They are used as shape selective catalysts

To remove the hardness of water

Q2 Write Uses of SiO_2?(L3)

Ans .It is used in manufacturing ofcement.

Used in reverberatory furnace as a flux.

Q3 Give reason Why Diamond is used as abrasive?(L2)

Ans. because it is the hardest substance .

All the four valencies are filled.

THREE MARKS QUESTIONS

Q1 Write Applications of Carbons Allotropes with examples? (L1)

Ans. 1.Graphite is used as a lubricant, soft and slippery.

2. Diamond is used as aabrasive, cutting tool and in jewellery.
3. Fullerene is used in nanotechnology.

Q2 What are the uses of carbon?(L1)

Ans. Carbon black is used as black pigment for black ink.

Coke is used as a reducing agent in metallurgy.

Graphite is used to make crucible and as electrodes

Diamond is used in used as a abrasive, cutting tool and in jewellery.

Q3 Trimetyl amine is pyramidal while trisilyl amine is trigonal planer . explain ?(L3)

Ans. In tri silylamine N is sp2 hybridised and pπ-dπ bonding take place while In trimethyl amine N is SP^3hybridised and No pπ-dπ bonding .

UNIT-12 ORGANIC CHEMISTRY- BASIC PRINCIPLES & TECHNIQUES

Concept :IUPAC Nomenclature

KNOWLEDGE

ONE MARK QUESTIONS

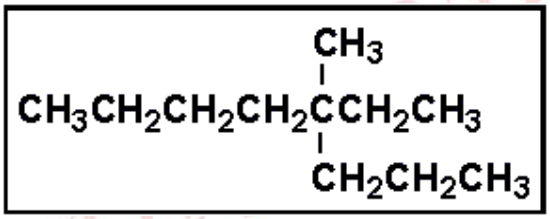
Q1 What makes carbon such a unique element? (L1)
Ans. Tetravalency and catenation

Q2 What is the hybridization of carbon atoms in alkanes ? (L1)
Ans. Sp3

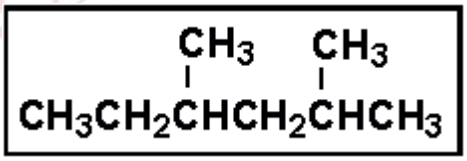
Q3 Write the IUPAC of molecule with the formula $C_3 H_8$? (L1)
Ans. propane

Q4 Select the correct IUPAC name for: (L2)

Ans.4-methyl-4-ethyloctane

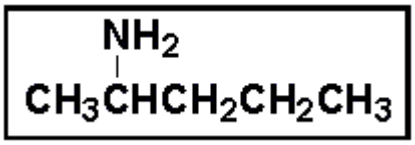


Q5 Select the correct IUPAC name for: (L3)
Ans. 2,4-dimethylhexane



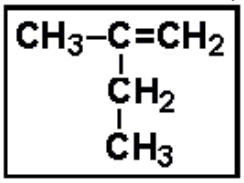
TWO MARKS QUESTIONS

Q1. Identify the functional group in the compound below. What is its type and write its IUPAC (L2)



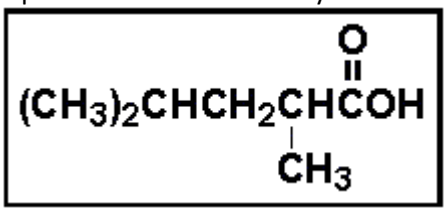
Ans. Amine, secondary,pentan-2-amine

Q2. Name the systematic name for the compound and write the hybridization. (L2)



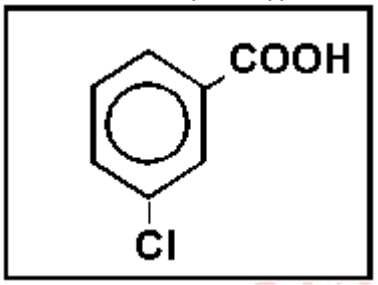
Ans. 2-Methyl but-1-ene ,sp^2, sp^3

Q3. Provide the IUPAC name for the compound below and identify the functional group (L3)



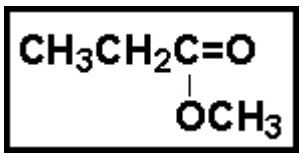
Ans. 2,4-dimethylpentanoic acid, carboxylic acid

Q4. Select the IUPAC name for this compound and identify the type of compound?



Ans.3-chlorobenzoic acid, aromatic carboxylic acid (L1)

Q5. What is the IUPAC name for the following compound and identify the class to which it belongs? (L2)



Ans. Methylpropan-1-oate, ester

THREE MARKS QUESTIONS

Q1 Enter the number of carbons indicated by each of the following root names in the designated answer box.(L3)

Word Root	Number of Carbons	Word Root	Number of Carbons
Hexane	6	**Propane**	3
Butane	4	**Pentane**	5
Nonane	9	**Heptane**	7
Decane	10	**Ethane**	2

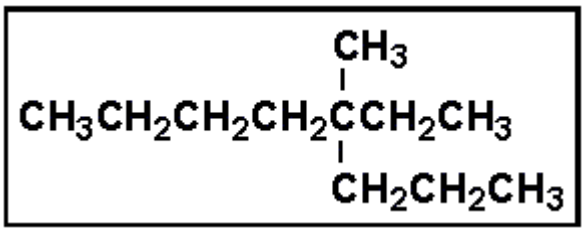
Q2: The line formula for a branched alkane is shown below.**$CH_3C(CH_3)_2CH_3$** (L2)

What is the molecular formula of this compound? C_5H_{12}

How many carbon atoms are in the longest chain? 3

How many alkyl substituents are attached to the parent chain? 2

Q3: The line formula for another branched alkane is shown below. (L1)



In the IUPAC system what is the root or base name of this compound? octane

How many alkyl substituent are attached to the longest chain? 2

Give the IUPAC name for this compound. 4-Ethyl-4-methyloctane

Q4: The formula for a substituted cycloalkane is shown below.$C_6H_{11}CH_3$ (L1)

In the IUPAC system what is the root or base name of this compound? cyclohexane

How many alkyl substituents are attached to the ring? 1

Give the IUPAC name for this compound. 1-Methyl cyclohexane

Q5: The formula for another cycloalkane derivative is shown below.$C_6H_{11}CH_2CH_3$ (L1)

In the IUPAC system what is the root or base name of this compound? cyclohexane

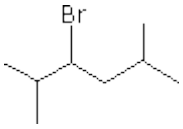
How many alkyl substituents are attached to the ring? 1

Give the IUPAC name for this compound. 1-Ethylcyclohexane

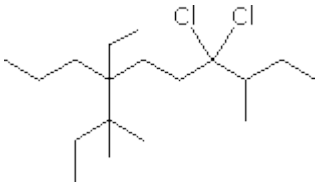
APPLICATION

ONE MARK QUESTIONS

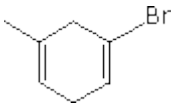
Q1. Name the following compounds according to the IUPAC system: (L1)

(1) 

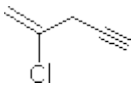
4-Bromo-2,3-dimethylhexane

(2) 

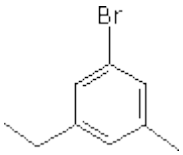
Enter the IUPAC name 4,4-Dichloro-7-ethyl-3-methyl-7-neopentyldecane (L3)

(3) 

Enter the IUPAC name 2-Bromo- 2- methylcyclohex-1,3-diene (L2)

(4) 

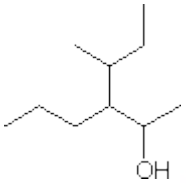
Enter the IUPAC name 2-chloropent-1-en-4-yne (L3)

(5) 

Enter the IUPAC name 1-Bromo-3-ethyl-5-methyl benzene (L2)

TWO MARKS QUESTIONS

Q1: The line formula for a compound is shown below. (L2)



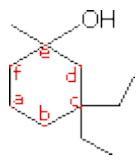
What IUPAC nomenclature suffix (ending) should be used for this compound? ol

How many carbon atoms are in the longest carbon chain? 6

How many carbon atoms are in the longest chain bearing the hydroxyl group? 6

Give the IUPAC name for this compound. 3-Isobutylhexan-2-ol

Q2: The formula for a substituted carbocyclic compound is shown below. (L3)



What IUPAC nomenclature suffix (ending) should be used for this compound? -ol

In numbering the ring, which carbon (a-f) is #1? e

In numbering the ring, which carbon (a-f) is #2? d

Give the IUPAC name for this compound. 3,3-diethyl-1-methyl cyclohexanol

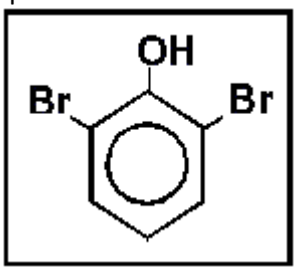
Q3: $CH_2=C(C_2H_5)CH_2C(CH_3)_2OH$ (L1)

Give the IUPAC name for this compound.

Name the functional group.

Ans. 4-ethyl-2-methylpent-4-en-2-ol, alcohol

Q4. What is the name of the following compound? Name the substituents. (L2)



Ans. 2,5-dibromophenol , Bromine

Q5.

Which one of the following is a secondary alcohol? Does any isomer of this exist?

(a) CH_3CH_2OH

(b) CH_3OH

(c) $CH_3CH(OH)CH_3$

(d) $(CH_3)C_3OH$

(e) none of these

Ans. c , yes propan-1-ol (L1)

THREE MARKS QUESTIONS

Q1. Which one of the following is a tertiary alcohol? (L2)

(a) CH_3CH_2OH

(b) CH_3OH

(c) $CH_3CH(OH)CH_3$

(d) $(CH_3)C_3OH$.

How many carbon atoms are in the longest chain? Write the name of its positional isomer?

Ans. d,,3, 2-Methyl propan-2-ol

Q2. Write the IUPAC name for: $(CH_3)_2CHCH(OH)CH_2C(CH_3)_3$,identify the functional group and type of compound.(L3)

Ans. 2,5,5-trimethylhexan-3-ol, alcohol, secondary alcohol

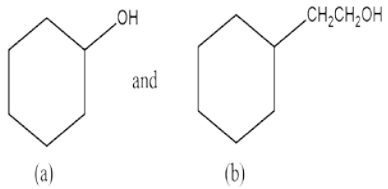
Q3. Name two isomers of butanol? Which has higher boiling point? (L1)

Ans. n-butanol and 2-methyl propan-2-ol.Butanol has the higher boiling point as the branching increases the surface area of the molecule decreases so the boiling point decreases.

Q4. Give the IUPAC name of this compound: CH_3OCH_3.Name one of its isomer. What kind of isomer are they? (L2)

Ans. methoxymethane, ethanol .functional isomers.

Q5. In the given diagram name the two structures. Are they isomers? How many carbon atoms are in their longest chain? (L3)



Ans. a) is cyclohexanol and b) is 2-cyclohexylethanol . No they are not isomers. a) 6 b) 2

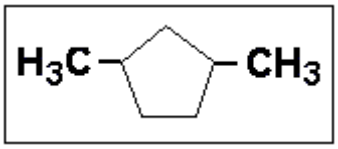
UNDERSTANDING

ONE MARK QUESTIONS

Q1. Name the following compounds according to the IUPAC system:

1. CH_2=$CHCH_2CH_2COOH$ (L2) Ans Pent-4-enoic acid
2. $HOOCCH_2CHCH_2CH(C_2H_5)COOH$ (L3) Ans 2-Ethyl hexan-1,6-dioic acid
3. $CH_3CH_2CH_2COOH$ (L1) Ans Butanoic acid

4. Select the correct IUPAC name for:

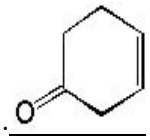


(L1)

Ans. 2,3-dimethylcyclopentane

Q2. What is the general formula for non cyclic alkynes? (L1)
Ans. C_nH_{2n-2}

TWO MARKS QUESTIONS



Q1._____ What is the correct name of the following molecule? Identify the functional group. (L2)

Ans. Cyclohex-3-en-1-one, ketone

Q2. Predict which of the following compounds will have the highest boiling point. (L1)

a. 1-butanol
b.propan-2-ol
c. 1-butene

d. Butanoic acid

Ans Butanoic acid due to hydrogen bonding

Q3 What is a proper name for the following ester? Identify the functional group?

$CH_3CH_2CH(CH_3)COOC_2H_5$(L2)

a. 2-butyl ethyl ester
b. ethyl 2-pentanoate
c. ethyl 2-methylbutanoate
d. methylbutanoic ethyl ester

Ans Ethyl 2-methylbutanoate, COO^-

Q4. What is the correct name of the following compound? P-$CH_3CH_2C_6H_5COOH$ (L3)

Ans.4- Ethylbenzoic acid ,

Q5. What is the correct name of the following molecule? $C_6H_5CH=CH_2$. Identify the hybridization? (L2)

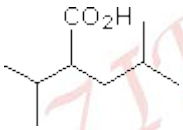
Ans Styrene (1-Phenyl ethene), sp^2

Q6 . What are the hybridizations of carbons 1 and 2 respectively in the following structure?

Ans. 1-*sp*3 and 2-sp^2

THREE MARKS QUESTIONS

Q1. A line formula for a compound is shown below.(L2)

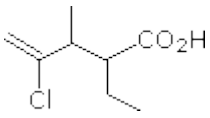


How many carbon atoms are in the root chain? [ ]

How many alkyl substituents are on this chain? [2]

Give the IUPAC name for this compound. [2-Isopropyl-4-methylpentanoic acid]

Q2. A line formula for a compound is shown below. (L3)



How many carbon atoms are in the root chain? [5]

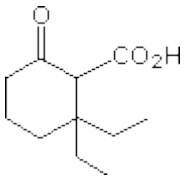
Give the IUPAC name for this compound. [5-Chloro-2-ethyl-3-methylpent-4-enoic acid]

How many alkyl substituents are on this chain? 2

Q3: The line formula for a cyclic compound is shown below.(L3)

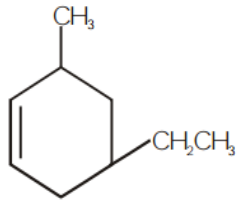
How many carbon atoms are in the root chain? 6

How many alkyl substituents are on this chain? 2



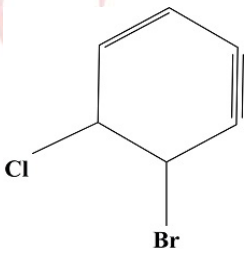
Give the IUPAC name for this compound. 6,6-diethyl-2-oxo-cyclohexane-1-carboxylic acid

Q4. Identify the class of this compound? Write the no. of substituents .What is the IUPAC name? (L2)



Ans.5-Ethyl-3-methylcyclohexene , AliCyclic compounds

Q5.Name the substituents. Write the class of the compounds. Write its IUPAC name.(L3)



Ans. chloro and bromo group . Ali cyclic . 5-bromo-6-chlorocyclohex-1-ene-3-yne

Concept: electronic displacement effects and isomerism.

KNOWLEDGE

ONE MARK QUESTIONS

Q.1. Define conformers/rotamers. (L-I)

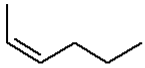
Ans1- **.** The spatial arrangements of atoms which can be converted into one another by rotation around a C-C single bond are called conformations or conformers or rotamers.

Q.2. What effect does branching of an alkane chain has on its boiling point? (L-I)

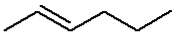
Ans. As the branching increases, the surface area of an alkane approaches that of a sphere. Since a sphere has minimum surface area, therefore, Vander Waal forces of attraction are minimum and hence the boiling point of the alkane decreases with branching.

Q.3. Draw the cis and trans structures of hex-2-ene.(L-II)

Ans:



cis-Hex-2-ene



Trans-Hex-2-ene

Q4. Among Cis and Trans structure of Hex-2-ene which has higher boiling point and why? (L-II)

Ans: The dipole moment of a molecule depends upon dipole-dipole interactions. Since cis-isomer has higher dipole moment, therefore it has higher boiling point.

Q5. Write IUPAC names of the following compounds (L-I)

(a) $CH_3CH=C(CH_3)_2$ (b) $CH_3CH(CH_3)CH=CH_2$

Ans. (a) 2-Methylbut-2-ene (b) 3-Methylbut-1-ene

TWO MARKS QUESTIONS

Q1. Out of pentane, 2-methylbutane and 2,2-dimethylpropane which has the highest boiling point and why?(L-II)

Ans. Pentane having a continuous chain of five carbon atoms has the highest boiling point (309.1K) whereas 2,2 – dimethylpropane boils at 282.5K. With increase in number of branched chains, the molecule attains the shape of a sphere. This results in smaller area of contact and therefore weak intermolecular forces between spherical molecules, which are overcome at relatively lower temperatures

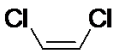
Q.2. Draw cis and trans isomers of the following compounds. Also write their IUPAC names (L-II)

(i) CHCl = CHCl

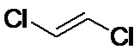
(ii) $C_2H_5CCH_3$ = $CCH_3C_2H_5$

Ans.

(i)

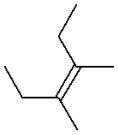


cis-1,2-dichloroethene

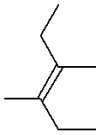


trans-1,2-dichloroethene

(ii)



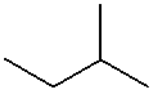
cis-3,4-dimethyl-hex-3-ene



trans-3,4-dimethyl-hex-3-ene

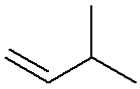
Q.3. Write structures of all the alkenes which on hydrogenation give 2-methylbutane?(L-II)

Ans. The basic skeleton of 2-methylbutane is :

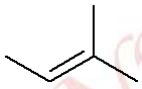


2-methylbutane

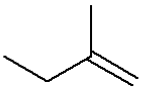
On hydrogenation of 2-methylbutane, the structures of various alkenes are:



3-methylbut-1-ene



2-Methylbut-2-ene



2-methylbut-1-ene

Q.4. Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile, E^+

(a) Chlorobenzene, 2,4-dinitrochlorobenzene, *p*-nitrochlorobenzene (L-III)

(b) Toluene, *p*-$H_3C - C_6H_4 - NO_2$, *p*-$O_2N - C_6H_4 - NO_2$.

Ans. Chlorobenzene> p-nitrochlorobenzene> 2,4-dinitrochlorobenzene

Toluene> *p*-$H_3C - C_6H_4 - NO_2$>*p*-$O_2N - C_6H_4 - NO_2$

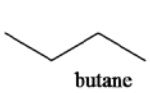
Q.5. Out of benzene, *m*–dinitrobenzene and toluene which will undergo nitration most easily and why?(L-II)

Ans. -CH_3 group is electron donating while –NO_2 group is electron withdrawing. Therefore, maximum electron density will be in toluene, followed by benzene and at least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

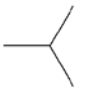
Toluene> benzene> m-dinitrobenzene

THREE MARKS QUESTIONS

Q.1 Write structures of different chain isomers of alkanes corresponding to the molecular formula C_4H_{10} and C_5H_{12}. Also write their IUPAC names.(L-II)



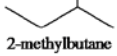
butane



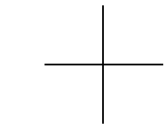
2-Methylpropane

Isomers of C_4H_{10}

pentane



2-methylbutane

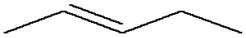


2,2-dimethylpropane

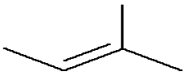
Q.2. Write structures and IUPAC names of different structural isomers of alkenes corresponding to C_5H_{10}

Ans:

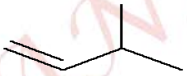
pent–1–ene



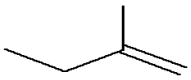
pent–2–ene



2–methylbut–2–ene



3–methylbut–1–ene



2–methyl–but–1–ene

Q.3. Discuss about structural isomerism and stereoisomerism. (L-II)

Ans. Structural Isomerism: Compounds having the same molecular formula but different structure i.e. different arrangement of atoms within the molecule are called structural isomers and the phenomenon is called as structural isomerism.

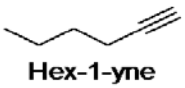
Types:

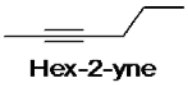
- Chain isomerism
- Position isomerism
- Functional isomerism
- Metamerism
- Tautomerism

- **Stereoisomerism**: Isomers which have the same structural formula but have different relative arrangement of atoms or groups in space are called stereo isomers and the phenomenon is called as stereoisomerism.

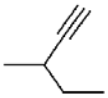
Q.4. Write structures of different isomers corresponding to the 5th member of alkyne series. Also write IUPAC names of all the isomers.

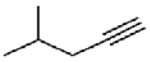
Ans.5th member of alkyne has the molecular formula C_6H_{10}. The possible isomers are:

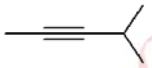

Hex-1-yne

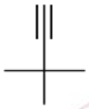

Hex-2-yne


Hex-3-yne


3-methylpent-1-yne


4-methylpent-1-yne


4-methylpent-2-yne


3,3-dimethyl-but-1-yne

Q.5. Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?(L-II)

Ans. Due to the presence of an electron cloud containing 6 pi electrons above and below the plane of the ring, benzene is a source of electrons. Consequently, it attracts the electrophiles towards it and repels nucleophiles. As a result, benzene undergoes electrophilic substitution reactions easily and nucleophilic substitution with difficulty.

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Write the no of possible isomers in case of following:

i) $CH_3C{\equiv}C\text{-}C{\equiv}CCH_3$ ii) $HC{\equiv}C\text{-}C{\equiv}C\text{-}CH_2CH_3$

Ans: i) one ii) three

Q2. Define metamers with example.

Ans: It arises due to different alkyl chains on either side of the functional group in the molecule. For example, $C_4H_{10}O$ represents methoxypropane (CH3OC3H7) and ethoxyethane ($C_2H_5OC_2H_5$).

Q3. What type of fissions is possible in a Covalent Bond?

Ans: Homolytic and Heterolytic

Q4. Write the order of stability of following Carbocation

H_3C^+, $(CH_3)_3C^+$, $(CH_3)_2C^+H$

Ans: H_3C^+ < $(CH_3)_2C^+H$ < $(CH_3)_3C^+$

TWO MARKS QUESTIONS

Q1. Trans-Pent-2-ene is polar while trans-but-2-ene is non polar. Explain. (L-II)

Ans. In trans-but-2-ene, the dipole moment of two C-CH_3 bonds are equal and opposite and hence they exactly cancel out each other. Thus trans-but-2-ene is non polar.

In trans-pent-2-ene, the dipole moments of C-CH_3 and C-CH_2CH_3 bonds are unequal. Although these two dipoles oppose each other, yet they do not exactly cancel out each other and hence trans-pent-2-ene has a small value of dipole moment and thus is polar.

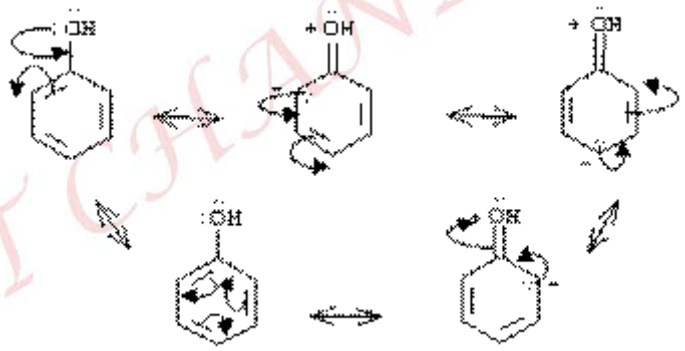
Q2. Explain why $(CH_3)_3C^+$ is more stable than $CH_3CH_2^+$ and $^+CH_3$. (L-I)

Ans. Greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyperconjugation interaction and +I effect of methyl group greater is the stabilisation of the cation.Thus, $CH_3)_3C^+$ is more stable than $CH_3CH_2^+$ and $^+CH_3$.

Q3. Explain the influence of different functional groups on monosubstitution of benzene.(L-II)

Ans. When monosubstituted benzene is subjected to further substitution, three possible disubstituted products are not formed in equal amounts. Two types of behaviour are observed. Either *ortho and para products or meta* product is predominantly formed.

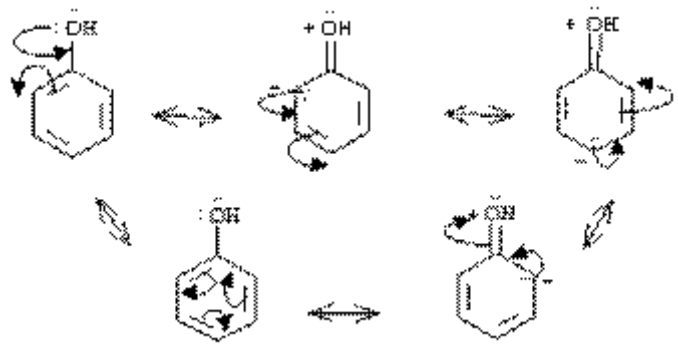
For example: Phenol gives ortho and para substitution.



And if nitro group is present in place of-OH group then, meta product will be predominant.

Q.4. Give one examples of *o* and *p* directing group.(L-I)

Ans. The groups which direct the incoming group to ortho and para positions are called ortho and para directing groups. For example: Phenol



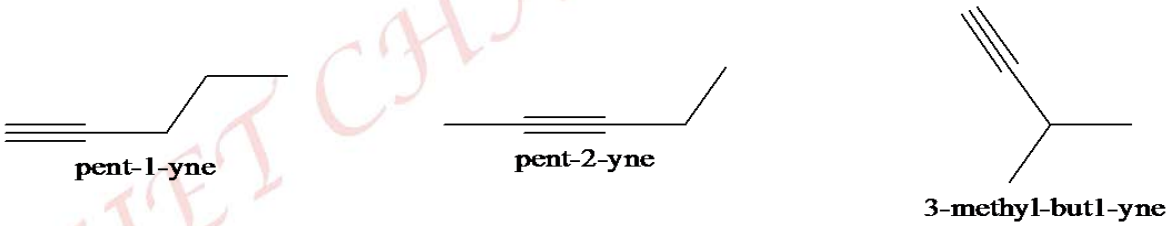
THREE MARKS QUESTIONS

Q1. For the following compounds, write structural formulas and IUPAC names for all possible isomers having the number of double or triple bond as indicated: (L-II)

(a) C_4H_8 (one double bond) (b) C_5H_8 (one triple bond)

Ans. (a) Isomers of C_4H_8 having one double bond are:

(b) Isomers of C_5H_8 having one triple bond are:



Q2. Explain electromeric effect, resonance effect and hyperconjugation. (L-II)

Ans: Electromeric effect is defined as the complete transfer of a shared pair of π-electrons to one of the atoms joined by a multiple bond on the demand of an attacking reagent. It is represented by E and the shifting of the electrons is shown by a curved arrow.

The resonance effect is defined as 'the polarity produced in the molecule by the interaction of two π-bonds or between a π-bond and lone pair of electrons present on an adjacent atom'. The effect is transmitted through the chain.

Hyperconjugation involves delocalisation of σ electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p orbital. The σ electrons of C—H bond of the alkyl group enter into partial conjugation with the attached unsaturated system or with the unshared p orbital. Hyperconjugation is a permanent effect.

Q3. Discuss the Mechanism of Chlorination of CH_4(L-III)

Ans: Chlorination is supposed to proceed via free radical chain mechanism involving three steps

Step I :Chain Initiation step

The reaction is initiated by hemolytic cleavage of Chlorine molecule in the presence of light or heat. The Cl-Cl bond is weaker than the C-C and C-H bond and hence, is easiest to break.

$Cl\text{-}Cl \longrightarrow Cl^{\cdot} + Cl^{\cdot}$

Chlorine free radicals

Step II : Chain Propagation step

Chlorine free radicals attacks the methane molecules and takes the reaction in the forward direction by breaking the C-H bond to generate methyl free radicals with the formation of HCl.

(a) $CH_4 + Cl^{\cdot} \longrightarrow CH_3^{\cdot} + H\text{-}Cl$

The methyl radicals attacks the second molecule of chlorine to form CH_3-Cl with the liberation of another Cl by homolysis of Cl_2 molecule

(b) $CH_3^{\cdot} + Cl\text{-}Cl \longrightarrow CH_3\text{-}Cl + Cl^{\cdot}$

The chlorine and methyl free radicals repeats steps (a) and (b) respectively and thereby setup a chain of reactions.

The propagation steps (a) and (b) are those which directly gives principal products, but many other propagation steps are possible.

Two such steps shown here explains how more halogenated products are formed

$CH_3Cl + Cl^{\cdot} \longrightarrow CH_2^{\cdot}Cl + HCl$

$CH_2^{\cdot}Cl + Cl\text{-}Cl \longrightarrow CH_2Cl_2 + Cl^{\cdot}$

Step III : Termination

The reaction stops after some time due to consumption of reactants and / or due to the following side reactions :

(a) $Cl^{\cdot} + Cl^{\cdot} \longrightarrow Cl\text{-}Cl$

(b) $CH_3^{\cdot} + CH_3^{\cdot} \longrightarrow H_3C\text{-}CH_3$

(c) $CH_3^{\cdot} + Cl^{\cdot} \longrightarrow H_3C\text{-}Cl$

Though in (c) CH_3-Cl , the one of the product is formed but free radicals are consumed and the chain is terminated.

This mechanism helps us to understand the formation of *ethane as a byproduct* during chlorination of methane

APPLICATION

ONE MARK QUESTIONS

Q1. In which C–C bond of $CH_3CH_2CH_2Br$, the inductive effect is expected to be the least? (L-II)

Ans. The magnitude of inductive effect decreases with distance and hence the effect is least in C_2-C_3 bond.

Q2. Write the metamer of diethyl ether. What is its IUPAC name? (L-I)

Ans.1-methoxypropane, $CH_3OCH_2CH_2CH_3$ or 2-methoxypropane,$CH_3OCH(CH_3)_2$

Q3. Give any two consequence of hyperconjugation effect? (L-II)

Ans: Consequence of hyperconjugation effect:-

1. Shortening of c-c single bond adjacent to multiple bond.
2. Stability of methylated alkenes.

TWO MARKS QUESTIONS

Q1. Which of the two: $O_2NCH_2CH_2O–$ or $CH_3CH_2O–$ is expected to be more stable and why? **(L-III)**

Ans. $O_2NCH_2CH_2O–$ is more stable than $CH_3CH_2O–$ because NO_2 group has –I effect and hence it tends to disperse the negative charge on the oxygen atom. In contrast, CH_3CH_2 has +I effect. It, therefore, tends to intensify the negative charge and hence destabilizes it.

Q2. Discuss the order of stability of1^0,2^0 and 3^0 free radicals? (L-I)

Ans. The stability of free radicals is as:

$3^0>2^0>1^0$

It is explained on the basis of hyperconjugation.

Greater the number of alkyl groups attached to the carbon atom carrying the odd electron, greater is the delocalisation of the odd electron and hence more stable is the free radical.

Q3. Discuss the order of stability of 1^0,2^0and3^0 carbocation. (L-I)

Ans. The stability of 1^0,2^0and3^0 carbocation is as:

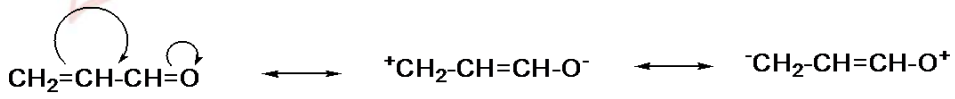
$3^0>2^0>1^0$

It is explained on the basis of Inductive effect.

Greater the number of alkyl groups attached to the carbon atom carrying the odd electron, greater is the delocalisation of the odd electron and hence more stable is the carbocation.

THREE MARKS QUESTIONS

Q1. Write resonance structures of $CH_2=CH–CHO$. Indicate relative stability of the contributing structures. (L-III)



I II III

Structure I is most stable since each C and O atom has an octet of electrons and none of these atom carries any charge. Structures II and III both involve separation of charge and hence both are less stable than structure I. However, Structures II is more stable than structure (III) since it carries a negative charge on the more electronegative O atom and positive charge on the less electronegative C atom while in structure (III), the more electronegative O atom carries the positive charge while the less electronegative C atom carries the negative charge.

Thus, the decreasing order of stability:

I>II>III

Q2. Give three point of difference between Resonance and Inductive effect. (L-I)
Ans. Resonance:
a. The resonance involves pi-electrons or lone pair of electrons.
b. This effect moves all along the length of the conjugate system.
c. This result in complete transfer of electrons.
Inductive effect:
a. This effect involves sigma electrons.
b. This effect moves upto three carbon atoms and become negligible from the fourth carbon atom onwards.
c. This effect causes slight displacement of electrons.

Concept :Purification, Qualitative And Quantitative Analysis Of Organic Compounds

KNOWLEDGE

ONR MARK QUESTIONS

Q1 Suggest a method to purify a liquid which decomposes at its boiling point.
A 1. The process Distillation under reduced pressure is used to purify a liquid which decomposes at its boiling point.

Q 2 How will you separate a mixture of o-nitrophenol and p- nitrophenol ?
A 2. o-nitrophenol is steam volatile therefore it can be separated by Steam distillation.

Q 3 Lassaigne's test is not shown by diazonium Salt. Why?
A 3. On heating diazonium Salts loses Nitrogen and could not fuse with the sodium metal therefore diazonium salt do not show Positive Lassaigne's test for nitrogen.

Q4. What is sublimation? What kind of organic compounds can be purified by this technique?
A4. Process of change of solid substance directly into vapour phase without the intermediate liquid state is called sublimation. This technique is used to separate sublimable compounds.Like camphor ,ammonium chloride.

Q5. How we can separate coloured components?
A5. By chromatography.

TWO MARKS QUESTIONS

Q 1. Why is nitric acid is added to Sodium extract before adding Silver nitrate for testing halogens ? (L3)
A 1.Nitric acid is added to decompose NaCN and Na_2S

$$NaCN + HNO_3 \rightarrow NaNO_3 + HCN$$

$$Na_2S + 2HNO_3 \rightarrow 2NaNO_3 + H_2S$$

H_2S and HCN are gases and are escaped from the reaction vessel and do not interfere with the test.

Q2. How Sodium fusion extract is prepared ?(L2)

A 2. A small piece of dry Sodium metal is heated with a organic compound in a fusion tube for 2 -3 minutes and the red hot tube is plunged in to distilled water contained in a china dish. The contained of the china dish is boiled ,cooled and filtered. The filtrate is known as Sodium fusion extract.

Q 3. Why is an organic compound fused with Sodium for testing nitrogen,halogens and sulphur ?(L2)

A 3. On fusing with sodium metal the elements presents in an organic compounds are converted in to ionic compounds of sodium which are water soluble which can be filtered and detected by the respective tests.

Q4. Under what conditions can the process of steam distillation is used? (L2)

A 4. Steam distillation is used to purify the liquids which are steam volatile and insoluble in water and the liquids are not miscible with each other.

THREE MARKS QUESTIONS

Q 1 . Write a short note on differential extraction. (L2)

A . 1 When an organic compound is present in an aqueous medium it is separated by shaking it with organic solvent in which it is more soluble than in water. The aqueous solution is mixed with organic solvent in a separating funnel and shaken for sometimes and then allowed to stand for some time .When organic solvent and water form two separate layers the lower layer is run out by opening the tap of funnel and organic layer is separated. The process is repeated several times and pure organic compound is separated.

Q2.How carbon and Hydrogen is detected in a organic compounds. (L2)

A2. The Carbon and Hydrogen present in the Organic compound is detected by heating the compound with Copper II oxide in a hard glass tube when carbon present in the compound is oxidized to CO2 which can be tested with lime Water and Hydrogen is converted to water which can be tested with anhydrous copper sulphate which turns blue.

$C + CuO \longrightarrow 2Cu + CO_2$

$2\,H + CuO \longrightarrow Cu + H_2O$

$CO_2 + Ca(OH)_2 \longrightarrow CaCO_3 + H_2O$

$5H_2O + CuSO_4 \longrightarrow CuSO_4.5H_2O$

Q3. Explain the principle of paper chromatography.(L3)

A3. Paper chromatography is based on the difference in the rates at which the components of a mixture are adsorbed. The material on which different components are adsorbed is called Stationary phase which is generally made up of alumina, silica gel or activated charcoal. The mixture to be separated is dissolved in a suitable medium and it is called moving phase. The moving phase is run

on the Stationary phase, the different compounds are adsorbed on stationary phase at different rates and separated by differential adsorption method.

UNDERSTANDING

ONE MARK QUESTIONS

Q1.Will CCl_4 give white ppt.of AgCl on heating with $AgNO_3$? (L3)

A1.No, CCl_4 being covalent compound does not give white ppt.of AgCl on heating with $AgNO_3$.

Q2.Why is a solution of KOH is used to absorb CO_2 evolved during the estimation of carbon present in an organic compound?(L2)

A2.CO_2 is acidic reacts with strong base KOH to form K_2CO_3

$$2KOH + CO_2 \longrightarrow K_2CO_3 + H_2O$$

Q3. By which method aniline can be purified?(L2)

A3. By steam distillation.

Q4. Explain ,why an organic liquid vapourises at a temperature below its boiling point in steam distillation?(L2)

A4.Because for boiling to occur vapour pressure of organic compound & steam should be equal to atmospheric pressure. As vapour pressure of water is higher than organic liquid. Therefore, organic liquid vaporizes at a temperature below its boiling point in steam distillation .

Q5.Name a suitable technique of separation of the components from a mixture of calcium sulphate and camphor.(L1)

A5. The components from a mixture of calcium sulphate and camphor can be separated by the process of sublimation.

TWO MARKS QUESTIONS

Q1.. In DNA and RNA nitrogen is present in the ring system. Can Kjeldahl method can be used for the estimation of nitrogen present in these ?give reasons(L3)

A1. In DNA and RNA nitrogen is present in heterocyclic rings. Kjeldahl method can not be used to estimate nitrogen present in the ring because cannot be completely converted in to (NH4)2SO4 during digestion. Therefore Kjeldahl method cannot be used to estimate nitrogen present in DNA and RNA.

Q2.Give principles behind – (L2)

i) Crystallization ii) Chromatography

A2.i) impure solid is dissolved in minimum amount of solvent, insoluble impurities are filtered out .solution containing soluble impurities is heated till crystallization point. The crystals of pure substance separate out leaving behind impurities in mother liquor.

ii) It is based on the principle of selective adsorption of the components of a mixture between two phases, stationary phase and a moving phase. When stationary phase is solid the basis is adsorption and when it is liquid the basis is partition.

Q3.Two liquids (A)and(B)are separated by fractional distillation, the boiling point of (A) is less than (B).which liquid comes out first in distillate? Explain.(L2)
A3. The liquid (a) comes out first in distillate. On boiling the vapours of lower boiling component are formed first.

Q4.A liquid with high boiling point decomposes on simple distillation but it can be steam distilled for its purification .Explain how is it possible?(L2)
A4. In steam distillation boiling occurs when vapour pressure of organic compound & steam becomes equal to atmospheric pressure. As vapour pressure of water is higher than the organic liquid. Therefore, organic liquid vaporizes at a temperature below its boiling point in steam distillation without decomposing.

Q5.Why is acetic acid & not nitric acid is used to acidify soda extract for testing of sulphur by lead acetate test?(L3)
A5. Lead acetate on reacting with sulphuric acid will give a white ppt of lead sulphate which interferes in the detection of sulphur.

$(CH_3COO)_2Pb + H_2SO_4 \longrightarrow PbSO_4 + 2\ CH_3COOH$

APPLICATION

ONE MARK QUESTIONS

Q1. What indication is given by blood red coloration in Lassaigns test ?(L1)
A . Presence of both N and S together in an organic compound.

Q2. Why Glycerol could not be prepared by steam distillation?(L2)
A. Glycerol decompose at its Boiling point.

Q3. What is the common criteria for purifying organic compound ?(L1)
A. Their Fixed Melting and Boiling point.

Q4. Name a decolorizing agent commonly used to decolorize the organic compound?(L1)
A. Activated Charcoal.

Q5. It is advisable to prepare Lassaignes extract in distilled water why?(L2)
A. Tap water usually contain dissolved chlorine which gives test for halogen.

TWO MARKS QUESTIONS

Q1.Name the technique used to separate water from carbon tetrachloride?(L2)
A1.Water and carbon tetrachloride could be separated using a separating funnel, since the two are immiscible and heavier carbon tetrachloride forms the lower layer.

Q2 . What is the principle of Dumas method for the estimation of N in the organic compound?(L2)
A2 .In Dumas method , Nitrogen present in organic compound on heating with CuO release free nitrogen gas ,which collected by the downword displacement of KOH. From the voiume of nitrogen gas collected at STP, Nitrogen could be estimated.

Q3.Why freshly prepared $FeSO_4$ is used in nitrogen testing ?(L2)
A3.Because $FeSO_4$ gets hydrolysed if its solution is stored for long.

THREE MARK QUESTIONS

Q1.0.257g of organic substance was heated with conc. sulphuric acid and then distilled with excess of strong alkali .the ammonia gas evolved was absorbed in 50ml of .1M HCl which required 23.2ml of c for neutralization at the end of the process. Determine the % of nitrogen in the compound ?(L3)

A. Vol of 0 .1M HCl taken = 50ml

Vol of .1MNaOH used for neutralization of unused acid=23.2ml

Now,

23.2 ml of .1MNaOH =23.2ml of .1MHCl

Vol of .1MHCl unused=23.2ml

Vol of .1MHCl required for neutralization of NH_3 = 50-23.2=26.8ml

26.8ml of .1MHCl=26.8ml of .1M NH_3

100ml of 1M NH_3 solution contain nitrogen=14g

26.8 ml of .1M NH_3 solution contain nitrogen

= 14*26.8/10*1000

Percentage of Nitrogen=14*26.8*100/10*1000*.257

=14.6%

Q2. An organic compound contain 69% carbon and 4.8% hydrogen, the remaining being oxygen. Calculate the masses of carbon dioxide and water produced when 0.20g of this substance is subjected to complete combustion.(L3)

A . Calculation of mass of CO_2 produced:

Mass of compound =0.20g

%C =12 x C

69=12*mass of CO_2 formed*100/44*0.2

Mass of CO_2 formed =69*44*.2/12*100

= 0.506g

Similarly,

% H =2* mass of H_2O formed*100/18*mass of compound

4.8=2* mass of H_2O formed*100/18* 0.2

Mass of H_2O formed =4.8*18*0.2/2*100

=0.0864g

Q3. In an estimation of sulphur by carius method 0.468 g of an organic compound gave 0.668 g of barium sulphate. Find the percentage of sulphur in the compound.(L3)

A . Mass of the compound = 0.468 g

Mass of the barium sulphate = 0.668 g

% of sulphur = 32 X Mass of barium sulphate X 100/ 233 X Mass of the compound

= 32 x 0.668x100/ 233 x0.468 = 19.60 %

Q4.0.3780g of organic chloro compound gave 0.5740g of silver chloride in carius estimation .Calculate the percentage of chlorine present in the compound.(L2)

A. % of chlorine = 35.5*mass of AgCl formed * 100/143.5 * mass of the substance

= 35.5*0.5740*100/143.5*0.3780

= 19.6 %

Q5. In Dumas' method for estimation of nitrogen, 0.3g of an organic compound gave 50mL of nitrogen collected at 300K temperature and 715mm pressure. Calculate the percentage composition of nitrogen in the compound. (Aqueous tension at 300K=15 mm). (L2)

A. Volume of nitrogen collected at 300K and

715mm pressure is 50 mL

Actual pressure = 715-15 =700 mm

Volume of Nitrogen at STP=273*700*50/300*760

=41.9 ml

22400 ml of Nitrogen at STP weighs = 28 g

41.9 ml of Nitrogen weighs = 28*41.9/22400 g

% of Nitrogen = 28*41.9*100/22400*0.3

= 17.45 %

UNIT 13- HYDROCARBONS

ALKANES

KNOWLEDGE

ONE MARK QUESTIONS

Q1.What are conformations? (L-I)
Ans. Conformations are spatial arrangements which are obtained by rotation around sigma bonds.

Q2.What is decarboxylation? Give an example. (L-I)
Ans. The process by which carbon dioxide is removed from sodium acetate (or any sodium salt of acid) with the help of sodalime is called decarboxylation.

$$CH_3COONa + NaOH \xrightarrow{CaO} CH_4 + Na_2CO_3.$$

Q3.Why are alkanes called paraffins? (L-II)
Ans. Paraffin's means little affinity; alkanes due to strong C-C and C-H bonds are relatively chemically inert.

Q4. What do you mean by pyrolysis? (L-I)
Ans. The decomposition of a compound by the heat is called pyrolysis. This process when applied to alkanes is known as cracking.

Q5. Arrange the three isomers of pentane in increasing order of their boiling points? (L-II)
Ans.2, 2-Dimethylpropane<2- methyl butane<n-pentane

TWO MARKS QUESTIONS

Q1. Discuss the preparation of alkanes by Wurtz reaction. What is the limitation of the reaction? (L-II)
Ans. Wurtz synthesis: Higher alkanes are prepared by heating an alkylhalide (RX) with sodium metal in dry ether solution.

$$R\text{-}X + 2Na + XR \xrightarrow{\text{dry ether}} R\text{-}R + 2NaX$$

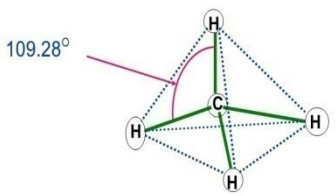
$$CH_3Br + 2Na + BrCH_3 \xrightarrow{\text{dry ether}} CH_3CH_3 + 2NaBr$$

Limitations: - use of two different alkyl holds in Wurtz Rxn always leads to a mixture of alkanes; those are difficult to separate because of little B.pt difference. So only symmetrical alkanes can be prepared by this method.

Q2. Discuss the shape of methane and ethane? (L-I)

Ans. Hybridization of C=sp^3

Shape-tetrahedral



Hybridization of C =sp^3

Structure- Tetrahedral

Q3. Explain hydrogenation reaction with example? (L-I)

Ans. Alkanes react with hydrogen in the presence of Ni or Pd Catalyst to form saturated compounds.

$CH_2=CH_2 + H_2 \xrightarrow{Pd} CH_3\text{-}CH_3$

Ethane

Q4. (a) What effect the branching of an alkane has on its melting point? (L-III)

(b) Which of the following has highest boiling point?(L-III)

(1) 2-methyl pentane.

(2) 2, 3-diethyl butane.

(3) 2, 2- dimethyl butane.

Ans.(a) In general conception, as the branching increases packing of the molecules in the crystals becomes less close and have melting point decreases accordingly.

(b) As the branching increases, surface area decreases and thus magnitude of Vander Waals forces of attraction decreases and hence the boiling point decreases. So, 2-methyl pentane has highest B.pt.

Q5. Write down the general combustion equation for alkanes. Also give one example. (L-I)

Ans. $C_nH_{2n+2} + \left[\frac{3n+1}{2}\right] O_2 \longrightarrow nCO_2 + (n+1)H_2O$

E.g $CH_4(g)+2O_2(g) \longrightarrow CO_2(g)+2H_2O(l)$

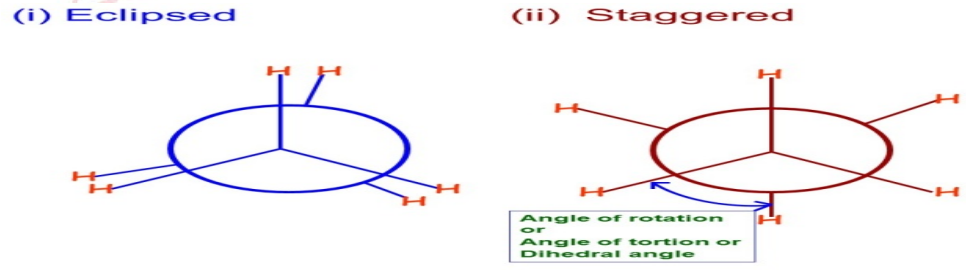
THREE MARKS QUESTIONS

Q1. Define the following terms with example. (L-I)

(a) Torsional strain
(b) Aromatization
(c) Isomerization

Ans .(a) The repulsive interaction between the electron clouds of a bonds of two non-bonded hydrogen atoms which affects the stability of a conformation is called torsional strain

E.g



(More torsional strain) (less torsional strain)

The process which involves conversion of alkanes containing six and more carbons into aromatic compound is called aromatization. Six to eight carbons atoms into aromatic compound when heated to about 773K under 10-20 atomic pressure in the presence of Cr_2O_3, V_2O_5, MO_2O_3as catalyst is called aromatization.

e.g.

(c) Isomerization : When n-alkanes are heated with anhydrous aluminium chloride and hydrogen chloride at 573K under a pressure of about 35 atmospheric, they are converted into branched chain alkanes.

$$\text{e.g. } CH_3 - CH_2 - CH_2 - CH_3 \xrightarrow[573K]{AlCl_3/HCL} CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$$

n-butane Isobutane

Q2. Discuss Kolbe's electrolytic method and for the preparation of alkanes. (L-II)

Ans. When sodium or potassium salt of a mono-carboxylic acid is electrolyzed it produces an alkane, this process is called as Kolbe's electrolytic method.

$$2RCOONa + 2H_2O \xrightarrow{\text{Electrolysis}} R\text{-}R + 2NaOH + H_2 + 2CO_2$$

Mechanism:

Step 1:

Ionization

$$2RCOONa \longrightarrow 2RCOO^- + 2Na^+$$

$$2H_2O \overset{\text{ionisation}}{\rightleftharpoons} 2OH^- + 2H^+$$

At Anode:

$$2RCOO^- \longrightarrow (2RCOO) + 2e^- \longrightarrow R\text{-}R^I + 2CO_2$$

Unstable Alkanes

R=Alkyl group

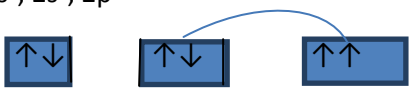
At Cathode:

$$2H^+ + 2e^- \longrightarrow [2H] \longrightarrow H_2$$

Q3. Explain the structure of (C_2H_6) Ethane using hybridization concept. Also draw the orbital diagram? (L-II)

Ans.In Ethane Molecules, each carbon atom undergoes sp^3 hybridization.

C (6) = $1s^2$, $2s^2$, $2p^2$

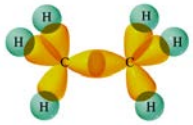
C (G.S)= 

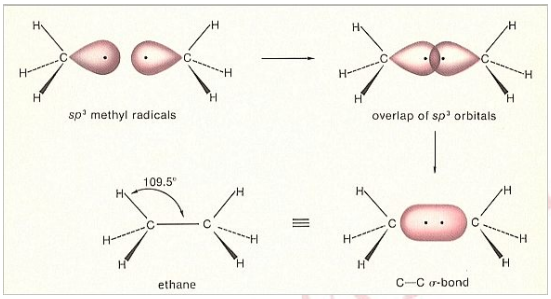
1s 2s 2p

C (G.S)= ↑↓ ↑↓ ↑ ↑ ↑

1s 2s 2p

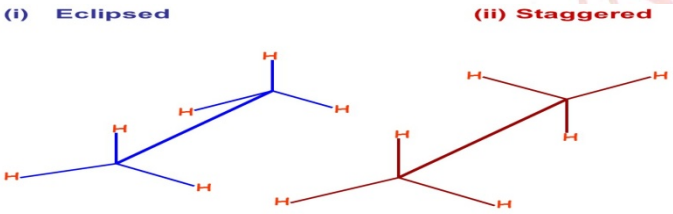
Orbital Diagram of Ethane





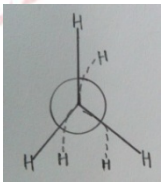
Q4. Define conformations. Also draw staggered & eclipsed conformation of ethane.(L-II)

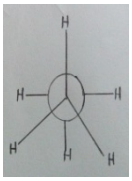
Ans. Conformations are spatial arrangements which are obtained by rotation around C-C sigma bond.



Saw-horse representation of eclipsed and staggered conformation of ethane

Eclipsed staggered





Newman projection for the eclipsed and staggered conformation of ethane.

Q5.Define the following terms with example.(L-II)

A. Wurtz Reaction.
B. Chain Isomerism.
C. Dihedral Angle.

Ans. (a) Wurtz Reaction: When alkyl halides react with sodium metal in the presence of dry ether the product obtained is alkanes with more no. of carbon atoms.

E.g. $CH_3 - Cl + 2Na + Cl - CH_3 \xrightarrow{\text{Dry ether}} 2NaCl + CH_3 - CH_3$

Ethane

(b) Chain Isomerism: The isomers which are differ with respect to the nature of the carbon atom which may be either straight chain or branched chain.

E.g. For C_4H_{10} butane the two isomers obtained are

$CH_3CH_2CH_2CH_3$ $\qquad$ $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$

Butane $\qquad$ 2-Methylpropane

(c) Dihedral Angle:- The angle between the two non bonded hydrogen atoms of the two neighboring carbon atoms in ethane is called Dihedral Angle.

UNDERSTANDING

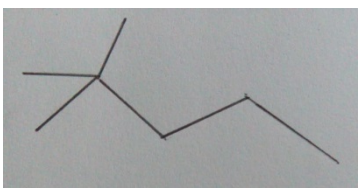
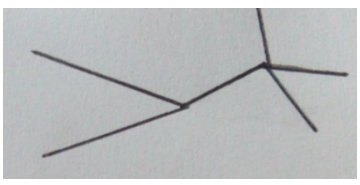
ONE MARK QUESTIONS

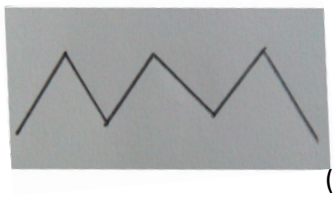
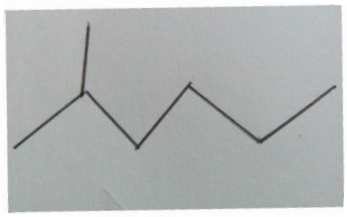
Q 1. Why do the C-C bonds rather than C-H bonds break during cracking of alkanes? (L-II)
Ans. Since the bond dissociation energy of C-C bonds (348kj /mol) is lower than bond dissociation energy of C-H bonds (414kj/mol), therefore, during cracking of alkanes, C-C bonds break more early than C-H bonds.

Q2. Give the IUPAC name of an isomer of hexane which has only two different sets of structurally equivalent hydrogen atom.(L-II)
Ans. $CH_3 - \underset{\displaystyle CH_3}{\underset{|}{CH}} - \underset{\displaystyle CH_3}{\underset{|}{CH}} - CH_3$ 2,2-dimethylbutane.

It has 12 equivalent 1^0 hydrogen and 2 equivalent 3^0 hydrogen

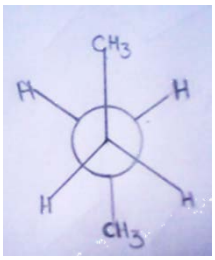
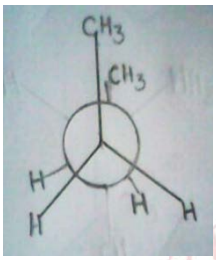
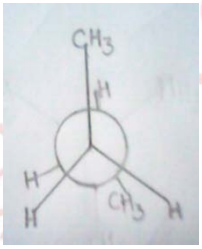
Q3. Arrange the following in increasing order of their release of energy on combustion.(L-II)

(a)  (b) 

(c)  (d) 

Ans. More the number hydrogen atoms in the carbon compound, greater is the heat of the combustion . Thus, the increasing order of heat of combustion is '(c) < (d) < (a) < (b)

Q4. Among the following, the most stable conformation of n-butaneis(L-III)

(a)  (b)  

(c)

Ans. (a) Anti conformation since the two bulky CH_3 groups is as far apart as possible.

Q5. Indicate the primary, secondary, tertiary and quaternary carbon atoms in the following: 3-ethyl-2-methylhexane.(L-III)

Ans.

$$\begin{array}{l} \quad\quad 1^0 \quad\; 2^0 \quad 1^0 \\ \quad\quad CH3 \quad CH_2{-}CH_3 \\ \quad\quad\;\; | \quad\quad | \\ CH_3-CH-CH-CH_2-CH_2-CH_3 \\ \quad 1^0 \quad 3 \quad 3^0 \quad 2^0 \quad\; 2^0 \quad 1^0 \end{array}$$

TWO MARKS QUESTIONS

Q1. Write the structural formula of the following compounds. (L-I)

1. 3,4,4,5 – tetramethylheptane
2. 2,5 – dimethylhexane

Ans. (a)

$$\begin{array}{l} \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad CH_3 \\ \quad\quad 1 \quad\; 2 \quad\; 3 \quad 4| \quad 5 \quad\; 6 \quad\; 7 \\ CH_3-CH_2-CH-C-CH-CH_2-CH_3 \\ \quad\quad\quad\quad\quad\quad\quad\quad | \quad | \quad | \\ \quad\quad\quad\quad\quad\quad\quad\quad H_3C \;\; CH_3 \;\; CH_3 \end{array}$$

(b) 1 2 3 4 5 6

$CH_3 – CH - CH_2 - CH_2 – CH - CH_3$

| |

CH_3 CH_3

Q2. Sodium salt of which acid will be needed for preparation of propane? Write chemical equation for the reaction.(L-II)

Ans. Since one carbon atom is lost as CO_2 during decarboxylation , therefore, the acid needed must contain one caron more than propane i.e butanoic acid or 2 methyl propanoic acid.

$$CH_3 – CH_2 – CH_2 – COONa + NaOH \xrightarrow[630K]{CaO} CH_3CH_2CH_3 + Na_2CO_3$$

propane

$$CH_3CH(CH_3)COONa + NaOH \xrightarrow[630K]{CaO} CH_3CH_2CH_3 + NaCO_3$$

propane

Q3. Which of the following has highest boiling point and why?(L-II)

(a) 2 methylpentane (b) 2,3 dimethyl butane (c) 2,2 dimythylbutane

Ans. As the branching increases, surface area decreases. As a result, magnitude of Vander Waals forces of attraction decreases and hence the boiling point decreases. Thus, the overall order of decreasing boiling point is: 2 methylpentane (333k) > 2,3 dimethylbutane (331k) > 2,2 dimethylbutane(323k)

Q4. Write structures for each of the following compounds. Why are the given names incorrect? Write correct IUPAC names?(L-III)

(a) 2- ethylpentane

(b) 5- ethyl -3- methylheptane.

Ans. (a) 1 2 3 4 5 6

$CH_3 - CH_2 – CH – CH_2CH_2CH_3$

CH_3

The longest chain here contains six carbon atoms. Therefore, the correct name is 3- methylhexane.

(b). 7 6 5 4 3 2 1

$CH_3 - CH_2 - CH - CH_2 - CH – CH_2 - CH_3$

| |

CH_3 $CH_2 – CH_3$

Since ‘e’ comes before ‘m’ in alphabetical order, therefore, numbering must be done from right to left . Therefore the correct name is 3 – ethyl – 5 – methylheptane.

Q5. Is it possible to isolate pure staggered ethane or pure eclipsed ethane at room temperature? Explain . (L-III)

The energy differences between staggered and eclipsed forms of ethane is just 12.55 kj mol^{-1} which is easily met by collisions of the molecules at room temperature. Therefore, it is not possible to isolate either pure staggered or pure eclipsed ethane at room temperature.

THREE MARKS QUESTIONS

Q1. How do you account for formation of ethane during chlorination of methane ?(L-I)

Ans. Chlorination of methane is a free radical reaction which occurs by the following mechanism.

Step I :Chain Initiation step

The reaction is initiated by hemolytic cleavage of Chlorine molecule in the presence of light or heat. The Cl-Cl bond is weaker than the C-C and C-H bond and hence, is easiest to break.

$Cl\text{-}Cl \longrightarrow Cl^{\cdot} + Cl^{\cdot}$

Chlorine free radicals

Step II : Chain Propagation step

Chlorine free radicals attacks the methane molecules and takes the reaction in the forward direction by breaking the C-H bond to generate methyl free radicals with the formation of HCl.

(a) $CH_4 + Cl^{\cdot} \longrightarrow CH_3^{\cdot} + H\text{-}Cl$

The methyl radicals attacks the second molecule of chlorine to form CH_3-Cl with the liberation of another Cl by homolysis of Cl_2 molecule

(b) $CH_3^{\cdot} + Cl\text{-}Cl \longrightarrow CH_3\text{-}Cl + Cl^{\cdot}$

The chlorine and methyl free radicals repeats steps (a) and (b) respectively and thereby setup a chain of reactions.

The propagation steps (a) and (b) are those which directly gives principal products, but many other propagation steps are possible.

Two such steps shown here explains how more halogenated products are formed

$CH_3Cl + Cl^{\cdot} \longrightarrow CH_2^{\cdot}Cl + HCl$

$CH_2^{\cdot}Cl + Cl\text{-}Cl \longrightarrow CH_2Cl_2 + Cl^{\cdot}$

Step III : Termination

The reaction stops after some time due to consumption of reactants and / or due to the following side reactions :

(a) $Cl^{\cdot} + Cl^{\cdot} \longrightarrow Cl\text{-}Cl$

(b) $CH_3^{\cdot} + CH_3^{\cdot} \longrightarrow H_3C\text{-}CH_3$

(c) $CH_3^{\cdot} + Cl^{\cdot} \longrightarrow H_3C\text{-}Cl$

Though in (c) CH_3-Cl , the one of the product is formed but free radicals are consumed and the chain is terminated.

Q2. Why is Wurtz reaction not preferred for preparation of alkanes containing odd number of carbon atom? Illustrate your answer by taking one example.(L-II)

Ans. For preparation of alkanes containing odd number of carbon atoms, a mixture of two alkyl halides has to be used since, two alkyl halides can react in three different ways, therefore , a mixture of three alkanes instead of the desired alkanes would be formed . For example , Wurtz reaction between 1 – bromopropane and 1- bromo butane gives a mixture of three alkanes , i.e hexane, heptane and octaneas shown below.

Dryether

$CH_3CH_2CH_2 – Br + 2Na + Br – CH_2CH_2CH_3 \longrightarrow CH_3CH_2\ CH_2CH_2CH_2CH_3 + 2NaBr$

(1 bromopropane) (1bromopropane) (Hexane)

Dry ether

$CH_3CH_2CH_2 – Br + 2Na + Br – CH_2CH_2CH_2CH_3 \longrightarrow CH_3CH_2CH_2CH_2CH_2CH_2CH_3 + 2NaBr$

(1 bromopropane) (1 bromopropane) (Heptane)

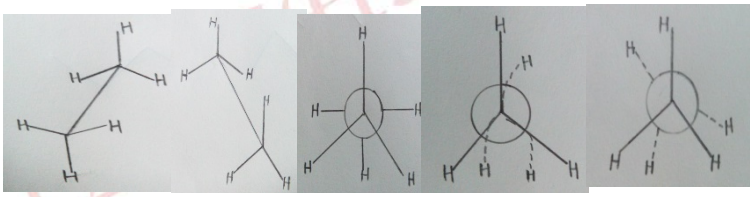
Dry ether

$CH_3CH_2CH_2CH_2 - Br + 2Na + Br – CH_2CH_2CH_2CH_3 \longrightarrow CH_3CH_2CH_2CH_2CH_2CH_2CH_2CH_3 + 2NaBr$

(1 bromobutane)(1 bromobutane)(Octane)

Q3. Rotation around carbon – carbon single bond of ethane is not completely free. Justify the statement.(L-III)

Ans. Rotation about C-C single bond is restricted due to repulsion between the electron clouds of C-H bonds on adjacent carbon atoms. As a result of this repulsion, ethane exists in infinite number of conformation out of which two extreme conformation i.e staggered and eclipsed are important



Staggered eclipsed staggered eclipsed skew

The staggered conformation is however, more stable than the eclipsed confarmation by about 12.55kj mol^{-1}. This energy difference of 12.55 kj mol^{-1} between the staggered and the eclipsed conformation is , in fact , the energy barrier to rotation about C-C single bond in ethane . However this energy barrier is not large enough to prevent rotation. Thus, the two conformations are readily interconvertible. As a result, it is not possible to seprate the two conformation of ethane. However at any given moment, most of the molecules would exist in the staggered conformation would exist in the staggered conformation due to its minimum energy and maximum stability.

Q4.Write the structure and names of products obtained in the reaction of sodium with a mixture of 1-iodo -2- methylpropane and 2-iodopropane.(L-II)

Ans. Wurtz reaction between 1-iodo -2- methylpropane and 2-iodopropane gives the following three products;

CH_2

I

(1) $CH_3 - \overset{1}{CH} - \overset{2}{CH_2} - \overset{3}{I} + 2Na + \overset{4}{I} - \overset{5}{CH_2} - \overset{6}{CH} - CH_3 \longrightarrow CH_3 - CH - CH_2 - CH_2 - CH - CH_3 + 2Na$

(1Iodo – 2- methylpropane -2molecules)

CH_3 CH_3

(2,5- dimethylhexane)

(2) $CH_3 - CH - I + 2Na + I - CH - CH_2CH_3 \longrightarrow CH_3 - CH - CH_2CH_2CH_3 + 2Na$

CH_3 CH_3

(2- Iodopropane (two molecules)) (2,3- dimethylbutane)

(3) $CH_3 - CH - CH_2 - I + 2Na + I - CH - CH_3 \longrightarrow CH_3 - CH - CH_2 - CH - CH_3 + 2NaI$

(1-Iodo -2- methylpropane) (2- iodopropane) (2,4- dimethylpentane)

Q5. Give reason for the following:

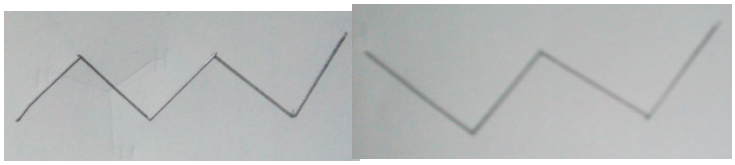
(1) The boiling points of alkanes decreases with branching.

(2) The melting points of alkanes with odd no. of carbon atoms are lower than those with even numbers of carbon atoms.

(3) Straight chain alkanes possess higher boiling points than the corresponding branched chain isomers.(L-II)

Ans.(1) With branching the shape of the molecule tends to approach that of a sphere . As a result, the surface area of the branched isomers decreases, so the vander waals forces of attraction between their molecule decreases, so the boiling point decreases.

(2) n-alkanes with even no. of carbon atoms have methyl groups in opposite directions and fit better in the crystal lattice than n-alkanes with odd number of carbon atoms have methyl groups in same directions and do not fit better in the crystal lattice and hence pack loosely in the crystal lattice.



Even no. of C-atoms odd no. of C-atoms

(more symmetrical) (less symmetrical)

Higher M.pt low M.pt

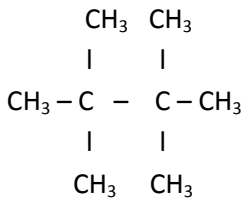
(3) Due to lower surface area, therefore strong vander waal's forces of attraction.

APPLICATION

ONE MARK QUESTIONS

Q1. An organic compound C_8H_{18} on monochlorination gives a single monochloride. Write the structure of the hydrocarbon.(L-III)

Ans.



Because, all the 18 H atoms are equivalent.

2,2,3,3 – tetramethylbutane.

Q2. What are the main constituent of LPG?(L-I)

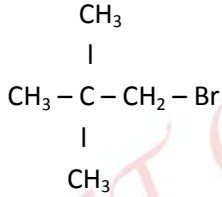
Ans. Butane and isobutane . Both these isomers can be easily liquified and hence can be conveniently transported in iron cylinder.

Q3. Explain why Grignard reagents do not reacts with alkanes.(L-II)

Ans. In alkanes , the C – H bond has very little polarity . The hydrogen cannot be abstracted by the Grignard reagent.

Q4. $C_5H_{11}Br$ on reaction with Na/ether gives 2,2,5,5 – tetramethylhexane. Assign structure of the compound.(L-II)

Ans.



1 -Bromo – 2,2 – dimethylpropane

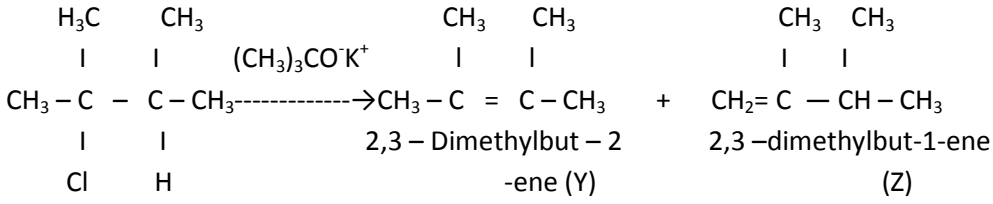
Q5. In cracking , C – C bonds cleave in preference to C – H bonds . Explain.(L-II)

Ans. The bond dissociation enthalpy of C –C bond (355 kj mol^{-1}) is loss a compared to that of C –H bond (414 kj mol^{-1}). Therfore, in th cracking of alkanes , generally C –C bonds cleave to form smaller molecule.

TWO MARKS QUESTIONS

Q1. An alkyl halide, X of formula $C_6H_{13}Cl$ on treatment with potassium tertiary butoxide gives two isomeric alkenes Y and Z (C_6H_{12}). Both alkenes on hydrogenation gives 2,3 – dimethylbutane. Predict the structure of X,Y and Z.(L-III)

Ans.



2 – Chloro – 2,3 – Dimethyl butane (X)

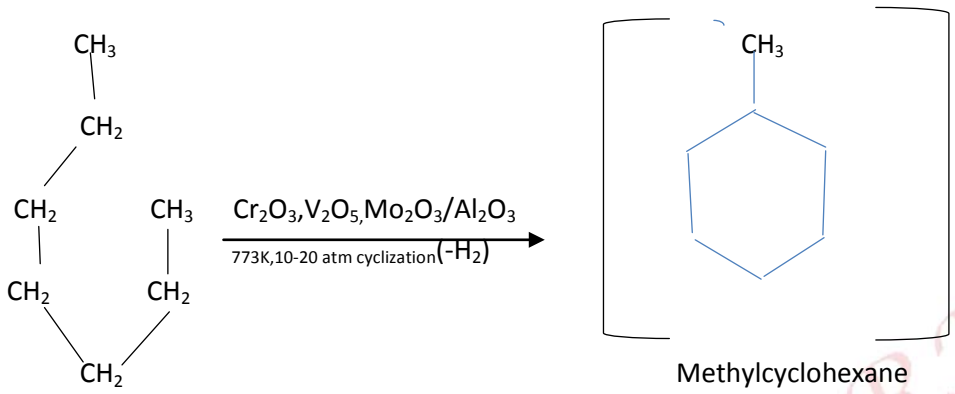
hydrogenation----------→$CH_3 - CH(CH_3) - CH(CH_3) - CH_3$

H_2/Pt

2,3 – dimethylbutane

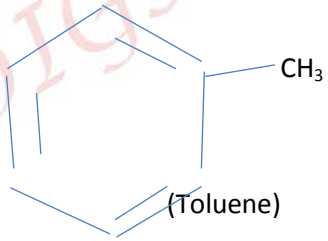
Q2. How will you convert n – heptane into toluene.

Ans.



Methylcyclohexane

Dehydrogenation($-3H_2$)

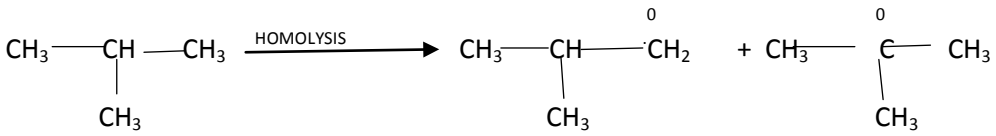


(Toluene)

Q3.Write hydrocarbon radicals that can be formed as intermediates during mono chlorination of 2-methylpropane?Which of them is more stable? Give reasons.

Ans. In general chlorination of alkanes proceed by free radical mechanism.2- methylpropane has both primary (1^0) and tertiary (3^9) carbon atoms. It will form two free radicals intermediates upon chlorination.

1^0 1^0



3^0 free radical is more stable 1^0 free radical(I) 3^0 free radical (II)

1^0 free radical due to

Hyperconjugation

Q4. An oxidising agent is needed in the iodination of methane but not in the chlorination or bromination . Assign reason-

Ans. In the iodination of methane, H-I is also formed as the product along with iodomethane. Since it is a strong reducing agent, it reduces iodomethane back to methane and makes the reaction reverssible. In order to destroy HI, oxidising agents like HIO_3(or HNO_3) is needed. But HCl and HBr formed in the chlorination and bromination reaction of methane are not in a position to react with the monosubstituted product , Since they are comparatively weak reducing agents . Therefore , no oxidising agents is needed for these reactions.

$CH_4 + I_2 \rightleftharpoons CH_3I + HI$

(Methane)

$5HI + HIO_3 \longrightarrow 3H_2O + 3I_2$

Q5. Iodine does not react with ethane though I_2 is more easily cleaved homolytically than the other halogens. Explain.

Ans. Bond dissociation enthalfy of I_2 is less as compared to that of Cl_2 and Br_2 which means that the homolysis of I_2 is the easier. However , HI formed in a reaction is a strong reducing agent and it makes the reaction reversible. Therfore, iodine does not reacts reversible. Therfore, iodine does not reacts with ethane.

$CH_3 - CH_3 + I_2 \rightleftharpoons CH_3 - CH_2 - I + HI$

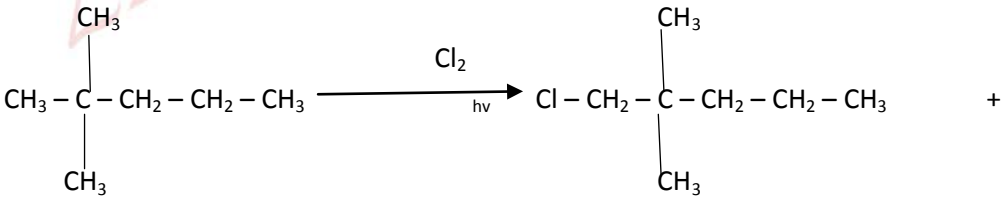
Ethane Iodoethane

THREE MARKS QUESTIONS

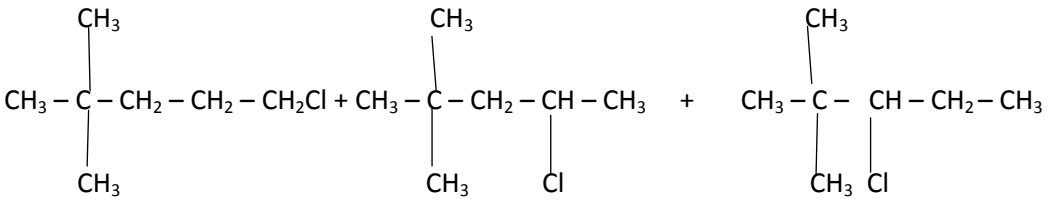
Q1. An alkane with molecular formule C_7H_{16} form four monochloro products when heated with chlorine in the presence of ultra violet radiations. Give the structure of the alkanes and also of the products . Write their IUPAC names as well.(L3)

Ans. The alkanes which gives four isomeric monochloro products is 2,2- dimethylpentane.

Since there are four types of carbon atoms present there are four isomeric product. The product as given as follow:



2,2- dimethylpentane (C_7H_{16}) 1- chloro-2,2-dimethyl pentane.



5-chloro-2,2-dimethylpentane 4-chloro-2,2-dimethylpentane 3-chloro-2,2-dimethyl pentane

Q2. A hydrocarbon C_4H_8 neither decolourises bromine dissolved in carbon tetrachloride nor reacts with HBr. When heated to 473k with hydrogen in the precence of nickel catalyst , a new hydrocarbon C_4H_{10} is formed . What is the original hydrocarbon?(L3)

Ans. The molecular formula of the hydrocarbon represent the following four structural isomers.

$CH_3 - CH_2 - CH = CH_2$ $\quad\quad$ $CH_3 - CH = CH - CH_3$

But-1-ene $\quad\quad$ But-2-ene

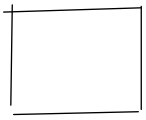
(I) $\quad\quad$ (II)

$CH_3 - C(CH_3) = CH_2$ $\quad\quad$ 

2-methylpropane $\quad\quad$ cyclobutane

(III) $\quad\quad$ (IV)

Since the hydrocarbon does not decolourise bromine dissolve in CCl_4 and also fails to react with HBr , this mean that it is not unsaturated in nature . The possibility of being an alkene is ruled out. It must be therefore, cyclobutane which reacts with hydrogen to form butane.



$+ H_2 \xrightarrow[473K]{Ni} CH_3 - CH_2 - CH_2 - CH_3$. Butane.

Cyclobutane

Q3. An alkane C_8H_{18} is obtained as the only product on subjecting a primary alkyl halids to Wurtz reaction . On monobromination this alkanes yeilds a single isomer of a teritiary bromids. Write the structure of alkane and the tertiary bromide.(L3)

Ans. Since the alkane upon monobromination forms a single isomeric tertiary alkyl bromide, the alkane is a symmetrical secondary alkane and the correponding primary alkyl halids which give this alkane by Wurtz reaction , is a branched chain derivation with four carbon atom. The reactions involved are given as follows:

$2CH_3 - CH(CH_3) - CH_2 - X + Na \xrightarrow{DRYETHER}$

.

$CH_3 - \overset{1}{C}H(CH_3) - \overset{2}{C}H_2 - \overset{3}{C}H_2 - \overset{4}{C}H(CH_3) - \overset{5}{C}H_3 \xrightarrow{Br_2(sunlight)}$ $\quad$ (1 2 3 4 5 6)

2,5-dimethylhexane(C_8H_{18})

$CH_3 - C(Br)(CH_3) - CH_2 - CH_2 - CH(CH_3) - CH_3$

2-bromo-2,5-dimethylhexane

Q4. An alkyl halide X of molecular formula $C_6H_{13}Cl$ on treatment with potassium tertiary butoxide give two isomeric alkanes Y and Z (C_6H_{12}). Both alkanes on hydrogenation gives 2,3-dimethylbutane. Predict the structuric of X,Y and Z.(L3)

Ans. The product of hydrogenation of both the alkanes Y and Z is:

$CH_3 - CH(CH_3) - CH(CH_3) - CH_3$ (2,3- dimethybutane)

The structure of alkanes (Y) and (Z) can be pridicted as follow:

$CH_2=C(CH_3) - CH(CH_3) - CH_3$ (Y) hydrogenation $CH_3 - C(CH_3) = C(CH_3) - CH_3$ (Z)

$CH_3 - CH(CH_3) - CH(CH_3) - CH_3$

The alkyl halide (X) which undergoes dehydrohalogenation with potassium tertiary butoxide is:-

$CH_3 - C(Cl)(CH_3) - CH(CH_3) - CH_3 \xrightarrow[-KCl,\ -H_2O]{(CH_3)_3\ CO^-K^+} CH_2= C(CH_3) - CH(CH_3) - CH_3$ + $CH_3 - C(CH_3)=C(CH_3) - CH_3$

2,3-dimethylbut-1-ene (Y) 2,3-dimethylbut-2-ene (Z)

Q5. n-butane is produced by the monobromination of ethane by Wurtz reaction. Calculate the volume of ethane required at NTP to produce 55g of n-butane if bromination takes place with 90 % yield and Wurtz reaction with 85 % yields.(L3)

Ans. The reaction involved are as follows :

$2CH_3CH_3 + Br_2 \longrightarrow 2CH_3CH_2Br$

$2_X30=60g$ $2_X(29+80)=218g$

$2CH_3CH_2Br + 2Na \rightarrow CH_3CH_2CH_2CH_3 + 2NaBr$

58g

Amount of bromoethane actually formed in the reaction = $\frac{218g \times 90}{100} = 196.2g$

Calculation of the amount of n-butane actually formed . From the available data, 218g of bromoethane are expected to form n-butane =58g

196.2g of bromoethane are exputed to form n-butane $= \frac{(58g)}{(218)} \times (196.2) = 52.2g$

But the yeild of n-butane is only 85 percent therefore, the amount of n-butane actually formed in the Wurtz reaction $= \frac{(52.2g)x85}{100} = 44.37g$

Caculaton of volume of ethane required at MTP 58g of n-butane are produced from ethane=60g

44.37 of n-butane are peoduced from ethane= $\frac{(60g)}{(58g)} \times (44.37g) = 45.9g$

Now , 30g of ethane at NTP correspond to 22.4L.

45.9g of ethane at N.T.P correspond to $= \frac{22.4l \times 45.9g}{(30g)} = 34.27L$

ALKENE AND ALKYNE

KNOWLEDGE

ONE MARK QUESTIONS

Q1. What is the general formula of alkanes? (L-I)
Ans. C_nH_{2n+2}

Q2. Write the general formula of alkenes. (L-I)
Ans. C_nH_{2n}
Q3. What is the general formula of alkynes? (L-I)
Ans. C_nH_{2n-2}

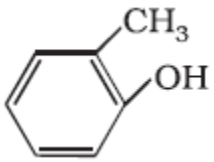
Q4. Give the IUPAC name of lowest molecular weight alkane that contains a quaternary carbon. (L-II)
Ans. 2,2-Dimethylpropane.

TWO MARKS QUESTIONS.

Q1.Write the IUPAC names of the following (L-I)

a) $CH_2=CH-C\equiv C-CH_3$

Pent-1-en-3-yne

b) 

2-Methylphenol

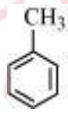
Q2. Write chemical equations for combustion reaction of (i) Butane (ii) Toluene (L-I)

Ans.

(i) $2C_4H_{10(g)} + 13O_{2(g)} \longrightarrow 8CO_{2(g)} + 10H_2O_{(g)} + \text{Heat}$

Butane

.

(ii) 

$+9O_{2(g)} \longrightarrow 7CO_{2(g)} + 4H_2O_{(g)} + \text{Heat}$

Toluene

Q3. What are the necessary conditions for any system to be aromatic? (L-I)
Ans. A compound is said to be aromatic if it satisfies the following three conditions:
(i) It should have a planar structure.
(ii) The π–electrons of the compound are completely delocalized in the ring.
(iii)The total number of π–electrons present in the ring should be equal to
$(4n + 2)$, where $n = 0, 1, 2 \ldots$ etc. This is known as Huckel's rule.

Q4. What effect does branching of an alkane chain has on its boiling point? (L-II)
Ans. As branching increases, the surface area of the molecule decreases which results in a small area of contact. As a result, the Van der Waals force also decreases which can be overcome at a relatively lower temperature. Hence, the boiling point of an alkane chain decreases with an increase in branching.

THREE MARKS QUESTIONS

Q1. What is Wurtz reaction? How can it be used to prepare butane? (L2)

Ans- When alkyl halides are treated with metallic Na in presence of dry ether, alkanes are formed. This reaction is called Wurtz reaction.

Butane is prepared by the reaction of bromoethane with metallic Na in presence of dry ether.

$$\underset{\text{Bromoethane}}{C_2H_5Br} + 2Na + \underset{}{BrC_2H_5} \xrightarrow{\text{dry ether}} \underset{\text{n-Butane}}{C_2H_5 - C_2H_5}$$

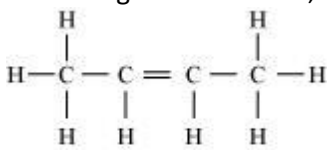
Q2. An alkene 'A' contains three C – C, eight C – H σ bonds and one C – C π bond. 'A' on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Deduce IUPAC name of A'. (L3)

Ans.. The formation of two moles of an aldehyde indicates the presence of identical structural units on both sides of the double bond containing carbon atoms. Hence, the structure of 'A'can be represented as:

XC = CX

There are eight C–H σ bonds. Hence, there are 8 hydrogen atoms in 'A'. Also, there are three C–C bonds. Hence, there are four carbon atoms present in the structure of 'A'. where X is $(CH_3)CH$

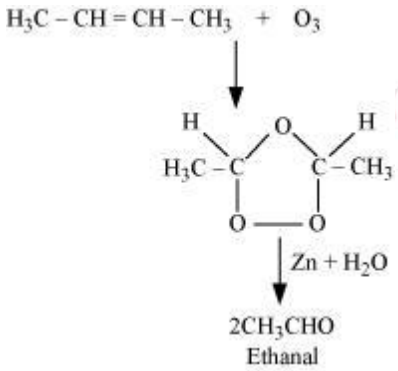
Combining the inferences, the structure of 'A'can be represented as:



(A)

the IUPAC name of 'A' is But-2-ene.

Ozonolysis of 'A' takes place as:

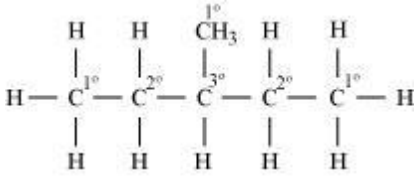


The final product is ethanal with molecular mass

$$= \left[(2\times 12)+(4\times 1)+(1\times 16)\right]$$

$$= 44 \text{ u}$$

3. In the alkane $H_3C - CH_2 - C(CH_3)_2 - CH_2 - CH(CH_3)_2$, identify 1°,2°,3° carbon atoms and give the number of H atoms bonded to each one of these.(L2)



The given structure has five 1° carbon atoms and fifteen hydrogen atoms attached to it.

The given structure has two 2° carbon atoms and four hydrogen atoms attached to it.

The given structure has one 3° carbon atom and only one hydrogen atom is attached to it

Q4. Discuss the laboratory preparation of Acetylene? (L-I)
A. Acetylene is prepared in the laboratory as well as in the industrial scale by the reaction of water on calcium carbide

$CaC_2 + 2H_2O \longrightarrow CH{\equiv}CH + Ca(OH)_2$

Calcium carbide is prepared by heating quick lime with coke. Quick lime can be obtained by heating limestone as shown in the following reactions:

$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$

$CaO + 3C \longrightarrow \underset{\text{Calcium Carbide}}{CaC_2} + CO$

UNDERSTANDING

ONE MARK QUESTIONS

Q1. Arrange the following in the increasing order of C-C bond length- C_2H_6 , C_2H_4, C_2H_2 (L-I)
Ans. $C_2H_2 < C_2H_4 < C_2H_6$

Q2. Out of ethylene and acetylene which is more acidic and why? (L-I)
Ans. Acetylene, due to greater electonegativity of the sp hybridised carbon.

Q3. Name two reagents which can be used to distinguish between ethene and ethyne. (L-II)
Ans. Tollen's reagent

Q4. Arrange the following in order of decreasing reactivity towards alkanes. HCl, HBr, HI, HF (L-I)
Ans. HI> HBr> HCl >HF

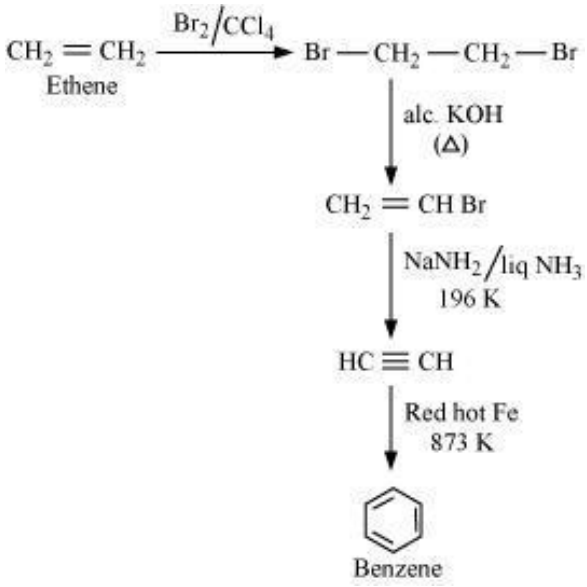
Q5.How will you detect the presence of unsaturation in an organic compound? (L-II)
Ans. Generally Unsaturated organic compound decolorize Bayer's reagent and Bromine water.

TWO MARKS QUESTIONS

Q1. How would you convert the following compounds into benzene? (i) Ethyne (L-II) (ii) Ethene ?(L-III)
Ans. **(i)** Benzene from Ethyne:

$$\underset{\text{ethyne}}{3CH \equiv CH} \xrightarrow[873\ K]{\text{Red hot Fe}} \underset{\text{Benzene}}{C_6H_6}$$

(ii) Benzene from Ethene:



Q2. Suggest the name of Lewis acids other than anhydrous aluminium chloride which can be used during ethylation of benzene. (L-I)
Ans. anhydrous $FeCl_3$, $SnCl_4$, BF_3 etc.

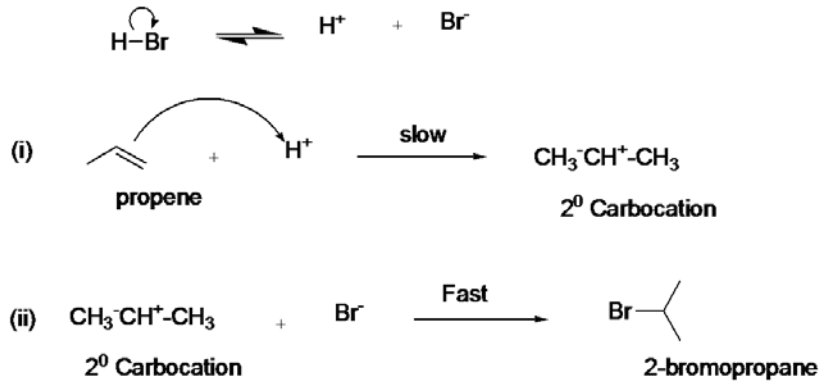
Q3. Write the name of all the possible isomers of $C_2H_2Cl_2$ and indicate which of them is non-polar. (L-II)
Ans. (i) cis-1,2-dichloroethene (ii) trans-1,2-dichloroethene (iii) 1,1- dichloroethene. trans-1,2 dichloroethene is non-polar.

Q4. Although benzene is highly unsaturated, it does not undergo addition reactions, why? (L-I)
Ans. Because of extra stability, due to delocalization of π-electrons.

THREE MARKS QUESTIONS

Q1. What is meant by restricted rotation around of carbon-carbon double bond? What type of isomerism does it lead to? (L-II)
Ans. The carbon-carbon double bond in alkene contains one sigma bond and one pi-bond. The Pi-bond involves the overlapping of unhybridised p orbital of two carbon atom .The rotation around the carbon-carbon double bond is only possible only if Pi bond breaks. The breaking of pi bond required 251KJ/M energy which is not provide by the molecular collision at room temperature .Therefore ,the atom or group attached to the double bonded carbon atoms cannot rotate about. In other words, the free rotation around C=C double bond is restricted, which gives rise to Geometrical Isomerism.

Q2 . Addition of HBr to propene yields 2-bromopropane, not 1-bromopropane. Explain and give mechanism. (L-III)
Ans. Addition of HBr to propene is an ionic electrophilic addition reaction in which the electrophile i.e. H^+first adds to give a more stable 2^0 Carbocation which is readily attacked by the nucleophile Br^- ion to give 2-bromopropane.



Q3. Calculate number of sigma (σ) and pi (π) bonds in the following (L-II)

(i) $CH_2 = C(CH_2CH_2CH_3)_2$

(ii) $CH_2 = CH - CH(CH_3) - CH_3$

(iii) $CH_3 - CH = CH - CH_3$

(i) Sigma bonds=23, pi bonds=1

(ii) Sigma bonds=14, pi bonds=1

(iii) Sigma bonds=11, pi bonds=1

APPLICATION

ONE MARK QUESTIONS

Q1. What is Grignard reagent? (L-1)
Ans. Alkyl magnesium halides

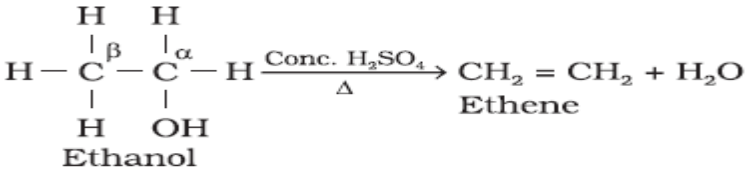
Q2. How will you demonstrate that double bonds of benzene are somewhat different from that of olefins? (L-II)
Ans. The double bonds of olefins decolorize bromine water and discharge the pink colour of Bayer's reagent while those of benzene not.

Q3. How will you separate propene from propyne? (L-III)
Ans. By passing the mixture through ammonical silver nitrate solution when propyne reacts while propene passes over.

TWO MARKS QUESTIONS

Q1. What are alkanes? Why are they called paraffins? (L-I)
Ans. Those hydrocarbons which contain single bond between carbon- carbon are called alkanes. They are called paraffins because they are very less reactive (Latin- Parum= little, affins = affinity)

Q2.How can ethene be prepared from (i) ethanol (ii) ethyl bromide? (L-II)
Ans. (i) Ethene from ethanol- by acidic dehydration of alcohols



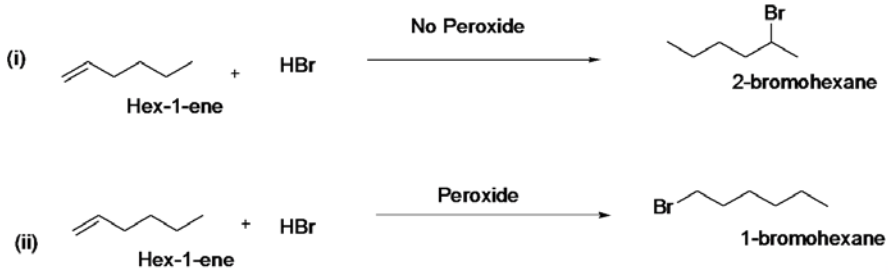
(ii) Ethene from ethyl bromide- by dehydrohalogenation of ethyl bromide

$CH_3CH_2Br + KOH\ (alc) \rightarrow H_2C = CH_2 + KBr + H_2O$

THREE MARKS QUESTIONS

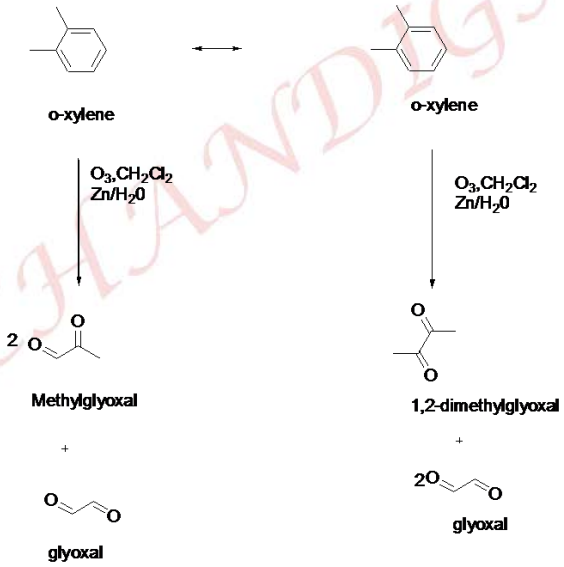
Q1. Write IUPAC names of the products obtained by addition reactions of HBr to hex-1-ene
(i) in the absence of peroxide and (L-II)
(ii) in the presence of peroxide.

Ans.



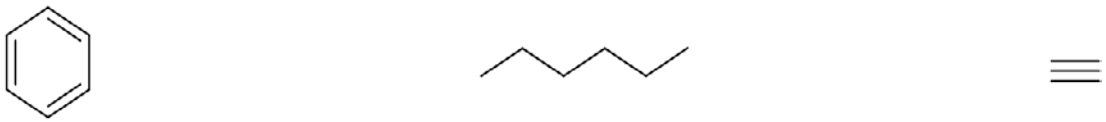
Q2**.** Write down the products of ozonolysis of 1,2-dimethylbenzene (*o*-xylene). How does the result support Kekulé structure for benzene? (L-II)

Ans. O-xylene may be regarded as a resonance hybrid of the following two Kekule structure. Ozonolysis of each one of these gives two products as shown below:



Q3. Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour. Also give reason for this behaviour. (L-III)

Ans.



Benzene Hexane Ethyne

Sp^2 sp^3 sp

Since s-electrons are close to the nucleus, therefore as the s-character of the orbital making the C-H bond increases, the electrons of C-H bond lie closer and closer to the carbon atom. In other words,

the partial positive charge on the H-atom and hence the acidic character increases as the s character of the orbital increases.
Thus the acidic character decreases in the order:
Ethyne> Benzene> Hexane

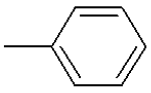
Q4. Write chemical equations for combustion reaction of the following hydrocarbons:
(i) Butane (ii) Pentene (iii) Hexyne (iv) Toluene .(L-II)

A.

(i) C_4H_{10} (Butane) + $13/2O_2$ ⟶ $4CO_2$ + $5H_20$

(ii) C_5H_{10} (Pentene) + $15/2O_2$ ⟶ $5CO_2$ + $5H_20$

(iii) C_6H_{10} (Hexyne) + $17/2O_2$ ⟶ $6CO_2$ + $5H_20$

(iv)  (Toluene) + $9O_2$ ⟶ $7CO_2$ + $4H_20$

Aromatic Compounds

KNOWLEDGE

ONE MARK QUESTIONS

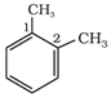
Q1 Define Aromatic Compounds. L_1

Ans: The Compounds which gives pleasant smell.

Q2 Define benzenoids Compounds. L_1

Ans: Aromatic compounds containing benzene ring.

Q3. Write the IUPAC name of following aromatic compound L_2



Ans: 1,2-Dimethylbenzene

Q4 How many π e$^-$s are here in Benzene Ring?L_2

Ans: 6 π e$^-$s

Q5. Which one is more stable structure of benzene among Kekule and Dewar's structures?L_1

Ans: Kekule's structure.

TWO MARKS QUESTIONS

Q1. Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile, E^+ (L_2)

(a) Chlorobenzene, 2,4-dinitrochlorobenzene, *p*-nitrochlorobenzene

(b) Toluene, *p*-$H_3C - C_6H_4 - NO_2$, *p*-$O_2N - C_6H_4 - NO_2$.

Ans. Chlorobenzene> p-nitrochlorobenzene> 2,4-dinitrochlorobenzene

Toluene> *p*-$H_3C - C_6H_4 - NO_2$>*p*-$O_2N - C_6H_4 - NO_2$

Q2. Out of benzene, *m*–dinitrobenzene and toluene which will undergo nitration most easily and why? L_3

Ans. -CH_3 group is electron donating while –NO_2 group is electron withdrawing. Therefore, maximum electron density will be in toluene , followed by benzene and at least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene> benzene> m-dinitrobenzene

Q3. Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour. Also give reason for this behaviour. L_3

Ans:

Benzene

sp^2

Hexane

sp^3

Ethyne

sp

Since s-electrons are close to the nucleus, therefore as the s-character of the orbital making the C-H bond increases, the electrons of C-H bond lie closer and closer to the carbon atom. In other words, the partial positive charge on the H-atom and hence the acidic character increases as the s character of the orbital increases.

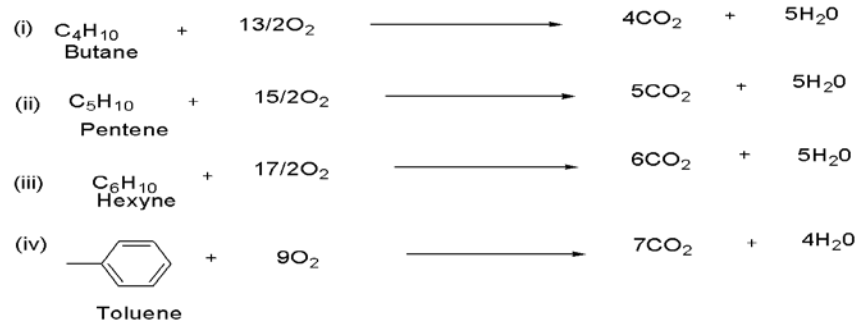
Thus the acidic character decreases in the order:

Ethyne> Benzene> Hexane

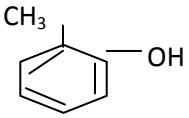
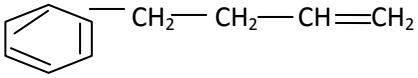
Q4 Write chemical equations for combustion reaction of the following hydrocarbons: L_2

(i) Butane (ii) Pentene (iii) Hexyne (iv) Toluene

Ans:



Q5. Write IUPAC names of following: L_2

i)  ii) 

Ans:

i) 2-methyl phenol ii) 4-phenyl but-1-ene

THREE MARKS QUESTIONS

Q1**.** Write three conditions for Aromaticity. L_1

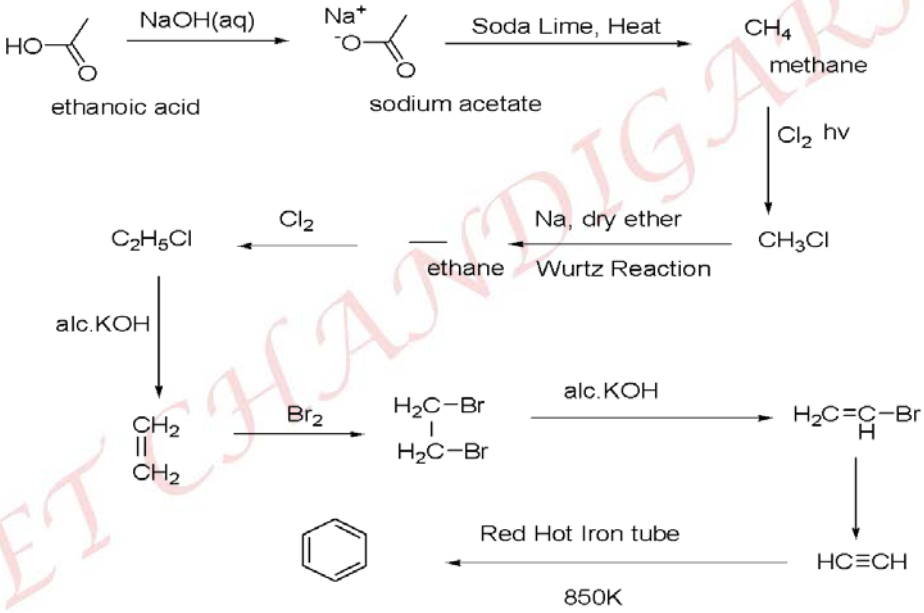
Ans: (i) Planarity

(ii) Complete delocalisation of the π electrons in the ring

(iii) Presence of $(4n + 2)$ π electrons in the ring where n is an integer (n = 0, 1, 2, . . .)

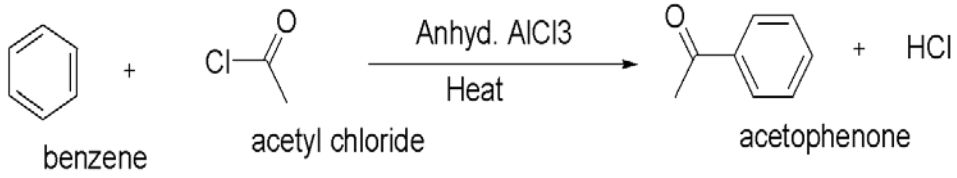
Q2. Write down the conversion of ethanoic acid into benzene? L_2

Ans:



Q3. What is Friedel-Crafts acylation reaction. Explain with example. L_2

Ans. The reaction of benzene with an acyl halide or acid anhydride in the presence of Lewis acids ($AlCl_3$) yields acyl benzene is known as Friedel-Crafts acylation reaction.



Q4. How would you convert the following into benzene?

(i)Ethyne (ii) Ethene (iii) Hexane L_3

Ans:

(i) $3 \equiv$ (ethyne) $\xrightarrow[873K]{\text{Red hot Fe Tube}}$ 

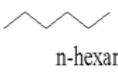
(ii) Ethene is first converted to ethyne and then to benzene :

$= \xrightarrow[\text{ethene}]{Br2/CCl4}$  $\xrightarrow[\text{dehyrobromination}]{\text{KOH(alc.), Heat}} \equiv$ ethyne

1,2-dibromoethane

$\xrightarrow[873K]{\text{Red hot Fe Tube}}$ 

(iii) when vapours of hexane are passed over heated catalyst consisting of Cr_2O_3, Mo_2O_3 and V_2O_5 at 773K under 10-20 atm pressure, cyclisation and aromatisation occurs simultaneously to afford benzene.

 $\xrightarrow[\text{Cyclisation}]{Cr_2O_3/V_2O_5/Mo_2O_3}$  $\xrightarrow{\text{Aromatisation}}$ 

n-hexane

Q5. Arrange benzene, n-hexane and ethyne in decreasing order of acidic behaviour. Also give reasons. L_3

Ans: Acidic behavior of these hydro carbons depends upon the elecrtonegativity of carbon which further depends upon the the s character of carbon involved.

		CH_3-$(CH_2)_4$-CH_3	CH	CH≡
Hybidisation of C	sp^2	sp^3		sp
% s character	33.3	25		50

Therefore acidic behavior will

CH_3-$(CH_2)_4$-CH_3 <  < CH ≡ CH

UNDERSTANDING

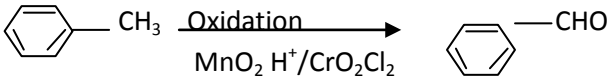
ONE MARK QUESTIONS

Q1. What does circle inside the benzene ring indicate? L_2

Ans: A delocalized ring of pi electrons.

Q2. Write down Etard's reaction. L_2

Ans: With mild oxidizing agent like acidified MnO_2(Manganese Dioxide) or CrO_2Cl_2 (chromyl chloride) the side chain is oxidized to aldehyde group is known as Etard's reaction.



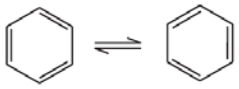
Q3. Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene. L_2

Ans. Anhydrous $FeCl_3$, $SnCl_4$, BF_3

TWO MARKS QUESTIONS

Q1. Draw the resonating structure of benzene. L_1

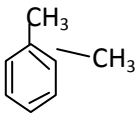
Ans:



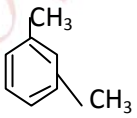
Q2. How many isomers are possible in monosubstituted and disubstituted benzene? L_2

Ans: Monosubstituted benzene do not show any isomer because all the five hydrogen attached to carbon atoms are identical.

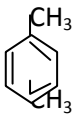
Disubstituted benzene exhibit position isomerism. For example there are three disubstituted benzenes namely 1,2- (or Ortho), 1,3- (or Meta), 1,4- (or Para) isomers as shown below



1,2-dimethyl benzene



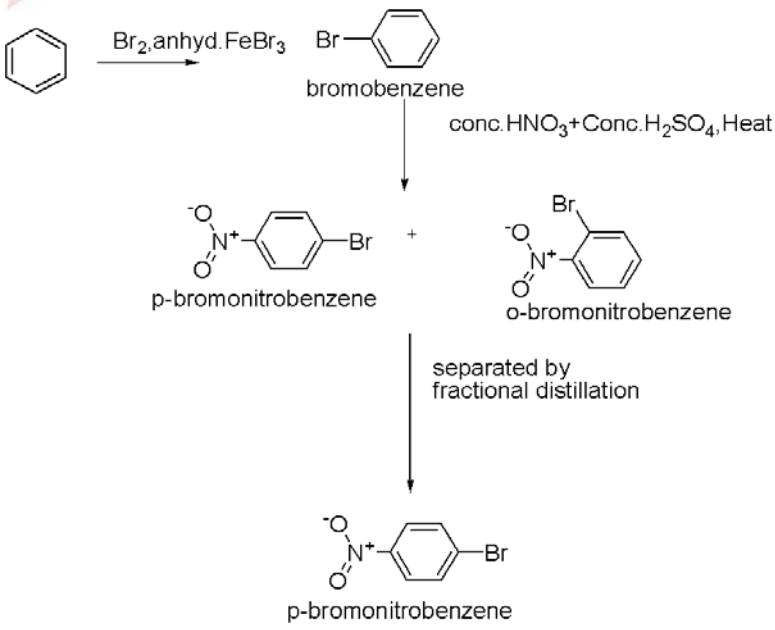
1,3-dimethyl benzene



1,4-dimethyl benzene

Q3. How will you convert benzene into *p*-nitrobromobenzene ? L_3

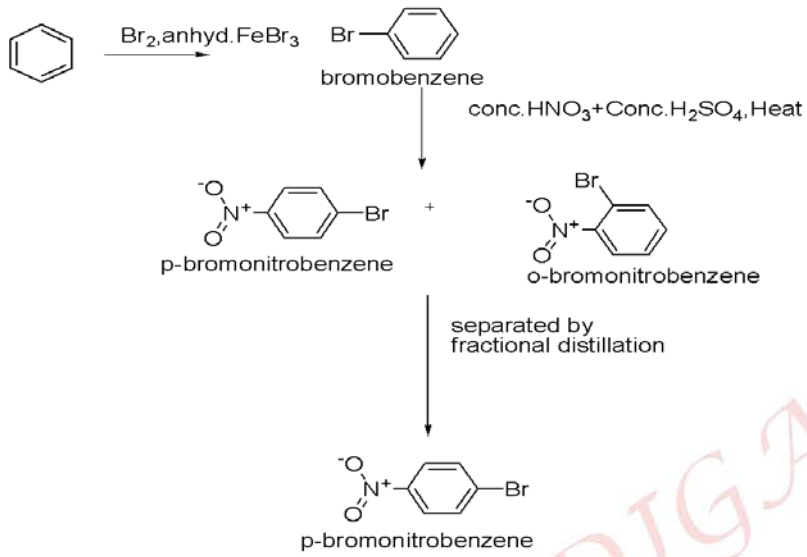
Ans:



Q4. Out of benzene, m-dinitrobenzene and toluene which will undergo nitration easily and why? L_3

Ans:- $-CH_3$ group is electron releasing while $-NO_2$ group is electron withdrawing. Therefore, maximum electro density will be in toluene followed by benzene and least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene> benzene> m-dinitrobenzene



THREE MARKS QUESTIONS

Q1. Explain the physical properties of benzene and its homologues. L_2

Ans: i. Benzene and its homologous upto eight carbon atoms are colourless liquids with characteristic smell.

ii. Aromatic hydrocarbons are immiscible with water but soluble in organic solvents.

iii. They are inflammable and burn with sooty flame.

iv. The melting and boiling points of aromatic compounds increases with increase in molecular mass due to increase in van der waals forces.

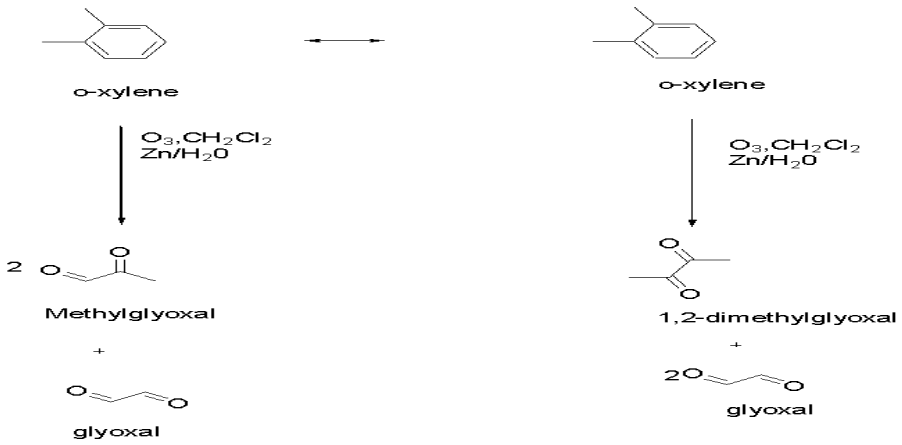
Q2. Explain the term resonance in term of Benzene. L_2

Ans: The stability of benzene can be explained on the basis of concept of resonance. Kekule in 1865 gave a ring structure for benzene in which the positions of the tree double bonds are not fixed. He suggested the double bond keeps on changing the positions and this is called resonance. According to Kekule benzene is the hybrid of following two structures:

Q3. Write down the products of ozonolysis of 1,2-dimethylbenzene (*o*-xylene). How does the result support Kekulé structure for benzene?

L_3

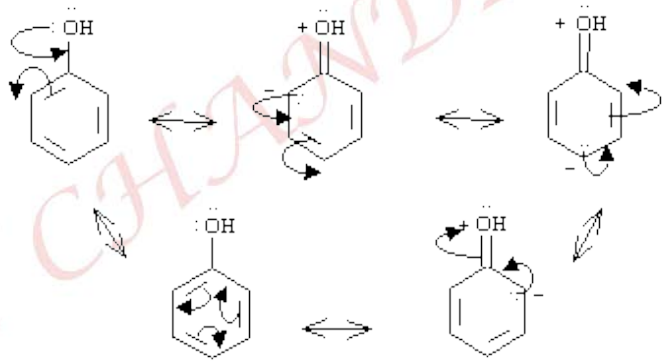
Ans. O-xylene may be regarded as a resonance hybrid of the following two Kekule structure. Ozonolysis of each one of these gives two products as shown below:



Q4. Explain the influence of different functional groups on monosubstitution of benzene. L_2

Ans. When monosubstituted benzene is subjected to further substitution, three possible disubstituted products are not formed in equal amounts. Two types of behaviour are observed. Either *ortho and para products or meta* product is predominantly formed.

For example: Phenol gives ortho and para substitution.



APPLICATION

ONE MARK QUESTIONS

Q1.Name the chemical name of lindane.L_1

Ans: BHC (Benzene Hexachloride)

Q2.Give the general formula of monocyclic Arenes.L_1

Ans: Monocyclic Arenes like benzene has general formula C_nH_{2n-6}.

Q3.What is halogen carrier? Give one example. L_2

Ans: A halogen compound used during halogenation of benzene is called as halogen carrier. For example $FeCl_3$

Q4.What type of isomerism exhibited by Arenes? L_2

Ans: Arenes exhibit position isomerism.

5.Name an ortho para deactivating group.L_2

Ans: $-NO_2$

TWO MARKS QUESTIONS

Q1.Why benzene is extraordinarily stable though it contains three double bonds?L_3

Ans: Extraordinarily stablility of benzene is due to resonance. Due to resonance pi electron cloud gets delocalized resulting in stability of molecule.

Q2.Which of the following are meta directors?L_2

$-NO_2$, -CHO, -OH, -Cl, $-NH_2$, $-SO_3H$

Ans: $-NO_2$, -CHO, $-SO_3H$

Q3.Describe Huckle's Rule with example.L_1

Ans: All planar cyclic polyenes contain (4n+2) pi electron where n=0,1,2,3… are Aromatic. For example Benzene.

Q4. What is delocalization energy?L_2

Ans: The difference in the energy of most stable resonating structure and resonance hybrid is called as resonance energy or delocalization energy.

Q5. Why C-C bond lengths in benzene are equal?L_3

Ans: Due to presence of delocalization of pi electrons.

THREE MARKS QUESTIONS

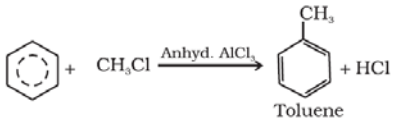
Q1.Explain the following with examples

i) Alkylation
ii) Nitration
iii) Sulphonation

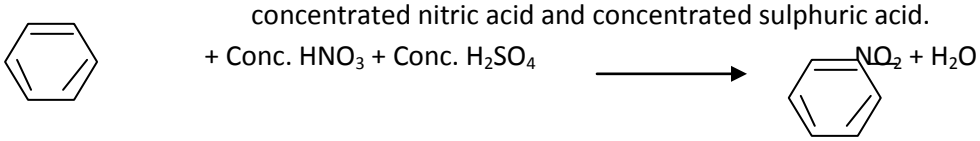
L_2

Ans: i) A*lkylation reaction:*

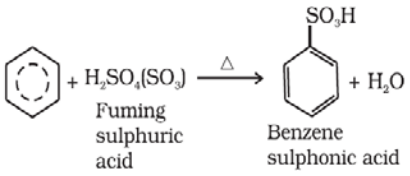
When benzene is treated with an alkyl halide in the presence of anhydrous aluminium chloride, alkylbenene is formed.



ii) *Nitration:* A nitro group is introduced into benzene ring when benzene is heated with a mixture of concentrated nitric acid and concentrated sulphuric acid.



iii) *Sulphonation:* The replacement of a hydrogen atom by a sulphonic acid group in a ring is called sulphonation. It is carried out by heating benzene with fuming sulphuric acid.



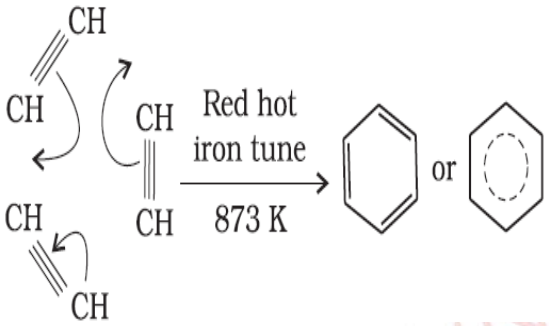
Q2. Why does benzene undergo electrophilic reactions easily and nucleophilic reactions with difficulty? L_3

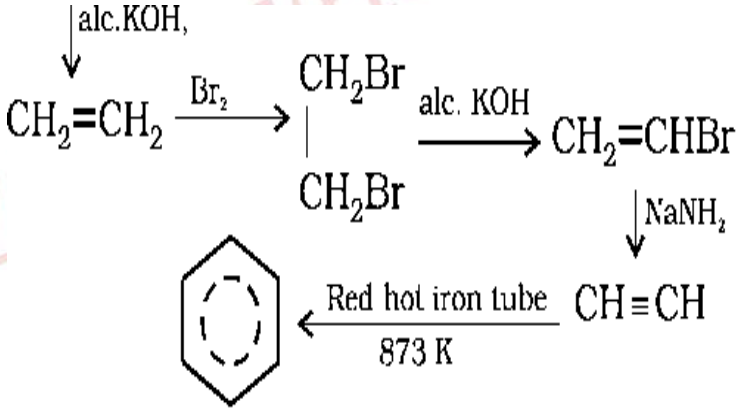
Ans: benzene has high electron density due to the presence of 3 π e$^-$pairs above and below the plane of the ring representing the double bond. Due to rich source of electrons benzene attracts the electrophile reagents towards it and repels nucleophile reagents.

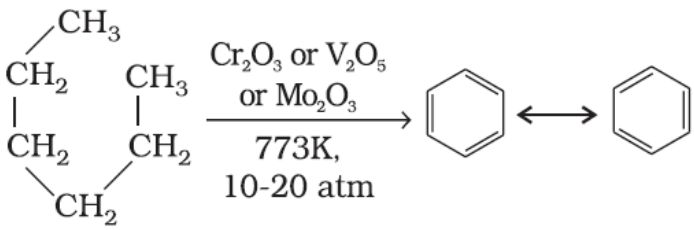
Q3. How will you convert the following compounds into benzene? L_3

i) Ethyne ii) Ethene iii) Hexane

Ans: i)



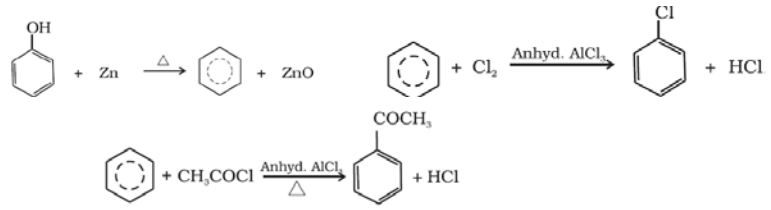




Q4. How will you convert? L_3

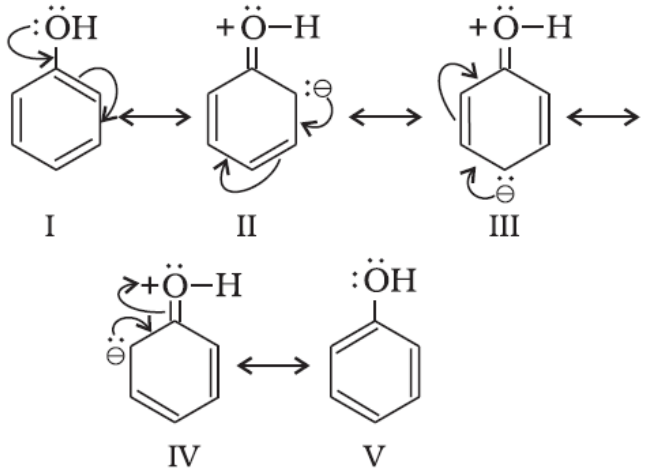
i) Phenol to Benzene ii) Benzene to Chlorobenzene iii) Benzene to Acetophenone

Ans: i) ii) iii)



Q5. How does OH group effects the reactivity of Benzene towards electrophilic substitution reactions? Explain with the help of resonating structures. L_3

Ans: Due to resonance the lone pairs of electrons on O atom of OH group are involved to increase the electron density at ortho and para positions.



UNIT-14 ENVIRONMENTAL CHEMISTRY

KNOWLEDGE

ONE MARK QUESTIONS

Q1. Name one insecticide?(L-I)
Ans-. DDT,BHC

Q2. Which acid is not present in acid rain?(L-II)
HNO_3, H_2SO_4, CH_3COOH, H_2CO_3?
Ans-. CH_3COOH.

Q3. Name two gases which are responsible for green house effect?(L-III)
Ans. CO_2 and CH_4 gases.

Q4. What is full form BOD and DDT?(L-I)
Ans. BOD-Biochemical oxygen Demand and DDT- DichchloroDiphenyl Trichloro ethane.

Q5. Write any two common chemicals of photochemical smog?(L-II)
Ans. Acrolein and formaldehyde

TWO MARKS QUESTIONS

Q1. Name two herbicides?(L-III)
Ans. $NaClO_3$ (sodium chlorate) and Na_3AsO_3 (Sodium Arsenite)

Q2.Write the methods for management of waste material?(L-I)
Ans- 1. Recycling:-materials are recycled which saves the cast of raw material and waste disposal.
2. Sewage treatment
3. Burning and Incineration
4. Digesting
5. Dumping

Q3. What are harmful effects as depletion of ozone layer? (L-II)
Ans- 1) The ozone layer protects the earth from the harmful UV radiation of the sun, with the depletion of the layer, more radiation will enter the earth's atmosphere. UV radiations are harmful because they lead to the skin cancer and sun burns.
2) They cause death of many phytoplankton's which lead to a decrease of fish productivity.

3) Increase in UV radiation, decreases the moisture content of the soil and damages both plants and fibres.

Q4. What are pathogens? Mention its harmful effect? (L-II)
Ans. Pathogens are disease causing microorganisms include bacteria, Virus etc. They enter into water from animal excreta and domestic sewage.

Q5. Write the harmful effect of CO_2? Mention its sources. (L-III)
Ans. Harmful effect: -It causes global warming
Sources: 1. Respiration
2. Burning of fossil fuels for energy
3. By volcanic eruptions
4. Deforestation
5. By decomposition of limestone during the manufacture of cements.

THREE MARKS QUESTIONS

Q1. Carbon monoxide gas is more dangerous than carbon dioxide gas. Why? Explain (L-III)
Ans. It is highly poisonous to living beings because of its ability to block the delivery of oxygen to the organs and tissues. It binds to haemoglobin of blood to form carboxyhaemoglobin (COHb) which is about 300 times more stable than oxy-haemoglobin complex. In the blood when the concentration of carboxyhaemoglobin reaches about 3-4 percent, the oxygen carrying capacity blood is greatly reduced. This oxygen deficiency, results in to headache, weak eyesight, nervousness and cardiovascular disorder CO_2 does not combine with haemoglobin and hence is less harmful as pollutant but it is the main contributor forwards green house effect & global warming.

Q2.What are pesticides and herbicides? Give examples.(L-II)
Ans. Pesticides: These are a mixture of two or more substances. They are used for killing pests. Pests include insects, plants pathogens, weeds, molluscs etc…., that destroys the plant crop and spread diseases eg: - Aldrin and Dieldrin

Herbicides: These are chemicals specially meant for killing weeds. Ex:-Sodium chlorate ($NaClO_3$), Sodium Arsenite ($Na_3\ AsO_3$)

Q 3. Define environmental pollution? Name its types? (L-I)
Ans. The addition of any undesirable material to air, water and soil by a nature source or due to human activity to such a level of concentration which adversely affects the quality of environment is called environmental pollution.
Types :-1. Water pollution 2. Soil pollution 3. Air pollution

Q 4. Write short note on :- (a) BOD (b) Photo chemical smog (c).Ozone hole. (L-II)
Ans(a)- BOD: Biochemical oxygen demand is defined as the amount of oxygen required microorganisms to oxidise the organic pollutants presents in water. Water having BOD less than 5ppm is clean water and greater than 17ppm is polluted water

(b) Photo chemical smog: It consists of oxides of nitrogen which absorb light and form free radicals. It is extremely harmful and is oxidizing in nature.

(c) Ozone hole: ozone layer is depleted near Antarctica and it is called ozone hole.

Q 5- Define green chemistry? Explain with one example.(L-I)
Ans-. Chemistry and chemical process involving the minimum use and generation of harmful substances is called green chemistry

Ex:- Earlier tetrachloroethene themes was used as solvents for dry cleaning. This compound is carcinogenic; therefore it has been replaced by liquefied CO_2 along with a suitable detergent, which is less harmful.

Q6. What are the major causes of water pollution? Explain (L-II)
Ans. 1. Pathogens: These are water pollutants include bacteria and other organisms. They enter water from animal excreta and domestic Sewage. Bacteria presents in human excreta causes gastrointestinal diseases (Excreta contains, Escherichia Coli and streptococcus faecalis)
2. Organic wastes: These are biodegradable water that pollutes water as a result run off. The presence of excess of organic wastes in water decreases the amount of oxygen held by water. This decrease in the amount of dissolved oxygen inhibits aquatic life.

3. Chemical pollutants: These are the water soluble chemicals like heavy metals such as cadmium, mercury, nickel etc… The presence of these chemicals (above the tolerance limit) can damage the kidneys, central nervous system and liver.

UNDERSTANDING

ONE MARK QUESTIONS

Q1.Define the term pollution?(L-I)
Ans. It is a substance present in the environment in great proportion than its natural abundance and resulting in harmful damage effect.

Q2. Which part of the atmosphere contains ozone layers?(L-I)
Ans. Stratosphere contains ozone layers.

Q3. What are PCBs?(L-II)
Ans. Polychlorinated biphenyls (PCBs) are used as cleansing solvent, detergents and fertilizers cause water pollution and it is carcinogenic compound.

Q4. Name the oxides of nitrogen?(L-II)
Ans. Nitric oxide (NO) and Nitrogen dioxide (NO_2).

Q5. Which can damage the great historical monument Tajmahal ? (L-I)
Ans. Acid rain
($CaCO_3$ (marble) +H_2SO_4---- > $CaSO_4$ + H_2O + CO_2)

TWO MARKS QUESTIONS

Q1. What do you mean by ozone hole? What are its Consequences.(L-II)
Ans. Ozone hole implies depletion of the ozone layer by the Harmful UV radiations .This depletion will virtually result in creating some sort of holes in the blanket of ozone which surround us. As a result, the harmful radiations cause skin cancer, loss of sight and also affect our immune system

Q2.What do you mean by Biochemical oxygen demand? (L-I)
Ans. Biochemical oxygen demand is the amount of oxygen required by bacteria to decompose organic matter in a certain volume of sample of water. Clean water would have BOD value of less than 5ppm, where as highly polluted water has a BOD of 17ppm or more

Q3.Write the chemical reaction take place during acid rain in the atmosphere?(L-III)
Ans. 1. $H_2O + CO_2$ -------> H_2CO_3

2. H_2CO_3 ------> $H^+ + HCO_3^-$

3. $2SO_2 + O_2 + 2H_2O$ ------> $2H_2SO_4$

Q4. A large number of fish are suddenly found floating dead on a lake. There is no evidence of toxic dumping by you find an abundance of phytoplankton, suggest a reason for the fish kill.(L-III)
Ans. The amount of dissolved oxygen present in water is limited. The abundance of phytoplankton causes depletion of this dissolved oxygen. This is because phytoplankton's are degraded by bacteria present in water. For their decomposition, they require a large amount of oxygen. Hence, they consume the oxygen dissolved in water. As a result, the BOD level of water drops below 6ppm, inhibiting the growth of fish and causing excessive fish kill.

Q5. Write by two harmful effects of oxides of nitrogen? (L-II)
Ans. :-1. Damage the leaves of plants and retard the rate of photosynthesis.
2. Nitrogen dioxide is a lung irritant that can lead to an acute respiratory disease in children.

THREE MARKS QUESTIONS
Q1. Statues and monuments in India are affected by acid rain, how? (L-III)
Ans. The air around the statues and monuments in India contains fairly high levels of the oxides of sulphur and nitrogen. This is due to a large number of industries and power plants in the nearby areas. The problem has been further aggravated due to use of poor quality of coal, kerosene and fire wood as fuel for domestic purposes. The states acid rain affects for marble of these statues and monuments.
$CaCO_3+H_2SO_4$ -> $CaSO_4+H_2O+CO_2$

As a result, this away and marble is getting discoloured and lusterless.

Q2.How can domestic waste be used as manure?(L-II)
Ans- Depending upon the nature of the waste domestic waste can be segregated in to two categories. i.e. biodegradable and non biodegradables. Biodegradables waste such as leaves, rotten food etc…. should be deposited in land fills, where they get decomposed aerobically and anaerobically in to manure. Non biodegradable waste (Which cannot be degraded) such as plastic, glass, metal scrapes etc…. should be sent for recycling.

Q3. What are the reactions involves for ozone layer depletion in the stratosphere? (L-III)
Ans. CFC'S (chlorofluorocarbons) that are released in the atmosphere mix with the other atmospheric gases and when eventually reach the stratosphere, gets broken down by UV radiations as fallows

CF_2Cl_2 ---UV rays---> $Cl^{\cdot}$ + $CF_2Cl^{\cdot}$

The chlorine radical reacts with ozone and breaks down ozone molecule as follows

$Cl^{\cdot} + O_3$ -----> $ClO^{\cdot} + O_2$

$ClO^{\cdot}$ radical further reacts with atomic oxygen and produces more chlorine radicals as follows

$ClO^{\cdot} + O$ ------> $Cl^{\cdot} + O_2$

Q4.Write the chemical reactions for the formation of oxides of sulphur? Mention its sources? (L-III)

Ans. 1. $2SO_2 + O_2$ ------> $2SO_3$

2. $SO_2 + O_3$ -------> $SO_3 + O_2$

3. $SO_2 + H_2O_2$ ------> $2H_2SO_4$

Sources: Burning of fossil fuels containing sulphur

Q5.What is acid rain? How is it harmful to the environment?(L-II)

Ans. When the PH of the rain water below 5.6 due to the presence of oxides of sulphur & nitrogen and carbon dioxide in the atmosphere is called acid rain. Harmful effects of acid rain

1. It is toxic to vegetation and aquatic life
2. It damages building and states and dissolves heavy metals from soils, rocks and sediments. Taj Mahal has been damaged by acid rain.
3. The heavy metal ions such as copper, lead and aluminium, leached from the soil, enter well water and produced variety of toxic effects.
4. Acid rain also corrodes water pipes resulting in the leaching as heavy metals such as iron, lead and copper into drinking water.

APPLICATION

ONE MARK QUESTIONS

Q1.Which type of harmful radiations absorbed in ozone layers?(L-I)

Ans. UV radiation

Q2.What type of radiation are absorbed by CO_2 in the atmosphere (L-II)

Ans. IR radiations

Q3.Give the use of ozone layer. (L-I)

Ans-.It prevents the harmful UV radiations to reach on earth which cause skin cancer.

Q4. What is green house effect? (L-II)

Ans-. The increase in temperature of atmosphere due to presence of gases like CH_4 , CO_2 and water vapours, which absorb infrared radiation is called green house effect.

Q5.What is effect of excess of SO_4^{2-} ion in drinking water?(L-III)

Ans-. Excess of SO_4^{2-} ion in drinking water causes laxative effect (>500ppm)

TWO MARKS QUESTIONS

Q1. List any two harmful effects of smog?(L-II)

Ans. a) Ozone, PAN Act as powerful eye irritants

b) Ozone and PAN irritate the nose and throat and their high concentration causes headache, chest pain, and dryness of the throat, cough and difficulty in breathing.

Q2.Write any two achievements of green chemistry? (L-I)

Ans. 1.Development of polystyrene foam sheet packaging material this Technology allows eliminations CFCs which contribute to ozone depletion, global warming and ground level smog.

2. Catalytic hydrogenation of diethanolamine in which environmental friendly herbicide is produced in less dangerous ways.

Q3. What do you mean by ozone hole? What are its Consequences (L-II)

Ans. Ozone hole implies distribution of the ozone layer by the Harmful UV radiations the depletion will virtually result in creating some sort of holes in the blanket of ozone which surround us. As a result, the harmful radiations cause skin cancer, loss of sight and also affect our immune system

Q4.How does detergent cause water pollution?(L-II)

Ans. Tetrachlorothene ($Cl_2C=CCl_2$) was used as solvents for dry cleaning of clothes. This compound is suspected to carcinogenic. Use of detergents also encourages the growth of algae and phytoplankton's which leads to eutrophication

Q5.Write the chemical reaction take place during acid rain in the atmosphere?(L-III)

Ans-. 1. $H_2O + CO_2$ -------> H_2CO_3

2. H_2CO_3 ------> $H^+ + HCO_3^-$

3. $2SO_2 + O_2 + 2H_2O$ ------> $2H_2SO_4$

THREE MARKS QUESTIONS

Q1. What is smog? How is classical smog different from photo chemical smog?(L-II)

Ans. Smog is a mixture of smoke, dust partials and small drops of fog.

Classical smog :---

a. It occurs in cool humid climate.

b .It is a mixture of smoke, fog and sulphur dioxide.

c. It is called reducing smog

Photochemical smog:--

a.It occurs in warm dry and Climate sunny climate

b. It is a mixture of oxides of nitrogen, formaldehyde ,acrolein and PAN.

c. It is called oxidizing smog.

Q2. Write the chemical reactions formation of oxides of nitrogen? Mention its sources?(L-III)

Ans. 1. $N_2(g) + O_2(g)$ ------>2NO(g)

2. $2NO(g) + O_2(g) \text{------>} 2NO_2(g)$

3. $NO(g)+O_3(g) \text{------>} NO_2(g) + O_2(g)$

Sources: 1. At high attitude when lightning strokes, dinitrogen and dioxygen combine to form oxides of nitrogen.
2. Burning of fossil fuels in an automobile engine at high temperature, dinitrogen and dioxygen combine to yield significant quantities of nitric oxide and nitrogen dioxide.

Q 3. Write down the chemical equation of reactions involved during the formation of photochemical smog. How can it be controlled?(L-III)
Ans. Photochemical smog is formed by absorption of sunlight by oxides of nitrogen to form free radicals which are highly reactive
a) NO2 -------> $NO^{\cdot}$ + $O^{\cdot}$

b) $O^{\cdot} + O_2 \text{------>} O_3$

c) $N O^{\cdot} + O_3 \text{------>} NO_2 + O_2$

d) $3CH_4 + 2O_3 \text{------>} 3HCHO + 3H_2O$
It can be prevented by spraying chemicals which will destroy free radicals in the atmosphere.

Q4. What are harmful effects of photochemical smog and how can they be controlled.(L-II)
Ans. a. Ozone and PAN acts as powerful eye irritants
b. Ozone and nitric oxide irritate the nose and throat, and then high concentration cause headache, chest pain, and dryness of the throat, cough and difficulty in breathing.
c. It also cause and corrosion and painted surfaces
d.It leads to cracking of rubber and extensive damage to plants life.
Control of photochemical smog
1. Use of catalysts converters in automobiles which prevents the release of oxides of nitrogen and hydrocarbons to the atmosphere
2. Certain plants e.g.…pinus, Juniparus, Quercus & Vitis can metabolize oxides of nitrogen and therefore, their plantation could help in this matter.

Q5.What do you mean by green chemistry? How will it help in decreasing environmental pollution?(L-I)
Ans. It is a production process that aims at using the existing knowledge and principles of chemistry for developing and implanting chemical products and processes to reduce the use and generation of substances hazardous to the environment. The release of different harmful chemicals (particulates, gases, organic and inorganic wastes) causes environmental pollution. In green chemistry, the reactants to be used in chemical reactions are chosen in such way that the yield of the end products is up to 100%. This prevents or limits chemical pollutants from being introduced in to the environment For example, through the efforts of green chemists, H_2O_2 has replaced tetrachloro methane and chlorine gas in drying and bleaching of paper. CO_2 has replaced CFCs as blowing agents in manufacture of polystyrene foam sheet.

MULTIPLE CHOICE QUESTIONS /ASSERTIONS

UNIT 1- SOME BASIC CONCEPTS OF CHEMISTRY

(I) Significant figure & Law of chemical composition

Q1 Who discovered electron ?

(A)Rutherford (B) J J Thomson (C) Bohr′ s (D) Goldstein

Q2The number of significant numbers in 0.0580 is;

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

Q3 S. I Unit of mass is

(A) Gram (B) Milligram (C) Kilogram (D) Quintal

Q4 Who is discovered proton ?

(A) Goldstein (B) Bohr′ s (C)Rutherford (D) J J Thomson

Q5 28.7 pm is equal to:

(A) 2.87x10 ^{12}m (B) 2.87x10 $^{-11}$m (C) 2.87x10 $^{-12}$ (D) 28.7x10^{-12} .

Q6 When two or more atoms are combine in definite ratio is called :

(A) Mixture (B) Substance (C) compound (D) Formula .

Q 7 A compound prepared by any method contains the same elements in the fixed ratio by mass e.g. What is name of this law;

(A) Law of multiple proportion (B) Law of constant composition

(C) Law of conservation of mass (D) Avogadro's Law

Q8 Express 0.0025 in scientific notation ;

(A) 2.0x10^{-3} (B) 2.5x10 $^{-2}$ (C) 2.5x100^{-3} (D) 2.5x10^{-4} .

Q9 Volume of gas at S.T.P is :

(A) 22400 Litres (B) 22000ml (C) 22.4 Litres (D) 24.2 Litres.

Q10. There are ---- fundamental unit.

(A) 8 (B) 9 (C) 7 (D) 14

Answers

1- (B) J J Thomson 2- (B) 3 3- (C) Kilogram 4- (A) Goldstein 5- (B) 2.87x10 $^{-11}$m

6- (C) compound 7- (B) Law of constant composition 8- (C) 2.5x100^{-3}

9 - (C) 22.4 Litres 10- (C) 7

(II)Mole Concept, Conc. Terms& Balancing

Assertion Reason type Questions

The questions given below consist of an Assertion and the Reason. Use the following key to choose the appropriate answer.

a) If both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b) If both assertion and reason are CORRECT, but reason is NOT THE CORRECT explanation of the assertion.
c) If assertion is CORRECT, but reason is INCORRECT.
d) If assertion is INCORRECT but reason is CORRECT.
e) If both assertion and reason are INCORRECT.

1.Assertion : Both 32 g of SO_2 and 8 g of CH_4 contain same number of molecules.
Reason: Equal moles of two compounds contain same number of molecules.

2.Assertion: The standard unit for expressing the mass of atom is a.m.u.
Reason: a.m.u. stands for mass of 1 atom of carbon.

3.Assertion: 1 mol of O_2 and 1 mol of CO_2 contain equal number of particles.
Reason: 1 mole of molecules is always double than 1 mol of atoms in all diatomic molecules.

4.Assertion: A balanced chemical equation has an equal number of atoms of each element in the reactants and the products.
Reason: A balanced chemical equation must be in accordance with the law of conservation of mass.

5.Assertion: Both CO_2 and H_2 have same molar volume at STP.
Reason: Molar mass of CO_2 is 44 g and that of H_2 is 2 g.

6.Assertion: The amount of solute present in a given quantity of solvent or solution is expressed in terms of concentration.
Reason: Units of molarity is mol Kg^{-1}.

7.Assertion: Molarity varies with temperature.
Reason: The sum of mole fraction of all the compounds of a solution is equal to 1.

8.Assertion: Gram atomic mass of oxygen is 32 g.
Reason: Gram molecular mass of oxygen is 16 g.

9.Assertion: 11.2 litre of oxygen (O_2) at NTP contain 3.01×10^{23} molecules.
Reason: 1 mole of any gas at NTP occupies 22.4 litre.

10.Assertion: Molarity of solution changes with temperature.
Reason: Molarity and mole fraction do not change with temperature.

Answers				
1. a	**2. c**	**3. c**	**4. a**	**5. b**
6. c	**7. d**	**8. e**	**9. a**	**10. b**

UNIT 2 - ATOMIC STRUCTURE

(II) Atomic Models, Spectrum & Dual nature

Q-1 The e/m value for cathode rays is

(i)$1.6X10^{-19}$ (ii)$9.1X10^{-31}$ (iii)$1.758X10^{11}$ (iv)$1.6749X10^{-27}$

Q-2 Charge of electron was experimentally determined by

(i)Rutherford (ii) J.J. Thomson (iii) R.A. Mullikan (iv) None of these

Q-3X-Rays are the beam which is consisted of particles named as

(i)Electrons (ii)Protons (iii)Neutrons (iv)Apha

Q-4 Wavelength of wave associated with a microscopic particle is inversely proportional to

(i) Momentum (ii)Velocity (iii)Mass (iv)All of these

Q-5 Calculate wave number of yellow radiations having wavelength of 5800Å.

(i)$1.72X10^{6}$ m^{-1} (ii)$1.67X10^{5}$ m^{-1} (iii)$6.67X10^{34}m^{-1}$ (iv)$1.6X10^{-19}$ Coulomb

Q-6 $_{18}Ar^{40}$ and $_{20}Ca^{40}$ are considered as a good example of

(i)Isotopes (ii)Isobar (iii)Isotones (iv)None of these

Q-7 When an electron transits from 2^{nd} Energy level to higher one ,its wave will fall in which Spectral Region

(i)Ultra Violet Region (ii)Visible Region (iii) Infra Red Region (iv)None

Q-8 Angular Momentum of Moving microscopic particles in its orbit is integral multiple of

(i)$h/2\prod$ (ii) $h/4\prod$ (iii) $h^2/2\prod$ (iv) $h^2/2\prod^2$

Q-9 Number of Angular Nodes for d orbitals is

(i) 4 (ii)3 (iii)2 (iv)1

(ii) Q-10 chlorine exits in two isotropic form cl-37, and cl-35.but its atomic mass is 35.5.This indicates the ratio of cl-37 and cl-35 is a

(iii) (i)1:2 (ii)1:1 (iii)1:3 (iv) 3:1

Answer				
1-(iii)	**2-(iii)**	**3-(i)**	**4-(iv)**	**5-(i)**
6-(ii)	**7-(ii)**	**8-(ii)**	**9-(ii)**	

(II) Quantum Numbers & Electronic Configuration

Q.1. What will be the value of n & l of $4s^1$

a) n=4 & l=1
b) n=4 & l=0
c) n=4 & l=3
d) n=4 & l=2

Q.2. Which one orbital has e-density on the axis.

a) d_{xy}
b) d_{yz}
c) d_{xz}
d) $dx^2\text{-}y^2$

Q.3. Select the correct set of quantum numbers

S. No	n	l	m
a.	1	1	+2
b.	2	1	2
c.	3	2	-2
d.	3	4	-2

Q.4. What indicate the $(\psi)^2$

a) probability density
b) electron position
c) Shell
d) Sub-shell

Q.5. How many nodal planes are there in $d_{x^2-y^2}$ & in dz^2?

a) Two & zero.
b) Two & one.
c) Two & Two.
d) One & zero.

Q.6. Which of the p orbital is not exist?

a) P_x
b) P_y
c) P_z
d) p_s

Q.7. Principal Quantum Numbers indicate the

a) The energy of an orbital.
b) The energy of a sub-shell.
c) The energy of a shell.
d) The energy of an electron.

Q.8. Write the value of n & l of unpaired e^- of Fluorine.

a) n=2, l=1.
b) n=2, l=0.
c) n=3, l=1.
d) n=3, l=0.

Q.9. Which of the following has no nodal plane.

a) p_x
b) p_z
c) $dx^2\text{-}dy^2$
d) dz^2

Q.10. Which of the following has no unpaired e^-?

a) Cu^{2+}
b) Fe^{3+}
c) Mn^{2+}
d) Sc^{3+}

Answers				
1(b)	**2(d)**	**3(c)**	**4(a)**	**5(d)**
6(d)	**7(c)**	**8(a)**	**9(d)**	**10(d)**

UNIT 3- CLASSIFICATION OF ELEMENTS AND PERIODICITY IN PROPERTIES

(I)Periodic Laws & s,p,d,f configuration

Question 1 The properties of an element in the periodic table depends on its, _____.
1. atomic size
2. atomic mass
3. electronic configuration
4. number of protons

Question 2 An element has configuration 2, 8, 1. It belongs to, _____.
1. 1 group and 3rd period
2. 3 group and 1st period
3. 1 group and 8th period
4. 17 group and 3rd period

Question3 The number of electrons in the valence shell is equal to its _____.
1. atomic mass
2. group number
3. period number
4. atomic volume

Question 4 The non-metallic element present in the third period other than sulphur and chlorine is _____.
1. oxygen
2. fluorine
3. nitrogen
4. phosphorus

Question5 At the end of each period the valence shell is _____.
1. incomplete
2. half filled
3. singly occupied
4. completely filled

Question 6 The family of elements having seven electrons in the outermost shell is _____.
1. alkali metals
2. alkaline earth metals
3. halogens
4. noble gases

Question 7 The family of elements to which potassium belongs is _____.
1. alkali metals
2. alkaline earth metals
3. Halogens
4. noble gases

Question 8 The modern periodic table is given by _____
1. Mendeleev
2. Einstein
3. Bohr
4. Mosley

Answers							
1- 3	2- 1	3- 2	4- 4	5- 4	6- 3	7- 1	8- 4

(ii)Trends In Physical Properties

ASSERTION REASON TYPE QUESTIONS: (TYPE 1)

1) **ASSERTION (A):** Generally, ionization enthalpy increases from left to right in a period.
REASON (R): When successive electrons are added tom the orbitals in the same principal quantum level, the shielding effect of inner core of electron does not increase very much to compensate for the increased attraction of the electron to the nucleus.
a) assertion is correct statement and reason is wrong statement.
b) assertion and reason are both correct statements and reason is correct explanation of assertion.
c) assertion and reason both are wrong statement.
d) assertion is the wrong statement and reason is the correct statement.

2) **ASSERTION (A):** Boron has a smaller first ionization enthalpy then beryllium.
REASON (R): The penetration of a 2s electron to the nucleus is more than the 2p electron hence 2p electron is more shielded by the inner core of electrons than the 2s electrons.
a) assertion and reason are both correct statements but reason is not correct explanation for assertion.
b) assertion is correct statement and reason is wrong statement.
c) assertion and reason are both correct statements and reason is correct explanation of assertion.
d) assertion and reason both are wrong statement.

3) **ASSERTION (A):** Electron gain enthalpy becomes less negative as we go down a group.
REASON (R): Size of the atoms increases on going down the group and the added electrons would be farther from the nucleus.
a) assertion and reason are both correct statements but reason is not correct explanation for assertion.
b) assertion and reason are both correct statements and reason is correct explanation of assertion.
c) assertion and reason both are wrong statement.
d) assertion is wrong statement and reason is correct statement.

ASSERTION REASON TYPE QUESTIONS: (TYPE 2)
DIRECTIONS: Questions given below contains statement 1 (assertion) and statement-2 (Reason).It has four options (a),(b),(c) and (d) out of which ONLY ONE is correct.
Choose the correct option as.
(a) Statement 1.is true, Statement 2 is true; Statement 2 is a correct explanation for statement 1.
(b) Statement 1.is true, Statement 2 is true; Statement 2 is not a correct explanation for statement 1.
(c) Statement 1.is true, Statement 2 is false.
(d) Statement 1.is false, Statement 2 is true.

4) Statement 1: the ionic size of O^{2-} is bigger than that of F^- ion.
Statement 2: O2- and F- are iso electronic ions.
5) Statement 1: Of all the elements, helium has the highest value of first ionization enthalpy.
Statement 2: Helium has the most positive electron gain enthalpy of all the elements.

ASSERTION REASON TYPE QUESTIONS: (TYPE 3)

Directions. In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements, mark the correct answer as

(a) If both assertion and reason are true, and reason is the true explanation of the assertion.

(b) If both assertion and reason are true, but the reason is not true explanation of the assertion.

(c) If assertion is true, but reason is false.

(d) If both assertion and reason are false.

6) Assertion. The first ionization enthalpy of aluminium is lower than that magnesium.
Reason. Ionic radius of aluminium is smaller than that of magnesium.

7) Assertion. F atom has less negative electron gain enthalpy than Cl atoms.
Reason. Additional electrons are repelled more effectively by 3 p-electrons in CL than by 2 p-electrons in F atom.

8) Assertion. The first ionization energy of Be is greater than that of B.
Reason. 2 p-electron is lower in energy than 2 s-orbital.

9) Assertion. First ionization energy for nitrogen is lower than that of oxygen.
Reason. Across a period effective nuclear charge decreases.

10) Assertion. F is more electronegative than CL.
Reason. F has higher electron affinity than CL.

Answers:

1) (b) Reason is correct explanation for assertion.

2)(c)Reason is correct explanation for assertion

3)(d) electron gain enthalpy becomes more negative as we go down a group.

4)(b) Correct explanation : O2- has higher negative charge than F-.

5)(c) Correct Statement :Helium is the smallest inert gas.

6)(b) Correct explanation: in Al, 3p electron is to be removed while in Mg, a 3s electron is to be removed .

7)(c)Correct explanation: Additional electron is repelled more effectively by 2p electrons in F than 3p electrons in Cl.

8)(c)Correct explanation: 2p orbital has higher energy than 2s orbital .

9)(d)Correct explanation: Nitrogen has stable exactly half filled electronic configuration but oxygen does not have.

10)(c)Correct explanation: F has greater tendency than Cl to attract the shared pair of electrons of a covalent bond.

UNIT 4- CHEMICAL BONDING AND MOLECULAR STRUCTURES

(I) VSEPR & VBT

In each of the following questions , a statement of Assertion (A) is given followed by a corresponding statement of reasons (R) .mark the correct answer as

a) If both A & R are correct and R is the correct explanation of the assertion.
b) If both A & R are correct but R is not the correct explanation of the assertion.
c) If A is correct ,but R is incorrect
d) If both A & R are incorrect

(1)Assertion : BF_3 molecule is planar but NF_3 is not
Reason : N atom is smaller than B

(2) Assertion : Though the central atom of both NH_3 and H_2O molecules are sp3 hybridized , yet H-N-H bond angle is greater than that of H-O-H .
Reason: this is because nitrogen atom has one lone pair and oxygen atom has two lone pair

(3) Assertion : Among the two O-H bonds in H_2O molecule ,the energy required to break the first O-H bond and the other O-H bond is the same
Reason : This is because the electronic environment around oxygen is the same even after breakage of one O-H bond.

(4)Assertion: H-S-H bond angle in H_2S is 90° but H-O-H bond angle in H_2O is 104.5°
Reason: lp-lp repulsion is stronger in H_2S than in H_2O

(5) Assertion : Molecular N_2 is less reactive than molecular O_2.
Reason: The bond length of N_2 is shorter than in O_2.

(6) Assertion: $SeCl_4$ does not have a tetrahedral structure .
Reason : Se in $SeCl_4$ has two lone pair

(7) Assertion :PCl_5 is covalent while PCl_3 ionic
Reason: Higher charges cause greater polarisation

(8) Assertion: LiCl is covalent whereas NaCl is ionic .
Reason: Greater the size of the cation ,greater is its polarising power.

(9) Assertion : SF_4 is more reactive than SF_6
Reason: SF_4 has see-saw structure while SF_6 is octahedral

10) Assertion : The bond lengths in SO_2 are equal in length.
Reason: It is due to resonance

Answers				
(1) b	**(2) a**	**(3) d**	**(4)b**	**(5) a**
(6)c	**(7) a**	**(8) c**	**(9) c**	**(10) a**

(II) MOT and Hybridisation

Directions. In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of reason (R) just below it. Of the statements, mark the correct answer as
(a) If both assertion and reason are true, and reason is the true explanation of the assertion.
(b) If both assertion and reason are true, but the reason is not true explanation of the assertion.
(c) If assertion is true, but reason is false.
(d) If both assertion and reason are false.

(1)Assertion :NO_3^- and CO_3^{2-} ion both are triangular planar
Reasoning :Hybridisation of central atom in both is sp^2

(2)Assertion :Water molecule has bent structure whereas carbon dioxide molecule is linear
Reason : Water is sp^3 hybridised whereas in CO_2 is sp hybridised
Ans .(a)

(3) Assertion :Both $\prod 2p_x$ and $\prod^* 2p_x$ molecular orbital have one nodal; plane each
Reason : All molecular orbital s formed by sideway overlapping of 2p orbitals have one nodal plane

(4)Assertion :H_2 , Li_2 and B_2 each has a bond order of 1 and hence are equally stable
Reason: Stability of molecule depends only on bond order

(5) Assertion :NO_3^- is planar while NH_3 is pyramidal
Reason : N in NO_3^- has sp^2 and in NH_3 has sp^3 hybridization

(6) Assertion :Bond order can assume any value including zero
Reason: Higher the bond order shorter is the bond length and greater is the bond energy

(7). Assertion :B_2 molecule is diamagnetic
Reason: The highest occupied molecular orbital is of σ type

(8) Assertion :H_2 molecule is more stable than HeH molecule
Reason: The anti bonding electron in the molecule destabilizes it

(9) Assertion :N_3^- is a weaker base than NH_2^-
Reason : The lone pair of electron on N atom in N_3^- is in sp_2 orbital while in NH_2^- it is in sp^3 orbital

(10). Assertion : Molecular nitrogen is less reactive than molecular oxygen
Reason : The bond length of N_2 is shorter then that of oxygen

Answers				
(1) a	**(2) a**	**(3) d**	**(4)d**	**(5) a**
(6)b	**(7) d**	**(8) b**	**(9) a**	**(10) a**

UNIT 5 - STATES OF MATTER

(I)Intermolecular Forces and Gas Laws

In the following questions a statement of Assertion (A) followed by a statement of Reason(R) is given.

Choose the correct option out of the choices given below:

(a) Both A and R are true and R is the correct explanation of A.

(b) Both A and R are true and R is the not correct explanation of A.

(c)If A is true but R is false.

(d)If both A and B are false.

1. Assertion (A): Three states of matter are the result of balance between intermolecular forces and the Thermal energy of the molecules.

Reason(R): Intermolecular forces tend to keep the molecules together but thermal energy of the molecules tends to keep them apart.

2. Assertion (A): At constant temperature, PV vs. V plot for real gases is not a straight line.

Reason(R): At high pressure, all gases have Z >1 but at intermediate pressure, most gases have Z <1.

3. Assertion (A): Gases like $N_{2,}$ $_{O2}$ behaves as ideal gas at low temperature and high pressure.

Reason(R): Strong molecular interactions are responsible for ideal behavior.

4. Assertion (A): Gases do not liquefy above their critical temperature even on applying high pressure.

Reason(R): Above their critical temperature the molecular speed is high and Intermolecular forces cannot hold the molecules together because they escape due to high speed.

5. Assertion (A): In order to increase the volume of a gas by 10% the pressure of gas, should be decreased by 10%.

Reason: According to Boyle's law P inversely proportional to V.

6. Assertion: At 0K the volume occupied by a gas is negligible

Reason: All molecular motion seized at 0K.

7. **Assertion** : Dipole- Dipole courses at between the molecules processing permanent dipole. Ends of dipole process partial charges

Reason: The partial charges are less then unit electronic charge.

8. Assertion: When two ice cubes are pressed over each other they unite to form one cube.

Reason: Vander Wall forces are responsible to hold them together.

9. Assertion: Liquid has a definite volume but no definite shape.

Reason: The intermolecular forces are strong enough to hold the molecules together.

10 Assertion: Dipole – induced dipole forces exist between helium atoms and HCl molecules.

Reason: HCl is polar while helium atom has symmetrical electron cloud .

Answers				
(1) a	**(2) b**	**(3) a**	**(4)a**	**(5) a**
(6)c	**(7) a**	**(8) c**	**(9) b**	**(10) a**

(II) Kinetic Molecular Theory , Ideal Gas & Real Gas

In each of the following questions , a statement of Assertion (A) is given followed by a corresponding statement of reasons (R) .mark the correct answer as

(a) If both A & R are correct and R is the correct explanation of the assertion.
(b) If both A & R are correct, but R is not the correct explanation of the assertion.
(c) If A is correct ,but R is incorrect
(d) If both A & R are incorrect

(1)Assertion : For a certain fixed amount of gas , the product PV is always constant.
Reason : Real gases have higher pressure and lower volume than ideal gas and hence product PV is constant.

(2) Assertion : Viscosity of a liquid decreases on increasing the temperature.
Reason: Evaporation of a liquid increases with rise in temperature

(3) Assertion : The value of Vander Waal's constant 'a' for ammonia is larger than that of nitrogen Gas.
Reason : Molecular weight of ammonia is smaller than that of nitrogen gas.

(4)Assertion: Compressibility factor for hydrogen gas varies with pressure with positive slope at all Pressures.
Reason: Even at low pressures, repulsive forces dominate in hydrogen gas.

(5) Assertion : At high pressure, the compressibility factor Z is (1 + Pb/RT)
Reason: At high pressure, van der Waal's equation is modified as P(V – b) = RT.

(6) Assertion: Three states of matter are the result of balance between intermolecular forces and thermal energy of the molecules.
Reason : Intermolecular forces tend to keep the molecules together but thermal energy tend to keep them apart.

(7) Assertion : At constant temperature PV vs V plot for real gases is not a straight line.
Reason: At high pressure all gases have Z>1 but at intermediate pressure most gases have Z<1.

(8) Assertion: The temperature at which vapour pressure of a liquid is equal to the external pressure is called Boiling temp.
Reason :at high altitude , atmospheric pressure is high.

(9) Assertion : Gases do not liquefy above their critical temperature even on applying high pressure.
Reason: Above critical temperature, the molecular speed & intermolecular attractions cannot hold the molecules together because they escape because of high speed.

(10) Assertion : At critical temperature liquid passes into gaseous state imperceptibly and continuously.
Reason: The density of liquid& gases phase is equal at critical temp.

Answers				
(1) d	**(2) c**	**(3) b**	**(4)a**	**(5) a**
(6)a	**(7) b**	**(8) c**	**(9) a**	**(10) a**

UNIT 6 - CHEMICAL THERMODYNAMICS

(I)States of System, State Functions& First Law of Thermodynamics

In each of the following questions ,a statement of assertions(A) is given followed by a corresponding statement of reason (R) just below the statements , mark the correct answer as

(a)If both (A) and (R)are true and (R) is the true explanation of (A).

(b) If both (A) and (R)are true but (R) is not the true explanation of (A).

(c) If (A) is true but (R) is false.

(d) If both (A) and (R) is false.

Q1.Assertion (A) : The temperature of a gas does not change when it undergoes an adiabatic expansion.

Reason (R) : During an adiabatic expansion of real gas

Q2.Assertion (A) : Entropy is a state function because its value depends upon the conditions of temperature and pressure.

Reason (R) : A state function depends only upon the initial and final states of the system and is independent of the path.

Q3.Assertion (A) : When a gas at high pressure expands against vacuum ,the work done is maximum.

Reason (R) : work done in expansion depends upon the pressure of gas inside the vessel and increase in volume.

Q4.Assertion (A) : The increase in internal energy (ΔU)for the vaporization of one mole of water at 1 atm and 373K is Zero.

Reason (R) : For all isothermal processes , (ΔU) = 0.

Q5.Assertion (A) : Internal energy change in a cyclic process is Zero.

Reason (R) : Internal energy is a state function.

Q6.Assertion (A) : Adiabatic process is one in which the change in internal energy is equal to the mechanical work done

Reason (R) : No heat enters or leaves the gas

Q7.Assertion (A) : Enthalpy of graphite is lower than that of diamond.

Reason (R) : Entropy of graphite is greater than that of diamond.

Q8.Assertion (A) : The enthalpy of formation of $H_2O(l)$ is greater than that of $H_2O(g)$.

Reason (R) : Enthalpy change for a condensation reaction $H_2O(g) \rightarrow H_2O(l)$ is negative.

Q9.Assertion (A) : The enthalpy of formation of gaseous oxygen molecules a 298K and under a pressure of 1 atm is zero.

Reason (R) : The entropy of formation of gaseous oxygen molecules under the same conditions is zero.

Q10.Assertion (A) : For a particular reaction heat of combustion at constant pressure (q_p) is always greater than that of constant volume (q_v).

Reason (R) : Combustion reactions are invariably accompanied by increase in the number of moles.

Answers				
1. (d)	**2. (a)**	**3. (d)**	**4. (d)**	**5. (a)**
6. (a)	**7. (a)**	**8. (b)**	**9. (a)**	**10.(a)**

(II) Standard enthalpies,Entropy & Free energy

Q.1. If an endothermic reaction is non-spontaneous at freezing of water and becomes feasible at its boiling point, then

(a) ΔH is –ve, ΔS is +ve

(b)ΔH and ΔS both are +ve

(c) ΔH and ΔS both are –ve

(d)ΔH is +ve, ΔS is _ve.

Q.2.Which of the following statements is correct according to the basic concept of thermodynamics which governs the feasibility of metallurgical process?

(a)When the value of ΔG is positive for all the equation ΔG=ΔH-TΔS, the reaction will proceed.

(b)If reactants and products of two reactions are put together and ΔG is –ve, the overall reaction will occur.

(c) On increasing the temperature, the value of ΔG becomes +ve.

(d) Feasibility of thermal reduction of an ore can be established by Ellingham diagram in which a straight line shows the reaction will precede.

Q.3.The process is spontaneous at the given temperature, if

(a) ΔH is +ve and ΔS is –ve

(b) ΔH is-ve and ΔS is +ve

(c) ΔH is +ve and ΔS is +ve

(d) ΔH is +ve and ΔS is equal to zero.

Q.4. Predict the sign of ΔS^0 for the following reaction:

$2H_2S(g)+3O_2(g) \rightarrow 2H_2O(g) + 2SO_2(g)$

(a) +ve (b) – ve (c) zero (d) cannot be predicted.

Q.5. A process is taking place at constant temperature and pressure. Then

(a) ΔH = ΔE (b) ΔH =TΔS (c) ΔH=0 (d) ΔS =0

Q.6.Which one of the following demonstrates a decrease in entropy?

(a)Dissolving a solid into solution (b) An expanding universe

(c) Burning a log in a fire (d) Raking up leaves into a trash bag

Q.7.If K <1.0, what will be the value of ΔG^0 out of the following?

(a)1.0 (b)Zero (c)Negative (d) Positive

Q.8. The enthalpies of elements in their standard states are taken as zero. The enthalpy of formation of a compound:

(a) is always negative

(b) is always positive

(c) may be positive or negative

(d) is never negative

Q.9.Enthalpy of sublimation of a substance is equal to :
(a) enthalpy of fusion + enthalpy of vaporization
(b) enthalpy of fusion
(c) enthalpy of vaporization
(d) twice the enthalpy of vaporization

Q.10. Which of the following is not correct?
(a)ΔG is zero for a reversible reaction
(b) ΔG is positive for a spontaneous reaction
(c) ΔG is negative for a spontaneous reaction
(d) ΔG is positive for a non-spontaneous reaction.

Answers:

1)(b) For endothermic reaction, ΔH=+ve. Now, ΔG=ΔH-TΔS
ΔG will be +ve when ΔH and ΔS both are +ve and temperature is low so that ΔH> (-TΔS). ΔG will be –ve When ΔH and ΔS both are +ve and temperature is high so that ΔH<(-TΔS).

2) (b) The process of interpretation involves coupling of two reactions, getting the sum of ΔG and looking for its sign. Overall –ve value of ΔG shows that reduction of ore is possible.

3) (b) ΔG=ΔH-TΔS (Gibbs energy equation). When, ΔH is –ve, but TΔS is +ve → ΔG will be (-ve) [Highly spontaneous]

4) (b) $\Delta_r H$ = Σ BE (Reactants) – Σ BE (Products).

5) (b) At constant T&P, process is in equilibrium. ΔG =0. Hence, ΔH = TΔS.

6) (d) Scattered leaves have greater randomness then in the bag.

7) (d) ΔG = - RT ln K. When K<1, ΔG = + ve.

8) (c) May be positive or negative.

9) (a) Enthalpy of fusion + enthalpy of vaporization.

10) (b) ΔG is positive for a spontaneous reaction.

UNIT 7 - EQUILIBRIUM

(I)Laws & Factors Affecting Chemical Equilibrium

1. In what manner will increase of pressure affect the following equilibrium?
   $C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2O(g)$ –
   (a) Shift in the forward direction
   (b) Shift in the reverse direction
   (c) Increase in the yield of hydrogen
   (d) (d) no effect.

2. The equilibrium constant for the reaction, $N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ is 4×10^{-4} at 2000 K. In presence of a catalyst, equilibrium is attained ten times faster. Therefore, the equilibrium constant, in presence of the catalyst, at 2000 K is –
   (a) 40×10^{-4} (b) 4×10^{-4} (c) 4×10^{-3} (d) difficult to compute without more data.

3. In a reaction, $A + 2B \rightleftharpoons 2C$, 2.0 mole of 'A' 3.0 mole of 'B' and 2.0 mole of 'C' are placed in a 2.0 L flask and the equilibrium concentration of 'C' is 0.5 mole/L. The equilibrium constant (K) for the reaction is –
   (a) 0.073 (b) 0.147 (c) 0.05 (d) 0.026

4. If K_1 and K_2 are the respective equilibrium constants for the two reactions
   $XeF_6(g) + H_2O(g) \rightleftharpoons XeOF_4(g) + 2HF(g)$
   $XeO_4(g) + XeF_6(g) \rightleftharpoons XeOF_4(g) + XeO_3F_2(g)$, the equilibrium constant of the reaction
   $XeO_4(g) + 2HF(g) \rightleftharpoons XeO_3F_2(g)$ will be –
   (a) K_1 / K_2^2 (b) $K_1 . K_2$ (c) K_1/K_2 (d) K_2/K_1

5. K_p/K_c for the reaction
   $CO(g) + \frac{1}{2}O_2(g) \rightleftharpoons CO_2(g)$ is –
   (a) 1 (b) RT (c) $1/\sqrt{RT}$ (d) $(RT)^{1/2}$

6. For the reaction $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$, the equilibrium constant K_p changes with –
   (a) Temperature (b) Total pressure (c) Catalyst (d) amount of H_2 and I_2

7. For the reversible reaction, $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$ at 500^0C, the value of K_p is 1.44×10^{-5} when partial pressure is measured in atmospheres. The corresponding value of K_c, with concentration in mole litre^{-1}, is –
   (a) $1.44 \times 10^{-5} / (0.082 \times 500)^{-2}$ (b) $1.44 \times 10^{-5}/(8.314 \times 773)^{-2}$
   (c) $1.44 \times 10^{-5} / (0.082 \times 773)^2$ (d) $1.44 \times 10^{-5} / (0.082 \times 773)^{-2}$

8. If concentration of OH^- ions in the reaction $Fe(OH)_3(s) \rightleftharpoons Fe^{3+}(aq) + 3OH^-(aq)$ is decreased by $\frac{1}{4}$ times, then equilibrium concentration of Fe^{3+} will increase by –
   (a) 8 times (b) 16 times (c) 64 times (d) 4 times

9. The dissociation constant of acetic acid and HCN at 25^0C are 1.5×10^{-5} and 4.5×10^{-10} respectively. The equilibrium constant for the equilibrium
$CN^- + CH_3COOH \rightleftharpoons HCN + CH_3COO^-$ would be –
(a) 3.0×10^{-5} (b) 3.0×10^{-4} (c) 3.0×10^{4} (d) 3.0×10^{5}

10. In which of the following equilibrium, K_c and K_p are not equal?
(a) $2C(s) + O_2(g) \rightleftharpoons 2CO_2(g)$
(b) $2NO(g) \rightleftharpoons N_2(g) + O_2(g)$
(c) $SO_2(g) + NO_2(g) \rightleftharpoons SO_3(g) + NO(g)$
(d) $H_2(g) + I_2(g) \rightleftharpoons 2HI(g)$

ASSERTION AND REASONING TYPE QUESTIONS

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as –

(a) If both assertion and reason are true, and reason is the true explanation of the assertion.
(b) If both assertion and reason are true, but reason is not the true explanation of the assertion.
(c) If assertion is true, but reason is false.
(d) If both assertion and reason are false.

11. **Assertion (A).** The equilibrium constant is fixed and characteristic for any given chemical reaction at a specified temperature
Reason (R). The composition of the final equilibrium mixture at a particular temperature depends upon the starting amount of reactants.

12. **Assertion (A).** When a catalyst is added to a reaction mixture in equilibrium, the amount of the products increases.
Reason (R). The forward reaction becomes faster on adding the catalyst.

13. **Assertion (A).** If standard free energy change of a reaction is zero, this implies that equilibrium constant of the reaction is unity.
Reason (R). For a reaction in equilibrium, equilibrium constant is always unity.

14. **Assertion (A).** If to the equilibrium $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$, in a closed vessel, an inert gas is added, total pressure will increase and hence, equilibrium will shift backward.
Reason (R). Addition of an inert gas to an equilibrium mixture at constant volume shifts the equilibrium in the backward direction.

15. **Assertion (A).** If reaction quotient (Q_c) is less than the equilibrium constant (K_c), the equilibrium tends to shift in the direction of products.
Reason (R). The expression for equilibrium constant is different than the expression for reaction quotient.

16. **Assertion (A).** K_p can be equal to or less than or even greater than the value of K_c.
Reason (R). $K_p = K_c (RT)^{\Delta n}$.
Relation between K_p and K_c depends on the change in the number of moles of gaseous reactants and products.

17. **Assertion (A).** For $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$, the equilibrium constant is 'K', then for $\frac{1}{2}N_2(g) + \frac{3}{2}H_2(g) \rightleftharpoons NH_3(g)$ the equilibrium constant will be $\sqrt{K}$.
Reason (R). If concentrations are changed to half the equilibrium, equilibrium constant will be halved.

18. **Assertion (A).** A catalyst does not influence the values of equilibrium constant.
Reason (R). Catalysts influence the rate of both forward and backward reactions equally.

19. **Assertion (A).** The active mass of pure solid and pure liquid is taken unity.
Reason (R). The active mass of pure solids and liquids depends on density and molecular mass. The density and molecular mass of pure liquids and solids are constant.

20. **Assertion (A).** For $PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g)$. If more Cl_2 is added, the equilibrium will shift in backward direction, hence equilibrium constant will decrease.
Reason (R). Addition of inert gas to be equilibrium mixture at constant volume, does not alter the equilibrium.

Answers							
1	B	6	A	11	A	16	A
2	B	7	D	12	D	17	C
3	C	8	C	13	C	18	A
4	D	9	C	14	D	19	A
5	C	10	A	15	C	20	C

(II)Ionisation of electrolytes & hydrolysis of salts

Q1. Which of the following salts is basic in nature?
(a) NH_4NO_3 (b) Na_2CO_3 (c) Na_2SO_4 (d) NaCl

Q2. Which of the following salts has the minimum pH value?
(a) $(NH_4)_2SO_4$ (b) $NaHCO_3$ (c) K_2SO_4 (d) NaCl

Q3. The pH of a sample of pure water is 7 at room temperature. What is its pH when a pinch of solid sodium bicarbonate is dissolved in it?
(a) vary near to 7 (b) less than 7 (c) more than 7 (d) exactly 7

Q4. There are acid base theories that define an acid as any species that can
(a) donate a proton (b) donate an electron (c) accept a proton (d) none of these

Q5. The colour of neutral litmus solution is
a) red (b) blue (c) purple (d) yellow

Q6. Metallic oxides are _____ in nature, but non-metallic oxides are _____ in nature. The information in which alternative completes the given statement?
(a) neutral, acidic (b) acidic, basic (c) basic, neutral (d) basic, acidic

Q7. When a drop of unknown solution X is placed on a strip of pH paper, a deep red colour is produced. This sample is which one of these?
(a)NaOH (b) HCl (c) Water (d) CH_3COOH

For (8-12).In each of the following questions, two statements are given; one in assertion (A) column while the other in reason (R) column . Examine the statements carefully and mark the correct answer according to the instructions given below:
If both (A) and (R) are correct and (R) is the correct explanation of (A)
If both (A) and (R) are correct but (R) is not the correct explanation of (A)
If (A) is correct but (R) is wrong
If (A) is wrong but (R) is correct

Q8. (A) The PH of an aqueous solution of acetic acid remains unchanged on the addition of sodium acetate
(R) The ionization of acetic acid is suppressed by the addition of sodium acetate

Q9. (A) PH of a neutral solution is always 7
(R) The PH of a solution depends upon temperature

Q10. (A) PH of 10^{-8} M HCl is not equal 8
(R) HCl does not dissociates properly in very dilute solution

Q11. (A) PH of water increases with increases in temperature.
(R) K_w of water increase with increase with increase in temperature

Q12 . (A) Acetic acid is a weak acid
(R) It has weak conjugate base

Q13 (A) When small amount of an acid or base is added to pure water its PH undergoes a change
(R) Addition of an acid or a base increases the degree of ionization of water

Q14 (A) H_2SO_4 acts as a base in presence of $HClO_4$.
(R) Perchloric acid is stronger acid than H_2SO_4 .

Answers				
1. (b)	**2. (a)**	**3.(c)**	**4. (a)**	**5. (b)**
6.(d)	**7. (b)**	**8.(a)**	**9.(a)**	**10.(a)**
11.(d)	**12.(c)**	**13 .(a)**	**14.(a)**	

(III)Common Ion Effect & Solubility Product

Choose the one correct option in the following:

1. Solubility of a substance which dissolve with a decrease in volume and absorption of heat will be favoured by
   (a) High pressure and high temperature.
   (b) Low pressure and high temperature.
   (c) Low pressure and low temperature.
   (d) High pressure and low temperature.

2.In a chemical reaction equilibrium is established when
   (a) Opposing reaction ceases
   (b) Concentration of reactants and product are equal.
   (c) Velocity of the opposing reaction is same as that of forward reaction.
   (d) Forward reaction ceases.

3.The value of K for the reaction;
   $H_2 + I_2 \leftrightarrow 2HI$ is 49. The value of K for the reaction,
   $2HI \leftrightarrow H_2 + I_2$ will be
   (a) 49 (b) 1/49
   (c) 7 (d) 1/7

4.Application of Le-Chatelier's principal indicates that synthesis of ammonia
   $N_2 + 3H_2 \leftrightarrow 2NH_3$, $\Delta H = -92.4$ kJ mol^{-1}
   Is favored by
   (a) Low pressure. (b) High temperature.
   (c) Pressure of catalyst. (d) Removal of ammonia.

5. For the reaction, $N_2(g) + O_2(g) \leftrightarrow 2NO(g)$, the production of NO will be favored by
(a) High pressure. (b) Low pressure.
(c) Presence of catalyst (d) High concentration of N_2.

6. Consider the gas phase equilibrium system represented by the reaction,
   $2H_2O(g) \leftrightarrow 2H_2(g) + O_2(g)$ $\Delta H = 241.7$ kJ
Which of the following changes will decreases the equilibrium amount of H_2O
   a) Adding more oxygen.
   b) Increasing the temperature at constant pressure.
   c) Increasing the pressure at constant temperature.
   d) Adding catalyst.

7. According to Le-Chatelier's principle adding heat to a solid and liquid in equilibrium will cause the
   (a) Amount of solid to decrease. (b) Amount of liquid to decrease.
   (c) Temperature to rise. (d) Temperature to fall.

8. In a vessel containing SO_2, SO_3 and O_2 at equilibrium some helium gas is introduce so that The pressure increases while temperature and volume remain constant. According to Le-Chatelier's principal, the dissociation of SO_3
   (a) Increases (b) Decreases
   (c) Remains unaltered (d) Changes unpredictably.

9. In a reversible reaction, two substances are in equilibrium. If the concentration of each one is doubled the equilibrium constant will be
(a) Reduce to half its original value.
(b) Reduced to one fourth of its original value.
(c) Doubled.
(d) Constant.

10. In what manner will increase of pressure effect the following equilibrium?
$C(s) + H_2O(g) \leftrightarrow CO(g) + H_2(g)$
(a) Shift in the forward direction.
(b) Shift in the backward direction.
(c) Increase in the yield of hydrogen
(d) No effect.

11 Which of the following is correct about the equilibrium constant?
(a) Its value increases by increase in temperature.
(b) Its value decreases by decrease in temperature.
(c) May be (a) and (b).
(d) Remains constant at all temperature.

12. The units of equilibrium constant for the reaction,
$N_2 + 3H_2 \leftrightarrow 2NH_3 + heat$
(a) $Mol^{-2} L^2$ (b) $Mol\ L^{-1}$
(c) $Mol^2 L^{-2}$ (d) $L\ mol^{-1}$

13. The value of ΔG for a reaction, having K= 1, would be
(a) –RT (b) -1
(c) 0 (d) + RT

14. For a reaction, the value of K increases with increases with increase in temperature. The H for The reaction would be
(a) +ve (b) –ve
(c) Zero (d) None of these.

15. For the reaction, $H_2 + I_2 \leftrightarrow 2HI$, the equilibrium constant changes with
(a) Total pressure (b) Catalyst
(c) Temperature. (d) The amount of H_2 and I_2 present.

16. When two reactants, A and B are mixed to give products C and D, the rection quotient, Q, at the Initial stages of the reaction
(a) Is zero
(b) Decreases with time
(c) Is independent on time
(d) Increases with time.

17. The equilibrium constant of a reaction is 300. If the volume of the reaction flask is tripled, the Equilibrium constant will be
(a) 100 (b) 900
(c) 600 (d) 300

18. In which of the following equilibrium, change in the volume of the system does not alter the Number of mole
(a) $N_2(g) + O_2(g) \leftrightarrow 2NO(g)$
(b) $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$
(c) $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$
(d) $SO_2Cl_2 \leftrightarrow SO_2(g) + Cl_2(g)$

19. For the reaction,
$CO(g) + ½\ O_2(g) \leftrightarrow CO(g)$, Kp/Kc is
(a) RT
(b) $(RT)^{-1}$
(c) $(RT)^{-1/2}$
(d) $(RT)^{1/2}$

20. The reaction quotient (Q) for the reaction
$N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g)$
is given by $Q = [NH3]_2/[N2][H2]^3$. The reaction will proceed from right to left if
(a) Q < Kc
(b) Q > Kc
(c) Q = 0
(d) Q = Kc

21. For the reaction, $CO(g) + Cl_2(g) \leftrightarrow COCl_2(g)$, the Kp/Kc is equal to
(a) 1/RT
(b) 1
(c) $(RT)^{-2}$
(d) RT

22. Which of the following equimolar solutions can act as a buffer solution?
(a) NH_4Cl and NH_4OH
(b) HCl and NaCl
(c) HCOOH and HCOONa
(d) HNO_3 and NH_4NO_3

23. Which of the following has the highest pH?
(a) Distilled water
(b) 1 M NH_3
(c) 1 M NaOH
(d) Water saturated with chlorine.

24. The solubility of $Fe(OH)_3$ is x mol L^{-1}. Its Ksp would be
(a) $9x^3$
(b) $3x^4$
(c) $27x^4$
(d) $9x^4$

25. Among the following, the weakest Bronsted base is
(a) F^-
(b) Cl^-
(c) Br^-
(d) I^-

26. The value of K_w in an acidic aqueous solution at 298 K is
(a) > 10^{-14}
(b) < 10^{-14}
(c) 10^{14}
(d) 10^{-14}

27. The pH of a 10^{-10} M NaOH solution is nearest to

(a) 10 (b) 7

(c) 4 (d) -10

28. A certain sample of beer has a pH of 10. The H_3O^+ ion concentration of the beer is

(a) 10^{10} M (b) 10^{-2} M

(c) 10^{-4} M (d) 10^{-10} M

29. The solubility of AgI in NaI solution is less than that in pure water because

(a) AgI forms complex with NaI

(b) Of common ion effect

(c) Solubility product of AgI is less than that of NaI

(d) The temperature of the solution decreases

30. What is the conjugate base of OH^-?

(a) O^{2-} (b) O^-

(c) H_2O (d) O_2^-

Answers																				
Q.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
Ans.	**a**	**c**	**b**	**d**	**d**	**b**	**a**	**c**	**d**	**b**	**c**	**a**	**c**	**a**	**c**	**d**	**d**	**a**	**c**	**b**
Q.	**21**	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**										
Ans.	**a**	**c**	**c**	**c**	**d**	**d**	**b**	**d**	**b**	**a**										

UNIT 8- REDOX REACTIONS

(I)Types of reactions and oxidation number

In the following questions statement of Assertion (A) is followed by statement of Reason(R) is given. Choose the correct option out of the choices given below:-
(a)Both A and R are true and R is the correct explanation of the A.
(b)Both A and R are true and R is not the correct explanation of the A.
(c)A is true but R is False
(d)Both A and R are false.

1.Assertion (A) : Among halogens Fluorine is the best oxidant.
Reason(R) : Fluorine is the most electronegative element.

2. Assertion (A): In the reaction between potassium permanganate and potassium iodide, permanganate ions act as oxidizing agent
Reason(R) : Oxidation state of manganese changes from +2 to +7 during the reaction.

3. Assertion (A): The decomposition of hydrogen peroxide to make water is an example of disproportionation reaction
Reason(R) : The oxygen of peroxide is in -1 oxidation state and is converted to zero oxidation state in O_2 and -2 in water.

4. Assertion (A): Fluorine being most electronegative element its oxidation state is -1.
Reason(R) : Fluorine never shows disproportionate reaction.

5. Assertion (A): Oxidation involves loss of electrons.
Reason(R) : During oxidation number of an element decreases.

6. Assertion (A): The minimum oxidation state for an element can be less than 0.
Reason(R): The maximum oxidation state of s block and p block elements is no. of valence electrons in them.

7. Assertion (A): We cannot store copper sulphate in Zinc vessel.
Reason(R) : Zinc is having higher oxidation potential than copper.

8. Assertion (A): HNO3 acts only as oxidant. While HNO2 can act as oxidant and reductant both.
Reason(R): Maximum o.n for Nitrogen is +5 and minimum is -3.

9. Assertion (A): The compound AgF_2 is unstable. However, if formed, the compound acts as a very strong oxidizing agent.
Reason(R): The +2 oxidation state of Ag is unstable in nature, so the compound (Ag^{2+}) tend to gain an electron to possess the +1 oxidation state of silver.

10 Assertion (A): Valency of an element cannot not be zero but oxidation number can be.
Reason(R): Valency is the combining capacity whereas oxidation number refers to charge which an atom carries when present in the combined state.

Answers				
1. (a)	**2. (c)**	**3.(a)**	**4. (a)**	**5. (b)**
6.(b)	**7. (b)**	**8.(a)**	**9.(a)**	**10.(b)**

(II) Balancing of Redox reactions and Electrode Processes

In the following questions a statement of assertion (A) followed by a statement of reason (R) is given. Choose the correct option out of the choices given below each question

a) Both A and R are true and R is the correct explanation of A.
b) Both A and R are true but R is not the correct explanation of A.
c) A is true but R is false.
d) Both A and R are false.

1. Assertion (A) : Redox couple is the combination of oxidised and reduced form of a substance involved in an oxidation or reduction half cell.

Reason (R) : In the representation $E^{\ominus}_{Fe^{3+}/Fe^{2+}}$ and $E^{\ominus}_{Cu^{2+}/Cu}$, Fe^{3+}/Fe^{2+} and Cu^{2+}/Cu are redox couples.

2. Assertion (A) $CuO + H_2$ -----→ $Cu + H_2O$ is a redox reaction .

Reason(R): Cu is a less reactive metal.

3.Assertion (A) $Zn + 2\,HCl$ -----→ $ZnCl_2 + H_2$ Zn displaces hydrogen

Reason(R): E^o value of Zn is lower than that of Hydrogen

Question 4: Which of the following equations is not a redox reaction?

a) $Fe^{2+} \rightarrow Fe^{3+} + e^-$
b) B. $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$
c) C. $Zn + 2H^+ + 2Cl^- \rightarrow Zn^{2+} + 2Cl^- + H_2$
d) D. $MnO_2 + 4H^+ + 4Cl^- \rightarrow Mn^{2+} + 2Cl^- + 2H_2O + Cl_2$

Question 5: In the reaction $MnO_2 + 4HCl \rightarrow MnCl_2 + 2H_2O + Cl_2$

Which of the following species acts as reducing agent?

a) MnO_2
b) HCl
c) Cl^-
d) None of the above

Question 6: If acidified potassium dichromate (VI) acts as oxidizing agent, color changes from

a) orange to red
b) orange to green
c) yellow to green
d) yellow to red

Question 7: In an acidified solution of potassium dichromate (VI), dichromate ion becomes reduced to

a) chromate (V) ions
b) chromium (III) ions
c) Chromium (II) ions
d) None of the Above

Question 8: In a reaction between $CuSO_4aq)$ and Zn(s),

a) zinc experiences an increase in the oxidation state
b) Cu undergoes oxidation
c) No reaction occurs
d) None of the above

Question 9: Old paintings get blackened due to

a) Lead Sulphide PbS
b) Lead Sulphate $PbSO_4$
c) Lead Chloride $PbCl_2$
d) Lead Oxide PbO

Answers				
1. (a)	**2. (c)**	**3.(a)**	**4. (a)**	**5. (c)**
6.(b)	**7.(b)**	**8.(a)**	**9. (a)**	

UNIT 9- HYDROGEN

(I)Preparation ,Properties and Uses of Hydrogen, Hydrides

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as –

(e) If both assertion and reason are true, and reason is the true explanation of the assertion.
(f) If both assertion and reason are true, but reason is not the true explanation of the assertion.
(g) If assertion is true, but reason is false.
(h) If both assertion and reason are false.

1. **Assertion (A).** H_2O_2 liberates O_2 when it reacts with acidified $KMnO_4$ solution.
   Reason (R). $KMnO_4$ oxidises H_2O_2 to O_2.

2. **Assertion (A).** H_2O_2 has higher boiling point than water
   Reason (R). The dipole moment of H_2O_2 is little more than that of H_2O.

3. **Assertion (A).** Beryllium hydride is a covalent hydride.
   Reason (R). The electronegativity difference between Be and H is very high.

4. **Assertion (A).** The O – O bond length in H_2O_2 is shorter than that of O_2F_2.
   Reason (R). H_2O_2 is an ionic compound.

5. **Assertion (A).** Decomposition of H_2O_2 is a disproportionation reaction.
   Reason (R). H_2O_2 molecule simultaneously undergoes oxidation and reduction reactions.

6. **Assertion (A).** Nascent hydrogen can discharge the pink colour of $KMnO_4$ solution.
   Reason (R). Nascent hydrogen is much more reactive than dihydrogen.

7. **Assertion (A).** The water gas shift reaction can be used to increase the amount of H_2 in the syngas mixture.
   Reason (R). In this reaction, CO reduces stream of H_2.

8. **Assertion (A).** Dihydrogen oxidizes sodium to sodium hydride.
   Reason (R). Hydrogen can act only as a reducing agent.

9. **Assertion (A).** H_2O_2 can be used as an antichlor in bleaching.
   Reason (R). It oxidizes HCl to Cl_2.

10. **Assertion (A).** Chlorine reacts more rapidly with H_2 than with D_2.
    Reason (R). D – Cl bond is stronger than H – Cl bond.

Answers			
1	**A**	**6**	**A**
2	**B**	**7**	**A**
3	**C**	**8**	**C**
4	**D**	**9**	**C**
5	**A**	**10**	**B**

(II)Preparation, Properties of Water & Hydrogen peroxide

Q1 An oxide which gives H_2O_2 on treatment with dilute acid is

a) PbO_2 b)Na_2O_2
c) MnO_2 d)TiO_2

Q2 30 Volume of H_2O_2 means

a) 30% H_2O_2 b)30 cm3 of the solution contains 1 gm of H_2O_2
c)1 cm3 of solution liberates 30 cm3 of O_2 at STP
d) 30 cm3 of solution contains 1 mol of H_2O_2

Q3 Which of the following product is formed when calcium carbide reacts with heavy water

a)NH_3 c)C_2D_2
b)C_2H_2 d)ND_3

Q4 The structure of H_2O_2 is

a) Planer c) Spherical
b) Non planer d) Linear

Q5 Heavy water is obtained by

a) Boiling water c) Prolonged electrolysis of water
b) Fractional distillation of water d) Heating water

Q6 Which one of the following will produce permanent hardness in water ?

a) Sodium sulphate c) Calcium sulphate
b) Calcium carbonate d) Magnesium carbonate

Q7 Water obtained from hand pump and used for drinking purposes in rural area is

a) Distilled water c) Heavy water
b) Hard water d) Soft water

Q8 Which of the following method of removal of hardness of Water give water free from ions ?

a) Organic ion exchanger method c) Clarks method
b) Permutit method d) Boiling with sodium carbonate

Q9.In $CuSO_4 .5 H_2O$, how many molecules of water are attached by coordinate bond

a) 5 c) 3
b) 4 d) 1

Q10.Which of the following compound is used as Antichlor in bleaching to remove excess chlorine ?

a) Water c) Hard water
b) Hydrogen peroxide d) Hydrochloric acid

Answers				
1. (b)	**2. (c)**	**3.(c)**	**4. (b)**	**5. (c)**
6.(c)	**7. (b)**	**8.(a)**	**9. (b)**	**10.(b)**

UNIT 10 - s-BLOCK ELEMENTS

(I)Alkali Metals

(a) If both assertion and reason are true and reason is the true explanation of the assertion.
(b)If both assertion and reason are true but reason is not the true explanation of the assertion.
© If assertion is true ,but reason is false.
(d) If both assertion and reason are false.

1. Assertion. In the electrolysis of aqueous NaCl,Na is preferentially discharged at mercury cathode forming sodium amalgam.
Reason. It is due to the fact that hydrogen has a high overvoltage at mercury cathode.

2 Assertion. In rainy season ,common salt becomes damp after some time on keeping in air.
Reason. Common salt is NaCl which is hygroscopic in nature.

3.Assertion. Potassium carbonate cannot be prepared by a process similar to the solvays soda ammonia process.
R eason. Potassium hydrogen carbonate is less soluble in water than sodium hydrogen carbonate.

4.Assertion. Li resembles Mg.
Reason. Li^+ has approximately the same size as Mg^{2+}.

5. Assertion. Na_2SO_4 is soluble in water while $BaSO_4$ is insoluble.
Reason. Lattice energy of barium sulphate exceeds its hydration enthalpy.

6.A ssertion. Alkali metals impart colour to the flame.
Reason. Their ionization energies are low.

7.Assertion.K, Rb,Cs form superoxides.
R eason. The stability of the superoxides increases from K to Cs due to decrease in lattice energy.

8.Assertion.Among alkali metals , lithium salts exhibit the least electrical conductance in aqueous solutions.
Reason. Smaller the radius of the hydrated cation, lower is the electrical conductance in aq.

9.Assertion. LiCl is predominantly covalent compound.
Reason. Electronegativity difference between Li and Cl is too Small.

10.A ssertion. Alkali metals(except Li) exhibit photoelectric effect.
Reason. Ionisation enthalpies of alkali metals is low.

Answers				
1. (a)	**2. (c)**	**3.(c)**	**4.(a)**	**5. (a)**
6.(a)	**7.(c)**	**8.(c)**	**9.(c)**	**10.(a)**

(II)Alkaline earth metals

Question 1: Which of the following is not the correct reason for anomalous property of Be?

a. Its small size and high polarizing power.

b. Relatively high electro negativity and ionization energy as compared to other members.

c. Absence of vacant d – orbitals in its valence shell.

d. Presence of fully filled 2s orbital

Question 2: Which of the following statements is incorrect?

a. Be is harder than other members of its group.

b. Be is lighter than Mg.

c. Be does not react with water while Mg reacts with boiling water.

d. BeO is acidic while MgO is amphoteric.

Question 3: $BeO + 2HCl \rightarrow$

a. $BeCl_2 + H_2O$

b. $BeCl + H_2O + Cl_2$

c. $BeCl_2 + Cl_2$

d. $BeCl_2 + H_2$

Question 4: Be is not readily attacked by acids because of the presence of

a. an oxide film

b. empty d orbitals

c. fully filled 2s orbital

d. lone pair of electrons

Q 5 The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}?

a. $Ca^{2+} < Mg^{2+} < Be^{2+} < K^+$

b. $Mg^{2+} < Be^{2+} < K^+ < Ca^{2+}$

c. $Be^{2+} < K^+ < Ca^{2+} < Mg^{2+}$

d. $K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

Q 6 The solubility of carbonates decrease down the magnesium group (alkaline earth metals) due to a decrease in:

a. lattice energies of solids

b. hydration energies of cations

c. inter-ionic attraction

d. entropy of solution formation

Q 7 The charge/size ratio of a cation determines its polarizing power. Which one of the following sequences represents the increasing order of the polarizing power of the cationic species, K^+, Ca^{2+}, Mg^{2+}, Be^{2+}?

a) $Ca^{2+} < Mg^{2+} < Be^{2+} < K^+$

b) $Mg^{2+} < Be^{2+} < K^+ < Ca^{2+}$

c) $Be^{2+} < K^+ < Ca^{2+} < Mg^{2+}$

d) $K^+ < Ca^{2+} < Mg^{2+} < Be^{2+}$

Q 8 What are the metal ion are present in carnalite?

a. Mg^{2+}, K^+

b. Al^{3+}, Na^+

c. Na^+, Mg^{2+}

d. Zn^{2+}, Mg^{2+}

Q 9 Mortar is a mixture of:

a) Plaster of Paris + Silica

b) Slaked lime + Plaster of Paris + H_2O

c) $CaCO_3$ + Silica + H_2O

d) Slaked lime + sand + H_2O

Answers				
1. (d)	**2. (d)**	**3.(d)**	**4.(a)**	**5. (d)**
6.(b)	**7.(d)**	**8.(a)**	**9.(d)**	

UNIT 11- p-BLOCK ELEMENTS

(I)Boron Family

Level 1.

1.Which of the following does not constitute the Boron Family?

a) Barium
b) Aluminium
c) Gallium
d) Thallium

2.Which of the following elements of the Boron Family is the most abundant?

a) Aluminium
b) Boron
c) Gallium
d) Thallium

3.Which of the following elements of the Boron Family is a non-metal?

a) Gallium
b) Indium
c) Thallium
d) Boron

4.Boron is a :-

(a)Metal
(b)Non- metal
(c)Metalloid
(d)Compound

5.Boron forms :-

(a)Covalent compounds only
(b)Ionic compounds only
(c)Ionic as well as covalent compounds
(d)None of the above

Level 2.

6.Which of the following elements show oxidation state of +3 only?

(a)Boron
(b)Gallium
(c)Indium
(d)Thallium

7.In B_2H_6 :-

(a)There is a direct boron-boron bond
(b)The boron atoms are linked through hydrogen atoms
(c)The structure is similar to C_2H_6
(d)All the atoms are in one plane

8.Which of the following elements resembles boron the most?

(a)Aluminium
(b)Gallium
(c)Iron
(d)Silicon

9.Which of the following method is used for purification of bauxite containing iron oxide as impurity?

(a)Serpeck's method
(b)Electrolytic refining
(c)Baeyer's process
(d)Hoope's process

10.Boron compounds behave as Lewis acid because of their……

(a)Acidic Nature
(b)Electron deficiency
(c)Ionic property
(d)Smaller size

Level 3.

11.Which of the following is not correct for diborane?

(a)When methylated it produces $Me_4B_2H_2$
(b)All bond length B-H are equal
(c)Two boron atoms and four hydrogen atoms lie in the same plane
(d)Two bridging hydrogen atoms lie symmetrically above and below the plane formed by two B and 4 H

12.The basic character of the following hydroxides increase in the order :-

(a)$Al(OH)_3$> $B(OH)_3$> TlOH > $Ga(OH)_3$
(b)$Ga(OH)_3$> TlOH >$B(OH)_3$>$Al(OH)_3$
(c)$B(OH)_3$>$Al(OH)_3$>$Ga(OH)_3$> TlOH
(d)$Al(OH)_3$>$Ga(OH)_3$>TlOH >$B(OH)_3$

13.The bond angle Cl – B – Cl in BCl_3 is :-

(a)60^o
(b)109^o7^l
(c)120^o
(d)90^o

14.Which of the following is a Lewis Acid?

(a)PCl_3
(b)$AlCl_3$
(c)$TiCl_3$
(d)NCl_3

15.H_3BO_3 is :-

(a)Monobasic and a weak Lewis acid
(b)Monobasic and a weak Bronsted acid
(c)Monobasic and a strong Lewis acid
(d)Tribasic and a weak Bronsted acid

Answers

Level 1.	**1.(a)**	**2.(a)**	**3.(d)**	**4.(b)**	**5.(a)**
Level 2.	**1.(a)**	**2.(b)**	**3.(d)**	**4. (c)**	**5.(b)**
Level 3.	**1.(b)**	**2.(c)**	**3. (c)**	**4. (b)**	**5. (a)**

(II) Carbon Family

Q1) The stability of dihalides of Si, Ge, Sn and Pb increases steadly in sequence...

a) PbX2 << SnX2 << GeX2 << SiX2
b) GeX2<< SiX2 << SnX2 << PbX2
c) SiX2 << GeX2 << PbX2 << SnX2
d) SiX2 << geX2 << SnX2 << PbX2

Q2) Which of the following is the most ionic?

a) CCl4
b) SbCl4
c) PbCl4
d) SbCl2

Q3) Which one of the following is not a property of carbon

a) It exhibits catenation
b) It forms multiple bonds
c) Its melting point and boiling points are very high
d) It is a semi-metal

Q4) Which of the following is most allotropes of carbon is isomorphous with crystalline silicon?

a) Coke
b) Diamond
c) Graphite
d) Coal

Q5) A metal, M forms chlorides in +2 and +4 oxidation states. Which of the following statements about these chlorides is correct? [AIEEE 2006]

a) MCl2 is more volatile than MCl4
b) MCl2 is more soluble in anhydrous ethanol than MCl4
c) MCl2 is more ionic than MCl4
d) MCl2 is more easily hydrolyzed than MCl4

Q6) The oxidation number of C in CH2O is

a) -1
b) +2
c) zero
d) -4

Q7) Chrome yellow is

a) PbCrO4
b) Cr2O72-
c) PbCl2
d) PbCO3

Q8) What happened when SiO_4^{4-} is heated

a) $Si_2O_7^{6-}$

b) Changes to $Si_4O_{11}^{6-}$

c) Changes to SiO_2

d) Nothing will happen

Q9) $(Me)_2SiCl_2$ on hydrolysis will produce .

a) $(Me)_2Si(OH)_2$

b) $(Me)_2Si = O$

c) $-[(Me)_2Si - O]-n$

d) $(Me)_2SiCl(OH)$

Q10) CCl_4 does not show hydrolysis but $SiCl_4$ is readily hydrolyzed because

a) Carbon cannot expand its octet but silicon can expand

b) Electronegativity of carbon is higher than silicon

c) Ionization energy of carbon is higher than of silicon

d) Carbon form double and triple bonds but not silicon

Q11) Carbon monoxide reacts with Cl_2 in presence of sunlight to give

a) Phosgene

b) COCl

c) Phosphine

d) CCl_4

Q12) Which one of the following is correct set for SiO_2

a) Linear, acidic

b) Linear, basic

c) Tetrahedral, acidic

d) Angular, basic

Answers:

1)(d) For group 14 stability of dihalide increases down the group

2) (d) In group 14 oxidation state give ionic compounds while +4 oxidation states gives covalent compounds

3) (d) Carbon is non metal

4) (b) Diamond and crystalline Si have three dimensional tetrahedral structure

5) (c) Compounds of metal in lower oxidation state are more ionic than those in higher state. This is in accordance with Fajan's rule

6) (c)

7) (a)

8) (a)

9) (c) Dialkyl dichlorosilanes on hydrolysis followed by polymearization produce silicones

10) (a)

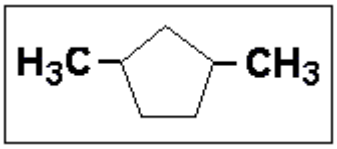
11) (a) Phosgene is $COCl_2$

12) (c)

UNIT12- ORGANIC CHEMISTRY:SOME BASIC PRINCIPLES AND TECHNIQUES

(I) IUPAC Nomenclature

1.Select the correct IUPAC name for:

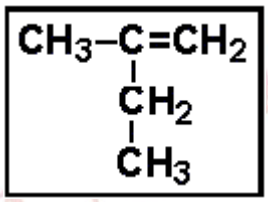


(a) 1,4-dimethylcyclopentane
(b) 1,3-dimethylcyclopentane
(c) 2,5-dimethylcyclopentane
(d) 2,3-dimethylcyclopentane
(e) 2,4-dimethylcyclopentane

2.The general formula for noncyclic alkenes is:

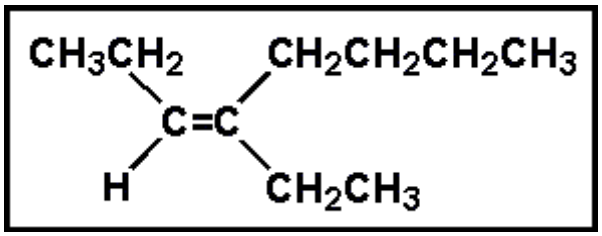
(a) C_nH_{2n+2}
(b) C_nH_{2n}
(c) C_nH_{2n-2}
(d) C_nH_{n+2}
(e) C_nH_n

3.The correct name for the compound given below is:



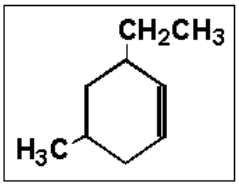
(a) 2-methyl-1-butene
(b) 2-ethyl-1-propene
(c) 2-ethyl-1-pentane
(d) 3-methyl-2-butene
(e) pentene

4.Select the best name for:



(a) 4-ethyl-cis-3-octene
(b) 4-ethyl-trans-3-octene
(c) 4-butyl-cis-3-hexene
(d) 5-ethyl-trans-5-octene
(e) 5-ethyl-cis-5-octene

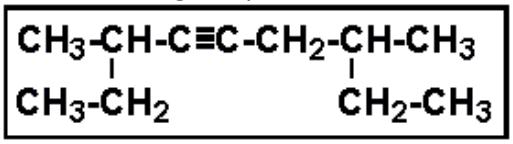
5. Name the following compound:



(a) 6-ethyl-4-methylcyclohexene
(b) 6-ethyl-3-methylcyclohexene
(c) 3-ethyl-5-methylcyclohexene
(d) 6-ethyl-4-methylcyclohex-1-ene
(e) 6,4-dialkylcyclohexene

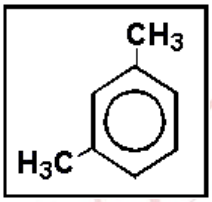
6.

What is the IUPAC name of the following compound?



(a) 2,6-diethyl-3-nonyne
(b) 2,5-diethyl-3-nonyne
(c) 3,7-dimethyl-5-nonyne
(d) 3,7-dimethyl-4-nonyne
(e) 2,6-diethyl-3-heptyne

7.The following chemical structure represents a molecule of what molecular formula?



(a) C_8H_{10}
(b) C_6H_6
(c) C_6H_8
(d) C_8H_{12}
(e) C_8H_6

8.How many **actual** double bonds does the benzene ring possess?
(a) None, carbon-carbon bonds in benzene are delocalized around the ring
(b) 1 double bond
(c) 2 double bonds
(d) 3 double bonds
(e) 4 double bonds

9.Para-xylene is the same as:
(a) 1,2-dimethylbenzene
(b) 1,3-diethylbenzene
(c) 1,3-dimethylbenzene
(d) 1,4-diethylbenzene
(e) 1,4-dimethylbenzene

10. Which of the following formulas represents an alkene?
(a) $CH_3CH_2CH_3$
(b) CH_3CH_3
(c) $CH_3CH_2CHCH_2$
(d) CH_3CH_2Cl
(e) CHCH

Answers				
1. (b)	**2. (b)**	**3. (a)**	**4. (a)**	**5. (c)**
6. (d)	**7. (a)**	**8. (a)**	**9. (e)**	**10(c)**

(II) Isomerism & Electronic Displacement

ASSERTION AND REASON TYPE QUESTIONS:

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as –

(a) If both assertion and reason are true, and reason is the true explanation of the assertion.
(b) If both assertion and reason are true, but reason is not the true explanation of the assertion.
(c) If assertion is true, but reason is false.
(d) If assertion is false ,but reason is true.

1. Assertion (A). All compounds having C=C bond exhibit geometrical isomerism.
Reason (R). Rotation about C=C bond is restricted.

2.Assertion (A). Alkanes containing more than three carbon atoms exhibit chain isomerism.
Reason (R). All carbon atoms in alkanes are sp hybridize.

3.Assertion (A). Metamers can also be chain or position isomers.
Reason (R). The term tautomerism was introduced to explain the reactivity of a substance according to two possible structures.

4.Assertion (A). Pent-1-ene and pent-2-ene are position isomers
Reason (R). Position isomers differ in the position of functional group or a substituent

5.Assertion (A). Energy of resonance hybrid is equal to the average energy of all canonical forms
Reason (R). Resonance hybrid cannot be represented by a single structure

6 . Which one of the carbocations is most stable?

a) $(CH_3)_3C^+$,
b) $(CH_3)_2C^+H$
c) $(CH_3)C^+H_2$
d) CH_3^+

7.Which one of the following has minimum hyperconjugating structures

a) $(CH_3)_3C^+$,
b) $(CH_3)_2C^+H$
c) $(CH_3)C^+H_2$
d) CH_3^+

8. In which of the following functional groups isomerism is not possible

a)Alcohols
b)Aldehydes
c) Alkyl halides
d) Cyanides

9.Which of the following carboxylate ions is the most stable

a)CH_3COO^-
b) $ClCH_2COO^-$
c)FCH_2COO^-
d)F_2CHCOO^-

10. Name the type of intermediate formed in the following Electrophillic addition reaction

$H_3C\text{-}CH{=}CH_2{+}H^+ \longrightarrow$

a)2^0 carbanion
d) 1^0 carbanion
c) 2^0 carbocation
d) 1^0 carbanion

Answers				
1. (d)	**2. (c)**	**3. (b)**	**4. (a)**	**5. (d)**
6. (a)	**7. (d)**	**8. (c)**	**9. (d)**	**10(c)**

(III) Purification, Detection & Estimation

In each of the following questions, a statement of Assertion (A) is given followed by a corresponding statement of Reason (R) just below it. Of the statements, mark the correct answer as

(A)If both assertion and reason are true, and reason is the true explanation of the assertion.

(B)If both assertion and reason are true, but reason is not the true explanation of the assertion.

(C) If assertion is true, but reason is false.

(D)If both assertion and reason are false.

1. **Assertion (A).** Essential oils are purified by steam distillation.
   Reason (R). Essential oils are volatile and are insoluble in water.
2. **Assertion (A).** Hydrazine contains nitrogen but does not give Lassaigne's test for nitrogen.
   Reason (R). Hydrazine reacts with fused sodium to give H_2 gas.
3. **Assertion (A).** Lassaigne's test is not shown by diazonium salts.
   Reason (R). Diazonium salts lose N_2 on heating much before they have a chance to react with fused sodium.
4. **Assertion (A).** A mixture of camphor and benzoic acid can be separated by sublimation.
   Reason (R). Camphor on heating sublimes but benzoic acid does not
5. **Assertion (A).** Glycerol can be purified by distillation under reduced pressure.
   Reason (R). Liquid organic compounds are purified by distillation
6. **Assertion (A).** simple distillation can help in separating a mixture of propanol (boiling point 97^{oc})and propanone(boiling point 56^{oc})
   Reason (R). liquids with a difference of more than 20oc in their boiling poimts can be separated by steam distillation.
7. The best &latest technique for isolation ,purification & separation of organic compounds is.
   a)crystallization b)distillation
   c)sublimation d)chromatography
8. In the lassaigne,s test for nitrogen in an organic compound,the Prussian blue colour is obtained due to formation of
   a)Na_4 [fe$(CN)_6$] b) Fe_4[fe$(CN)_6]_3$
   c)Fe_2 [fe$(CN)_6$] d) Fe_3 [fe$(CN)_6]_3$
9. The principle involved in paper chromatography is-
   a)adsorption b)partition
   c)solubility d)volatility
10. the fragrance of flowers is due to the presence of some steam volatile organic compounds called essential oils .these are generally insoluble in water at room temperature but are miscible with water vapour in vapour phase.a suitable method for extraction of these oils from the flower is –
    a)distillation b)crystallisation
    c)distillation under reduced pressure d)steam distillation

Answers				
1. (a)	**2. (b)**	**3. (a)**	**4. (d)**	**5. (b)**
6. (a)	**7. (d)**	**8. (b)**	**9. (b)**	**10(d)**

UNIT 13- HYDROCARBONS

(I)ALKANES

1 Assertion: Alkane has low electrical conductivity.

Reason: Electrical conductivity is due to the movement of the ions.

(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

2.**Assertion**: The melting and boiling point of alkanes are less compared with the inorganic compounds.

Reason: the attractive forces in their molecules are quite weak.

(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

3.**Assertion**: Alkanes are generally non-polar in nature and these are soluble in non-polar solvents.

Reason:The solubility is generally guided by the principle of like dissolve like.

(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

4.**Assertion**: Alkanesare saturated hydrocarbons.

Reason: saturated hydrocarbons are only formed by C-C single bond.

(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

5.**Assertion**: Halogenation reaction of alkanes can be take place with suitable halogens in the presence of ultra-violet.

Reason: The reactions taking place in presence of ultra–violet rays are known as photochemical reactions.

(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

6.**Assertion**: Among the isomeric alkanes, the branched chain isomers have lower boiling point than the straight chain isomers.

Reason: With branching of chain surface area decreases and the vander waal forces of attraction which depend upon surface area also tend to decreases.

(a) A is correct, R is correct and R is a correct explanation of A.

(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

7.**Assertion**: Melting point of neopentane is higher than that of n-pentane but the boiling point of n-pentane is higher than that of neopentane.
Reason: Melting point depends upon packing of molecules in the crystal lattice while boiling point depends upon surface area of the molecule.
(a) **A is correct, R is correct and R is a correct explanation of A.**
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

8.**Assertion**: Alkanes with more than three carbon atoms exhibit chain isomerism.
Reason: Branching of the carbon atom chain is necessary for exhibiting chain isomerism.
(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

9.**Assertion**: Sodium acetate on Kolbe's electrolysis gives methane.
Reason: Methyl free radical is formed at cathode.
(a) **A is correct, R is correct and R is a correct explanation of A.**
(b)A is not correct,R is correct and R is not a explanation for A.
(c)Both A and R are wrong.
(d)R is correct reason but A is wrong.

10.Assertion: It is possible to isolate pure staggered or pure eclipsed ethane at room temperature.
Reason: The energy difference between staggered and eclipsed forms of ethane is only 12.5 KJ/mol.
(a) A is correct, R is correct and R is a correct explanation of A.
(b) A is not correct,R is correct and R is not a explanation for A.
(c) Both A and R are wrong.
(d) R is correct reason but A is wrong.

Answers				
1. (a)	**2. (a)**	**3. (a)**	**4. (a)**	**5. (a)**
6. (a)	**7. (a)**	**8. (a)**	**9. (a)**	**10(b)**

(II)Alkene and Alkyne

1.Arrange the following Hydrogen Halides in order of their decreasing reactivity with propen

a) HCl> HBr > HI b) HBr > HI > HCl c) HI> HBr> HCl d) HCl > HI > HBr

2. The molecules having dipole moment are…….

a) 2,2-Dimethylpropane b) trans-pent-2-ene c) cis-Hex-3-ene d) 2,2,3,3-Tetramethylbutane

3. Ethyne react with Bayers reagents to give

a) Glycol b) Acetaldehyde c) Ethyl Alcohol d) oxalic acid

4. The copound which forms only Acetaldehyde on Ozonalysis is

a) Ethane b) Propane c) But -1-ene d) Butene

5. The lowest alkene which is capable of exhibiting geometrical isomerism :

a) 1-Butene b) 2-Pentene c) 2-Butene d) 2,3-dimethylbutene

6. when 3,3 –dimethyl-2-butanol is heated with H_2SO_4 , the major product is

a) 3,3-dimethyl-1-butene b) 2,3-dimethyl-2-butene

c) 2,3-dimethyl-1-butene d) Cis and Trans isomers of product named under(b)

7. The Alkyne which react with KMnO4 to give Pyruvic acid is

a) Ethyne b) Propyne c) Butyne d) 2-pentyne

8. Ethyne add a molecule of methyl alcohol in presence of alkali to give

a) Acetone b) Methyl vinyl ether c) acetaldehyde d) acetic acid

9. which alkene on ozonalysis give acetaldehyde and acetone

a) $CH_3CH_2CH=C(CH_3)_2$ b) $CH_3CH_2CH=CH-CH_3$

c) $CH_3CH_2CH=CHCH_3$ d) $C(CH_3)_2=CHCH_2CH_3$

10. Reaction of HBr with propene in presence of peroxide give

a) 3-bromopropane b) Alkyl Bromide

c) n-Propyl Bromide d) Isopropyl bromide

Answers				
1. (c)	**2. (b&c)**	**3. (a)**	**4. (c)**	**5. (c)**
6. (b)	**7. (b)**	**8. (b)**	**9. (a)**	**10. (c)**

UNIT14- ENVIRONMENTAL CHEMISTRY

In the following question a statement of assertion (A) followed by a statement of reason (R) is given. Choose the correct option out of the choice given below each questions.

1. Assertion (A) : Green house effect was observed in houses used to grow plants and these are made of green glasses.
   Reason (R) : Green house name has been given because green houses are made up of green glass.
   (a) Both A and R are correct and R is the correct explanation of A.
   (b) Both A and R are correct and R is not the correct explanation of A.
   (c) Both A and R are not correct
   (d) A is not correct but R is correct.

2. Assertion (A):-The PH of acid rain is less than 5.6
   Reason (R):-CO_2 present in the atmosphere dissolves in rain water and form carbonic acid.
   (a) Both A and R are correct and R is the correct explanation of A.
   (b) Both A and R are correct and R is not the correct explanation of A.
   (c) Both A and R are not correct.
   (d) A is not correct but R is correct.
3. Assertion(A) :-Photochemical smog is oxidising in nature.
   Reason(R) :-Photochemical smog contains NO_2 and O_3 which are formed during the sequence of reactions.
   (a) Both A and R are correct and R is the correct explanation of A.
   (b) Both A and R are correct and R is not the correct explanation of A.
   (c) Both A and R are not correct.
   (d) A is correct but R is not correct.

4. Assertion(A):-CO_2 is the one of the important greenhouse gases.
   Reason (R) :-It is largely produced by respiratory function of animals and plants.
   (a) Both A and R are correct and R is the correct explanation of A.
   (b) Both A and R are correct and R is not the correct explanation of A.
   (c) Both A and R are not correct.
   (d) A is not correct but R is correct.

5. Assertion(A):-Ozone is destroyed by solar radiation in upper stratosphere.
   Reason (R) :-Thinning of the ozone layer allows excessive UV radiations to reach the surface of earth
   (a) Both A and R are correct and R is the correct explanation of A.
   (b) Both A and R are correct and R is not the correct explanation of A.
   (c) Both A and R are not correct.
   (d) A is not correct but R is correct.

6. Assertion(A):-Excessive use of chlorinated synthetic pesticides causes soil and water pollution.
   Reason (R) :-Such pesticides are non- biodegradable.

(a) Both A and R are correct and R is the correct explanation of A.
(b) Both A and R are correct and R is not the correct explanation of A.
(c) Both A and R are not correct.
(d) A is not correct but R is correct.

7. Assertion(A):- If BOD level of water in a reservoir is less thas 5ppm,it is highly polluted.
Reason(R):-High biological oxygen demand means low activity of bacteria in water.
(a) Both A and R are correct and R is the correct explanation of A.
(b) Both A and R are correct and R is not the correct explanation of A.
(c) Both A and R are not correct.
(d) A is not correct but R is correct.

8. Assertion(A):- Classical smog is reducing in nature.
Reason(R):- It is a mixture of smoke, fog and sulphur dioxide
(a) Both A and R are correct and R is the correct explanation of A.
(b) Both A and R are correct and R is not the correct explanation of A.
(c) Both A and R are not correct.
(d) A is not correct but R is correct.

9. Assertion(A):- heavy metals such as cadmium, mercury, nickel etc.can also cause environment pollution.
Reason(R):- All these metals are dangerous to humans because human body can excrete them.
(a) Both A and R are correct and R is the correct explanation of A.
(b)Both A and R are correct and R is not the correct explanation of A.
(c) Both A and R are not correct.
(d) A is correct but R is not correct.

10. Assertion (A):- Acid rain is harmful for agriculture, trees and plants
Reason (R):- it dissolves and washes away nutrients needed for their growth.
(a) Both A and R are correct and R is the correct explanation of A.
(b)Both A and R are correct and R is not the correct explanation of A.
(c) Both A and R are not correct.
(d) A is correct but R is not correct.

Answers				
1. (c)	**2. (b)**	**3. (a)**	**4. (b)**	**5. (d)**
6. (a)	**7. (c)**	**8. (a)**	**9. (d)**	**10. (a)**

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CHEMICAL EQUILIBRIUM

❑ Writing Equilibrium Expressions

In order to write the equilibrium expression for a system in a state of equilibrium you need to know:

- the balanced equation for the reaction
- the phases (solid, liquid, gas, or dissolved) of each species involved in the reaction.

Writing Expressions for K_c

The general equilibrium expression for a reaction:

$$a\,A + b\,B \leftrightarrows c\,C + d\,D$$

is written as:

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

The brackets "[ ]" represent the concentration of the species (moles per liter or molarity). "a, b, c, and d" represent the coefficients used to balance the equation. The "c" in K_c indicates that the value of K is determined using the concentrations of each species.
There are two cases when a species is not shown in the equilibrium expression:

- when it is a solid
- when it is a pure liquid or solvent

Writing Expressions for K_p

When one or more of the species in a system exists in the gaseous phase, the partial pressure of that species can be used in the equilibrium expression Dissolved species are still expressed as moles per liter (molarity).

Examples

Examples of equilibrium expressions K_c for a variety of equilibrium systems follow. When one or more gaseous substances are involved, the K_p expression is also given.

- The production of ammonia from nitrogen and hydrogen gases.

$$N_2(g) + 3\,H_2(g) \leftrightarrows 2\,NH_3(g)$$

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

$$K_p = \frac{P^2_{(NH3)}}{P_{(N2)}P^3_{(H2)}}$$

- The thermal decomposition of calcium carbonate.

$$CaCO_3(s) \leftrightarrows CaO(s) + CO_2(g)$$

$$K_c = [CO_2]$$
$$K_p = P_{(CO2)}$$

- The oxidation-reduction reaction occuring between iron(III) chloride and tin(II) chloride.

$$2\ FeCl_3(aq) + SnCl_2(aq) \leftrightarrows 2\ FeCl_2(aq) + SnCl_4(aq)$$

$$K_c = \frac{[FeCl_2]^2[SnCl_4]}{[FeCl_3]^2[SnCl_2]}$$

- The replacement of silver ions by copper.

$$Cu(s) + 2\ Ag^+(aq) \leftrightarrows Cu^{2+}(aq) + 2\ Ag(s)$$

$$K_c = \frac{[Cu^{2+}]}{[Ag^+]^2}$$

- The interaction of acetic acid with water.

$$CH_3COOH(aq) + H_2O(l) \leftrightarrows H_3O^+(aq) + CH_3COO^-(aq)$$

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

- The reaction of carbon dioxide gas with a sodium hydroxide solution.

$$CO_2(g) + NaOH(aq) \leftrightarrows NaHCO_3(aq)$$

$$K_c = \frac{[NaHCO_3]}{[CO_2][NaOH]}$$

$$K_p = \frac{[NaHCO_3]}{P_{(CO2)}[NaOH]}$$

- The evaporation of water.

$$H_2O(l) \leftrightarrows H_2O(g)$$

$$K_c = [H_2O(g)]$$

$$K_p = P_{(H2O)}$$

MAKING AN ICE CHART AN AID IN SOLVING EQUILIBRIUM PROBLEMS

❑ An useful tool in solving equilibrium problems is an ICE chart.

- "I" stands for the initial concentrations (or pressures) for each species in the reaction mixture.
- "C" represents the change in the concentrations (or pressures) for each species as the system moves towards equilibrium.
- "E" represents the equilibrium concentrations (or pressures) of each species when the system is in a state of equilibrium.

- How to make an ICE chart
- Sample ICE charts
  - Only reactant species are present initially
  - Only product species are present initially
  - Species added to a system initially in a state of equilibrium
  - Gaseous species and K_p

How to Make an ICE Chart

In making an ICE chart the following items should be noted:

- Express all quantities in terms of **MOLARITY** (moles per liter). (If using K_p, gaseous species must be expressed in appropriate pressure units.)
- Use **initial quantities** when calculating the reaction quotient, Q, to determine the direction the reaction shifts to establish equilibrium.
- Use **equilibrium quantities** in calculations involving the equilibrium constant, K.
- The **change in each quantity** must be in agreement with the **reaction stoichiometry.**
- Read each problem carefully to identify what quantities are given, including their unit of measure, and to identify what is unknown.

- Clearly define the change you choose to be represented by "x." Define all other unknown changes in terms of this change.

The following is a "how to" make an ICE chart using the example to illustrate the process.

Example: A mixture consisting initially of 3.00 moles NH_3, 2.00 moles of N_2, and 5.00 moles of H_2, in a 5.00 L container was heated to 900 K, and allowed to reach equilibrium. Determine the equilibrium concentration for each species present in the equilibrium mixture.

$$2\ NH_3(g) \leftrightarrows N_2(g) + 3\ H_2(g) \quad K_c = 0.0076 \text{ @ } 900\ K$$

- Convert the initial quantities to molarities as shown for NH_3.

$$\frac{3.00 \text{ moles } NH_3}{5.00\ L} = 0.600\ M$$

- Create a chart as illustrated below and enter in the known quantities.

	NH_3	N_2	H_2
Initial Concentration (M)	0.600	0.400	1.00
Change in Conc. (M)			
Equilibrium Conc. (M)			

- Calculate Q_c and compare to K_c to determine the direction the reaction will proceed.

$$Q_c = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{(0.400)(1.00)^3}{(0.600)^2} = 1.11$$

$K_c < Q_c$ reaction will proceed towards the left

- Assign a variable "x" that represents the change in the amount of one of the species. The species with the lowest coefficient in the balanced equation usually is the easiest to handle when it comes to doing the math. Here let "x" = change in the amount of N_2.
- Determine the change in all the other species in terms of "x." Remember the change must be in agreement with the stoichiometry of the balanced equation, in this case 2:1:3. Since the reaction goes in the reverse direction the concentrations of N_2 and H_2gases will decrease (note the negative sign) and that of NH_3 will increase. Put these quantities into the chart (shown in red).

	NH_3	N_2	H_2
Initial Concentration (M)	0.600	0.400	1.00
Change in Conc. (M)	+ 2 x	- x	- 3 x
Equilibrium Conc. (M)			

- Express the equilibrium concentrations in terms of "x" and the initial amounts (shown in green).

	NH_3	N_2	H_2
Initial Concentration (M)	0.600	0.400	1.00
Change in Conc. (M)	+ 2 x	- x	- 3 x
Equilibrium Conc. (M)	0.600 + 2 x	0.400 - x	1.00 - 3 x

- Substitute the expressions for the equilibrium concentration into the expression for the equilibrium constant and solve for "x." Once x is known, the equilibrium concentration for each species can be calculated.

$$\frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{(0.400 - x)(1.00 - 3x)^3}{(0.600 + 2x)^2} = 0.0076$$

$$x = 0.21575 = 0.216$$

$$[N_2] = 0.400 - 0.216 = 0.184\ M$$
$$[H_2] = 1.00 - 3(0.216) = 0.352\ M$$
$$[NH_3] = 0.600 + 2(0.216) = 1.032\ M$$

The value of x was determined using the method of successive approximations.

❑ SAMPLE ICE CHARTS

The following examples illustrating writing ICE charts for the problems given. Although each problem appears to be "different" the process for creating the ICE chart is the same.

- Only reactant species are present initially
- Only product species are present initially
- Species added to a system initially in a state of equilibrium
- Gaseous species and Kp

Only Reactant Species Are Present Initially

Example: 4.00 moles of HI are placed in an evacuated 5.00 L flask and then heated to 800 K. The system is allowed to reach equilibrium. What will be the equilibrium concentration of each species?

$$2\ HI(g) \leftrightarrows H_2(g) + I_2(g) \quad K_c = 0.016\ @\ 800\ K$$

Let "x" represent the change in concentration of the hydrogen gas. Since we start with HI alone, the reaction must proceed to the right resulting in an increase in the amount of hydrogen gas.

	HI(g)	$H_2(g)$	$I_2(g)$
Initial Concentration (M)	0.800	0	0
Change in Concentration (M)	- 2 x	+ x	+ x
Equilibrium Concentration (M)	0.800 - 2 x	0 + x	0 + x

Only Product Species Are Present Initially

Example: 0.600 moles of NO and 0.750 moles of O_2 are placed in an empty 2.00 L flask. The system is allowed to establish equilibrium. What will be the equilibrium concentration of each species in the flask?

$$2\ NO_2(g) \leftrightarrows 2\ NO(g) + O_2(g) \quad K_c = 0.50$$

Let "x" represent the change in concentration of the oxygen gas. Since only NO and O_2 are present, the reaction must proceed to the left in order to establish equilibrium. The O_2 gas will decrease in concentration over time.

	$NO_2(g)$	NO(g)	$O_2(g)$
Initial Concentration (M)	0	0.300	0.375
Change in Concentration (M)	+ 2 x	- 2 x	- x
Equilibirum Concentration (M)	2 x	0.300 - 2 x	0.375 - x

Species Added to a System Initially in a State of Equilibrium

Example: The concentrations of an equilibrium mixture of O_2 , CO, and CO_2 were 0.18 M, 0.35 M, and 0.029 M respectively. Enough CO was added to the flask containing the equilibrium mixture to momentarily raise its concentration to 0.60 M. What will be the concentration of each species in the flask once equilibrium has been re-established after the additional carbon monoxide was added?

$$2\ CO_2(g) \leftrightarrows 2\ CO(g) + O_2(g)$$

After the addition of more CO the system is no longer in equilibrium. The once equilibrium quantities of the other three substances are now initial quantities. Let "x" represent the change in the amount of O_2 gas. Adding the CO will force the reaction to proceed in the reverse direction (K < Q) causing the amount of O_2 to decrease. (Note: The equilibrium quantities given in the problem, before the addition of more CO, are also used to calculate the value of the equilibrium constant, K_c.)

	$CO_2(g)$	CO(g)	$O_2(g)$
Initial Concentration (M)	0.029	0.60	0.18
Change in Concentration (M)	+ 2 x	- 2 x	- x
Equilibrium Concentration (M)	0.029 + 2 x	0.60 - 2 x	0.18 - x

Gaseous Species and K_p

Example: Cl_2 gas undergoes homolytic cleavage into chlorine atoms at 1100°C. K_p at 1100°C for this process is 1.13×10^{-4}. If a sample with an initial Cl_2 gas pressure of 0.500 atm was allowed to reach equilibrium, what is the total pressure in the flask?

$$Cl_2(g) \leftrightarrows 2\ Cl(g)$$

Let "x" represent the change in the pressure of the Cl_2 gas. Since the reaction will proceed forwards to establish equilibrium the pressure of the Cl_2 gas will decrease. The total pressure at equilibrium will equal the sum of the partial pressures of each gas at equilibrium.

	$Cl_2(g)$	$Cl(g)$
Initial Pressure (atm)	0.500	0
Change in Pressure (atm)	- x	+ 2 x
Pressure at Equilibrium (atm)	0.500 - x	0 + 2 x

❑ CALCULATING EQUILIBRIUM CONSTANTS

We need to know two things in order to calculate the numeric value of the equilibrium constant:

- the balanced equation for the reaction system, including the physical states of each species. From this the equilibrium expression for calculating K_c or K_p is derived.
- the equilibrium concentrations or pressures of each species that occurs in the equilibrium expression, or enough information to determine them. These values are substitued into the equilibrium expression and the value of the equilibrium constant is then calculated.

- Calculating K from Known Equilibrium Amounts
- Calculating K from Initial amounts and One Known Equilibrium Amount
- Calculating K from Known Initial Amounts and the Known Change in Amount of One of the Species

❑ Calculating K from Known Equilibrium Amounts

- Write the equilibrium expression for the reaction.
- Determine the molar concentrations or partial pressures of each species involved.
- Subsititute into the equilibrium expression and solve for K.

Example: Calculate the value of the equilibrium constant, K_c, for the system shown, if 0.1908 moles of CO_2, 0.0908 moles of H_2, 0.0092 moles of CO, and 0.0092 moles of H_2O vapor were present in a 2.00 L reaction vessel were present at equilibrium.

$$\mathbf{CO_2(g) + H_2(g) \leftrightarrows CO(g) + H_2O(g)}$$

- Write the equlibrium expression for the reaction system.

$$K_c = \frac{[CO][H_2O]}{[CO_2][H_2]}$$

- Since K_c is being determined, check to see if the given equilibrium amounts are expressed in moles per liter (molarity). In this example they are not; conversion of each is requried.

$[CO_2]$ = 0.1908 mol CO_2/2.00 L = 0.0954 M
$[H_2]$ = 0.0454 M
[CO] = 0.0046 M
$[H_2O]$ = 0.0046 M

- Substitute each concentration into the equilibrium expression and calculate the value of the equilibrium constant.

$$K_c = \frac{[0.0046][0.0046]}{[0.0954][0.0454]} = 0.0049 \text{ or } 4.9 \times 10^{-3}$$

❑ **Calculating K from Initial Amounts and One Known Equilibrium Amount**

- Write the equilibrium expression for the reaction.
- Determine the molar concentrations or partial pressures of each species involved.
- Determine all equilibrium concentrations or partial pressures using an ICE chart.
- Substitute into the equilibrium expression and solve for K

Example: Initially, a mixture of 0.100 M NO, 0.050 M H_2, 0.100 M H_2O was allowed to reach equilibrium (initially there was no N_2). At equilibrium the concentration of NO was found to be 0.062 M. Determine the value of the equilibrium constant, K_c, for the reaction:

$$2\,NO(g) + 2\,H_2(g) \leftrightarrows N_2(g) + 2\,H_2O(g)$$

- Write the equilibrium expression for the reaction.

$$K_c = \frac{[N_2][H_2O]^2}{[NO]^2[H_2]^2}$$

- Check to see if the amounts are expressed in moles per liter (molarity) since K_c is being . In this example they are.

- Create an ICE chart that expresses the initial concentration, the change in concentration, and the equilibrium concentration for each species in the reaction. From the chart you can determine the changes in the concentrations of

each species and the equilibrium concentrations. From the example, we start with the following information.

	NO	H_2	N_2	H_2O
Initial Concentration (M)	0.100	0.0500	0	0.100
Change in Concentration (M)	- 2 x	- 2 x	+ x	+ 2 x
Equilibrium Concentration (M)	0.062			

The change in concentration of the NO was (0.062 M - 0.100M) = - 0.038 M. Thus -2 x = - 0.038 and x = 0.019. Note: the negative sign indicates a decreasing concentration, not a negative concentration. The changes in the other species must agree with the stoichiometry dictated by the balance equation. The hydrogen will also change by - 0.038 M, while the nitrogen will increase by + 0.019 M and the water will increase by + 0.038 M. From these changes we can complete the chart to find the equilibrium concentrations for each species.

	NO	H_2	N_2	H_2O
Initial Concentration (M)	0.100	0.0500	0	0.100
Change in Concentration (M)	- 0.038	- 0.038	+ 0.019	+ 0.038
Equilibrium Concentration (M)	0.062	0.012	0.019	0.138

- Substitute the equilibrium concentrations into the equilibrium expression and solve for K_c.

$$K_c = \frac{[0.019][0.138]^2}{[0.062]^2[0.012]^2} = 650 \text{ or } 6.5 \times 10^2$$

❑ **Calculating K from Known Initial Amounts and the Known Change in Amount of One of the Species**

- Write the equilibrium expression for the reaction.
- Determine the molar concentrations or partial pressures of each species involved.
- Determine all equilibrium concentrations or partial pressures using an ICE chart.
- Substitute into the equilibrium expression and solve for K.

Example: A flask is charged with 3.00 atm of dinitrogen tetroxide gas and 2.00 atm of nitrogen dioxide gas at 25°C and allowed to reach equilibrium. It was found that the pressure of the nitrogen dioxide decreased by 0.952 atm. Estimate the value of K_p for this system:

$$N_2O_4(g) \leftrightarrows 2\ NO_2(g)$$

- Write the equilibrium expression to find K_p.

$$K_p = \frac{P^2_{(NO2)}}{P_{(N2O4)}}$$

- Check to see that the given amounts are measured in appropriate pressure units since K_p is to be In this example they are (atmospheres).
- Create an ICE chart and calculate the changes in pressure and equilibrium pressures for each species.

	N_2O_4	NO_2
Initial Pressure (atm)	3.00	2.00
Change in Pressure (atm)	+ 0.476	- 0.952
Equilibrium Pressure (atm)	3.476	1.048

- Substitute the equilibrium pressures into the expression for K_p and solve for K_p.

$$K_p = \frac{(1.048)^2}{(3.476)} = 0.3160$$

❑ CONVERTIONS BETWEEN K_C AND K_P

To convert between K_c to K_p use the following equation which is based on the relationship between molarities and gas pressures.

$$K_p = K_c(RT)^{\square n}$$

$\square n$ is the difference in the number of **moles of gases** on each side of the balanced equation for the reaction.

Δn = (number of moles of gaseous products - number of moles of gaseous reactants)

- Converting K_c to K_p
- Converting K_p to K_c

Converting K_c to K_p

- Calculate the difference in the number of moles of gases.
- Subsititute $\square n$, R, and T into the equation and solve.

Example: Calculate the value of K_p for the following reaction, at 333 K.

$$PH_3BCl_3(s) \leftrightarrows PH_3(g) + BCl_3(g) \quad K_c = 6.96 \times 10^{-5} \text{ @ } 333 \text{ K}$$

- Calculate the difference in the number of moles of gases, $\square n$.

$\square n$ = (2 moles of gaseous products - **0 moles of gaseous reactants) = 2**

- Substitute the values into the equation and calculate K_p.

$$K_p = (6.96 \times 10^{-5})[(0.0821)(333)]^2 = 0.052$$

Note: because we do not choose to use units for K_c and K_p , we cannot cancel units for R and T. However, be careful to use the value of R consistent with the units of pressure used in the problem, and T in Kelvin.

Converting K_p to K_c

- Calculate the change in the number of moles of gases.
- Subsititute $\square n$, R, and T into the equation and solve.

Example: Calculate the value of K_c at 373 K for the following reaction:

$$2\ NO(g) + Br_2(g) \leftrightarrows 2\ NOBr(g) \qquad K_p = 2.40\ @\ 373\ K$$

- Calculate the change in the number of moles of gases, $\square n$.

$$\square n = (2 \text{ moles of gaseous products} - \textbf{3 moles of gaseous reactants}) = \textbf{- 1}$$

- Substitute the values into the equation and calculate K_c.

$$\textbf{2.40} = K_c[(0.0821)(373)]^{-1}$$
$$K_c = 73.5$$

Note: because we do not choose to use units for K_c and K_p , we cannot cancel units for R and T. However, be careful to use the value of R consistent with the units of pressure used in the problem, and T in Kelvin.

Calculating K for a Reaction
Using Known K's for Other Reactions

- K for a Reversed Reaction
- Reaction Coefficients Multiplied by a Number
- Adding Two or More Equations
- Calculations Incorporating Two or More of These Algebraic Manipulations

K for a Reversed Reaction

The equilibrium expression written for a reaction written in the reverse direction is the reciprocal of the one for the forward reaction.

$$K' = 1/K$$

K' is the constant for the reverse reaction and K is that of the forward reaction.

Example: What is the value of the equilibrium constant for the reaction $2\ NO_2(g) \leftrightarrows N_2O_4(g)$ at 100^o C?

$$N_2O_4(g) \leftrightarrows 2\ NO_2(g) \quad K_c = 0.212\ @\ 100^oC?$$

The desired reaction is the reverse of the reaction for which the K_c is known. The equilibrium expression is the reciprocal of that given.

$$K'_c = 1/K_c = 1/0.212 = 4.72$$

Reaction Coefficients Multiplied by a Number

If the coefficients in a balanced equation are multiplied by a factor, n, the equilibrium expression is raised to the n^{th} power.

$$K' = (K)^n$$

K' is the constant for the reaction multiplied by n and K is the constant of the original reaction.

Adding Two or More Equations

If two or more reactions are added to give another, the equilibrium constant for the reaction is the product of the equilibrium constants of the equations added.

$$K' = K_1 \times K_2 \ \ldots$$

K_1 , K_2, etc. represent the equilibrium constants for reactions being added together, and K' represents the equilibrium constant for the desired reaction.

Example: Calculate the value of K_c for the reaction: $2\ NO(g) + Br_2(g) \leftrightarrows 2\ NOBr\ (g)$ using the following information.

$2\ NO(g) \leftrightarrows N_2(g) + O_2(g)$ $\qquad K_{c1} = 1 \times 10^{30}$

$N_2(g) + Br_2(g) + O_2(g) \leftrightarrows 2\ NOBr(g)$ $\qquad K_{c2} = 2 \times 10^{-27}$

The two equations can be added to yield the desired equation. The value of K_c for the reaction will be the product of the other two.

$$K'_c = K_{c1} \times K_{c2} = (1 \times 10^{30})(1 \times 10^{-27}) = 2 \times 10^3$$

Calculations Incorporating Two or More of These Algebraic Manipulations

It is possible to combine more than one of these manipulations.

Example: Calculate the value of K_c for the reaction: $2\ N_2O(g) + 3\ O_2(g) \leftrightarrows 2\ N_2O_4(g)$, using the following information.

Equation	Equilibrium Constant
$2\ N_2\ (g) + O_2(g) \leftrightarrows 2\ N_2O(g)$	$K_c = 1.2 \times 10^{-35}$
$N_2O_4(g) \leftrightarrows 2\ NO_2(g)$	$K_c = 4.6 \times 10^{-3}$

$N_2(g) + O_2(g) \leftrightarrows NO_2(g)$	$K_c = 4.1 \times 10^{-9}$

These three equations can be combined to get the desired reaction.

$$2\,N_2O(g) \leftrightarrows 2\,N_2(g) + O_2(g)$$
$$4\,NO_2(g) \leftrightarrows 2\,N_2O_4(g)$$
$$2\,N_2(g) + 4\,O_2(g) \leftrightarrows 4\,NO_2(g)$$
$$\overline{2\,N_2O(g) + 3\,O_2(g) \leftrightarrows 2\,N_2O_4(g)}$$

- Write the first equation backwards. The K for this reaction will be the recipricol of the forward reaction.

$2\,N_2O(g) \leftrightarrows 2\,N_2(g) + O_2(g)$ $\quad K_c = 1/(1.2 \times 10^{-35}) = \quad 8.3 \times 10^{34}$

- Write the second equation backwards and multiply the coefficients by 2. The K for this reaction will be the recipricol of the forward reaction squared.

$4\,NO_2(g) \leftrightarrows 2\,N_2O_4(g)$ $\quad K_c = 1/(4.6 \times 10^{-3})^2 = \quad 4.7 \times 10^{4}$

- Use the third equation in the forward direction but multiplied by 4. The K for this reaction will be the K of the given reaction raised to the fourth power.

$2\,N_2(g) + 4\,O_2(g) \leftrightarrows 4\,NO_2(g)$ $\quad K_c = (4.1 \times 10^{-9})^4 = \quad 2.8 \times 10^{-34}$

- Check to see that the three equations yield the desired equation when added together. The equilibrium constant for the desired equation will be the product of the constants for the three equations combined.

$$K_c = (8.3 \times 10^{34})(4.7 \times 10^{4})(2.8 \times 10^{-34}) = 1.1 \times 10^{6}$$

❑ CALCULATING THE REACTION QUOTIENT, Q

The expression for the reaction quotient, Q, looks like that used to calculate an equilibrium constant but Q can be calculated for any set of conditions, not just for equilibrium.

Q can be used to determine which direction a reaction will shift to reach equilibrium. If K > Q, a reaction will proceed forward, converting reactants into products. If K < Q, the reaction will proceed in the reverse direction, converting products into reactants. If Q = K then the system is already at equilibrium.

In order to determine Q we need to know:

- the equation for the reaction, including the physical states,
- the quantities of each species (molarities and/or pressures), all measured at the same moment in time.

To calculate Q:

- Write the expression for the reaction quotient.
- Find the molar concentrations or partial pressures of each species involved.
- Subsitute values into the expression and solve.

Example: 0.035 moles of SO_2, 0.500 moles of SO_2Cl_2, and 0.080 moles of Cl_2 are combined in an evacuated 5.00 L flask and heated to 100°C. What is Q before the reaction begins? Which direction will the reaction proceed in order to establish equilibrium?

$$SO_2Cl_2(g) \leftrightarrows SO_2(g) + Cl_2(g) \qquad K_c = 0.078 \text{ at } 100^oC$$

- Write the expression to find the reaction quotient, Q.

$$Q_c = \frac{[SO_2][Cl_2]}{[SO_2Cl_2]}$$

- Since K_c is given, the amounts must be expressed as moles per liter (molarity). The amounts are in moles so a conversion is required.

0.500 mole SO_2Cl_2/5.00 L = 0.100 M SO_2Cl_2

0.035 mole SO_2/5.00 L = 0.070 M SO_2

0.080 mole Cl_2/5.00 L = 0.016 M Cl_2

- Substitute the values in to the expression and solve for Q.

$$Q_c = \frac{(0.070)(0.016)}{(0.100)} = 0.011$$

- Compare the answer to the value for the equilibrium constant and predict the shift.

0.078 (K) > 0.011 (Q)

Since K >Q, the reaction will proceed in the forward direction in order to increase the concentrations of both SO_2 and Cl_2 and decrease that of SO_2Cl_2 until Q = K.

❑ **Determining Equilibrium Quantities from Initial Quantities and K**

To find the equilibrium quantities of each species from the initial quantities we must know:

- the balanced equation for the reaction
- the equilibrium expression for the reaction
- the value for the equilibrium constant
- the initial quantities of each species, either as molarities, or partial pressures
- the direction the reaction will proceed in order to establish equilibrium

Once these have been determined, we can solve for the equilibrium concentrations using the following steps:

- Write the equilibrium expression for the reaction.
- Check to see that the quantities are expressed in the same units as used in the equilibrium constant.
- Determine the direction the reaction will shift. Calculate Q if direction of shift is uncertain.
- Make an ICE chart and determine the equilibrium quantities in terms of a single unknown change.
- Substitute into the equilibrium expression and solve for the change.
- Calculate the equilibrium quantity for each species from the initial quantity and the change.
- Check your work.
- Determining Equilibrium Concentrations
- Determining Equilibrium Pressures

Determining Equilibrium Concentrations

Example: 0.050 mol of H_2 and 0.050 mol of Br_2 are placed in an evacuated 5.0 L flask and heated to 700 K. What is the concentration of each species in the flask when equilibrium has been established? The equation for the reaction is as follows:

$$H_2(g) + Br_2(g) \leftrightarrows 2\ HBr(g) \qquad K_c = 64 \text{ @ } 700\ K$$

- Write the equilibrium expression for the reaction.

$$K_c = \frac{[HBr]^2}{[H_2][Br_2]} = 64$$

- Since K_c is used in this problem, check to see if the given quantities are in moles per liter (molarity). In this example they are not. A conversion is required.

$$[H_2] = 0.050 \text{ mole } H_2/5.0\ L = 0.010\ M$$
$$[Br_2] = 0.010\ M$$
$$[HBr] = 0\ M$$

- The only direction that this reaction can proceed is forward due to the fact that initially there are only H_2 and Br_2 in the flask. The reverse reaction cannot begin to occur until some HBr is formed.

- Make an ICE chart with "x" representing the change in the concentration of the H_2 (or Br_2) as the system moves towards equilibrium. All of the other changes are expressed in terms of x.

	H_2	Br_2	HBr
Initial Concentration (M)	0.010	0.010	0
Change in Concentration (M)	- x	- x	+ 2 x
Equilibrium Concentration (M)	0.010 - x	0.010 - x	0 + 2 x

- Substitute the expressions for the equilibrium concentrations into the equilibrium expression and solve for "x".

$$64 = \frac{(2x)^2}{(0.010 - x)(0.010 - x)} = \frac{(2x)^2}{(0.010 - x)^2}$$

x = 0.008 M

- Calculate the equilibrium concentration for each species from the initial concentrations and the changes.

$[H_2] = [Br_2] = 0.010 - x = 0.010 - 0.008 = 0.002$ M for each
$[HBr] = 2x = 2(0.008) = 0.016$ M

- Check your answer by substituting the equilibrium concentrations into the equilibrium expression and see if the result is the same as the equilibrium constant.

$$\frac{(0.016)^2}{(0.002)(0.002)} = 64$$

❑ **Determining Equilibrium Pressures**

Example: 1.000 atm of SO_3, 0.150 atm of SO_2, 0.200 atm of NO_2, and 2.000 atm of NO at 460°C was allowed to reach equilibrium. What is the equilibrium pressure of each gas present in the flask?

$SO_2(g) + NO_2(g) \leftrightarrows NO(g) + SO_3(g)$ $K_p = 85.0$ @ 460°C

- Write the equilibrium expression for the reaction.

$$K_p = \frac{P_{(NO)}P_{(SO3)}}{P_{(SO2)}P_{(NO2)}} = 85.0$$

- Since we are using K_p, check to see if the given quantities are in appropriate pressure units (atmospheres). In this example they are, so no conversion is required.
- Calculate the value of the reaction quotient, Q, to determine the direction the reaction will proceed to reach equilibrium.

$$Q = \frac{(1.500)(2.000)}{(0.150)(0.200)} = 100$$

$K_p < Q$ so the reaction will proceed in the reverse direction.

- Make an ICE chart. Let "x" represnt the change in the pressure of the NO. Since the reaction proceeds in the reverse direction, the NO and SO_3 will decrease and the SO_2 and NO_2 will increase as equilibrium is established.

SO_2 NO_2

http://www.chem.purdue.edu/gchelp/howtosolveit/howtosolveit.html#Equilibrium

http://home.sbc.edu.hk/~chem/Supp%20Ex%20solution%20guideline/SuppEx_4B_E.pdf.

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STATES OF MATTER

1. What is the difference between vapour and gas?

Ans. A substance which is in gaseous state at room temperature is called a gas. However, if a Substance is not in gaseous state at room temperature but changes into gaseous state on heating, then the gaseous state obtained is called vapour or when a gas is below its critical temperature, it is called vapour.

2. Why mercury is used as a liquid in a barometer? Explain.

Ans. Mercury is used as a liquid in a barometer because.

(i) The height of the column in a barometer is inversely proportional to the density of the liquid, i.e. less dense the liquid, higher will be the column. Because of high density of mercury, it supports column of convenient height in a barometer.

(ii) Since mercury is not volatile at ordinary temperature, therefore, the pressure exerted by the vapours above the mercury column is very small and can be neglected.

3. The van der Waal's constants for two gases are as follows:

Gas	a(atm L^2 mol^{-2}	b(L moL^{-1})
X	1.39	0.0391
Y	3.59	0.0427

Which of them is more easily liquefiable and which has greater molecular size?

Ans. Greater the value of 'a', more easily the gas is liquefiable. Similarly, greater the value of 'b' greater is the molecular size. Hence, gas Y will be more easily liquefiable and will have greater molecular size.

4. Out of N_2 and NH_3, which one will have greater value of 'a' and which one will have greater value of 'b'?

Ans. (I) As NH_3 is more easily liquefiable (due to hydrogen bonding), intermolecular forces of attraction are stronger than in N_2. Hence, NH_3 will have greater value for 'a'

(II) As NH_3 molecule is larger in size than N_2, hence NH_3 will have greater value for 'b'

For NH_3, a= 4.17 L^2 atm mol^{-2}, b= 0.0371 L mol^{-1}

For N_2, a= 1.39 L^2 atm mol-^{2}, b = 0.0319 L mol^{-1}

5. A flask is of capacity of one litre. What volume of air will escape from the flask If it is heated from 27^{o}c to 37^{o}c? Assume pressure constant.

Ans. V_1=1litre V_2=?

T_1= 27^{0}c=300k, T_2=37^{0}C=310k

At Constant pressure, $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

$\frac{1}{300} = \frac{V_2}{310}$ V_2 = 1.0333 litre

Since capacity of flask is one litre

∴ Volume of air escaped out

= 1.0333-1= 0.0333 litre = 33.3ml

6. A cylinder containing cooking gas can withstand a pressure of 14.9 atm. The pressure gauge of cylinder indicates 12 atm at 27^{O}C. Due to sudden fire in the building, its temperature starts rising. At what temp. the cylinder will explode?

Ans. Suppose the cylinder will burst at T_2 K

Given P_1= 12atm, T_1 = (27 + 273) = 300 k

P2 = 14.9 atm,

Now $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

Here V_1 = V_2 as the volume does not change

∴ $T_2 = \frac{P_2 T_1}{P_1} = \frac{14.9 \times 300}{12}$ = 372.5 k

7. 8 g of methane is placed in 5 litre container at 27^{0}C. Find Boyle constant.

Ans. PV= Boyle Constant

But PV= nRT = $\frac{w}{M}$ RT

= $\frac{8}{16}$ mol x 0.0821L atm K^{-1} mol^{-1} x 300 k

= 12.315 L atm

Hence, Boyle constant= 12.315 L atm

8. A mixture of CO and CO_2 is found to have density of 1.50 g L^{-1} at 20^{0}C & 740 mm pressure. Calculate the composition of the mixture.

Ans. Calculation of average molecular mass of the mixture.

M = $\frac{dRT}{P}$ = $\frac{1.50 gl^{-1} \times 0.0821 L\ atm\ K^{-1}\ mol^{-1} \times 293K}{\left(\frac{740}{760}\right) atm}$ = 37.06 g mol-1

Calculation of percentage composition:

Suppose mol% of CO in the mixture=x

Then mol% of CO_2 in the mixture=(100- x)

Average Molecular mass= $\frac{x \text{ X } 28 + (100-x) \text{ X } 44}{100}$

$\frac{28x+4400-44\,x}{100}$ = 37.06

Or 16x= 4400-3706 = 694

Or = 694/16 = 43.38

Mol% of CO = 43.38

and Mol% of CO_2=100-43.38=56.62

9. Using van der Waals' equations calculate the constant 'a' when two moles of a gas confined in a four litre flask exerts a pressure of 11.0 atmosphere at a temperature of 300 k. The value of 'b' is 0.05 lit mol^{-1}

Ans. According to van der Waals' equation

$\left(P+\frac{an^2}{V^2}\right)(v-nb)=nRT$

$\left(11+\frac{a\ x\ 4}{16}\right)(4-2\ x\ 0.05)=2\ x\ 0.082\ x300$

$(\frac{176+4a}{16})\times 3.9=49.2$

(176 + 4a) 3.9=49.2 × 16

15.6a= 787.2-686.4 or

a= 6.4615 atm L^2 mol^{-2}

10. The compression factor (compressibility factor) for one mole of a van der Waals' gas at 0^0C and 100 atm pressure is found to be 0.5. Assuming that the volume of a gas molecule is negligible, calculate the van der Waals' constant 'a'.

Ans $Z=\frac{PV}{nRT}$ i.e, 0.5 = $\frac{100xV}{1x\ 0.082\ x\ 273}$

V=$\frac{0.5\times 0.082\times 273}{100}$ or V = 0.119L

$\left(P+\frac{a}{V2}\right)$(V-b) = RT for 1 mol

If volume of molecules is negligible i.e. b is negligible van der Waals' equation becomes

$\left(P+\frac{a}{V2}\right)$ (V-0)= RT or $\left(P+\frac{a}{V2}\right)$V= RT

Or PV+ $\frac{a}{v}$= RT or $\frac{PV}{RT}+\frac{a}{VRT}=1$

Or a= $\left(1-\frac{PV}{RT}\right)VRT$

a= (1- 0.5)0.1119 x 0.082 x 273

a=1.252 atm L^2 mol^{-2}

11. The critical temp. and pressure for NO gas at 177 k and 64.5 atm respectively. Calculate van der Waals constant 'a' & 'b' for the gas.

Ans. Given T_c = 177 k, P_c = 64.5 atm

$P_c = \frac{a}{27b^2}$ or $b^2 = \frac{a}{27P_c}$

Again $T_c = \frac{8a}{27Rb}$

Or $T_c^2 = \frac{64a^2}{(27)^2 R^2 b^2} = \frac{64a^2 \times 27\, P_c}{(27)^2 \times R^2 \times a} = \frac{64 \times a \times P_c}{27 \times R^2}$

Or $a = \frac{27(RT_c)^2}{64P_c} = \frac{27 \times (0.082 \times 177)2}{64 \times 64.5}$

$a = 1.37$ litre^2 atm mol^{-2}

$b = \frac{RT_c}{8Pc} = \frac{0.082 \times 177}{8 \times 64.5} =$ 0.02717 litre mol^{-1}

12. One mole of CCl_4 vapours at 77^0C occupies a volume of 35.0 L. If van der Waal's constants are a = 20.39 L^2 atm mol^{-2} and b = 0.1383 L mol^{-1}, calculate compressibility factor Z under,

Ans. (a) Low pressure region **(b)** High pressure region.

(a) Under low pressure region, V_m is high $(V_m - b) = V_m$

$\rightarrow [P + \frac{a}{V_m^2}] V_m = RT$

$\rightarrow PV_m + \frac{a}{V_m} = RT$

$Z = 1 - \frac{20.39}{0.0821 \times 350 \times 35} = 098$

$[\because Z = 1 - \frac{a}{RTV_m}]$

(b) Under high pressure region P is high,

$[P + \frac{a}{V_m^2}] = P$

$P(V_m - b) = RT$ or $PV_m - Pb = RT$

$P = \frac{RT}{V_m - b}$

$Z = \frac{PV_m}{RT} = \frac{V_m}{V_m - b} = \frac{1}{1 - \frac{b}{V_m}}$

$Z = \frac{1}{1 - \frac{0.138}{35}} =$ 1.004

THERMODYNAMICS

1. In a thermally insulated flask 50 g H_2O is taken at temperature 22^0C. In it 150 g of heated piece of Pb having temp. 100^0c is poured in it, where final temperature observed is 28.8^0c. if specific heat of water is 1 cal g^{-1}, then calculate the specific heat of Pb.

Ans. In Pb-water System

Heat Given by Pb = Heat absorbed by water

and $m_{pb} . C_{pb} (\Delta T)_{Pb} = m_{water} . C_{water} (\Delta T)_{water}$ ($\because Q= mC\Delta T$)

Given that

m_{pb} = 150 g m_{water} = 50 g

C_{pb} = ? C_{water} = 1 cal g^{-1}

$(\Delta T)_{Pb} = (100.0 -28.8)^0$C; $(\Delta T)_{water} = (28.8-22.0)$

$\therefore$ 150 x C_{Pb} x (100.0 -28.8) = 50 x 1 x (28.8-22.0)

i.e. C_{Pb}= O.032 cal g^{-1}

2. A swimming pool contains 1 x 10^5 L of water. How much energy in Joule is required to raise the temperature of water from 20^0c to 25^0c ? The specific heat capacity of water is 4.184 J/^{0}C g

Ans. Volume of water= 10^5 L = 10^8 mL

Mass of water= Vx d $\because$ d= 1g/mL

=10^8x1=10^8 g

Specific heat of water, Cs =4.184 J/^{0}C

Heat absorbed by the water to raise the temperature may be calculated as,

$q = mC_s \Delta T$

$q = 10^8$ x 4.184x 5=2.092 x 10^9J

3. A certain gas expands its volume from 3.0 L to 7.0 L at constant temperature. Calculate the work done by the gas if it expands,

(a) Against a vacuum.

(b) Against a constant pressure of 1.2 atm.

Ans. (a) when gas expands into vacuum, P= 0 Therefore, w= -PΔV i.e w = 0

(b) If the external opposing pressure is 1.2 atm, then w= - PΔV

W = -1.2(7.0-3.0) =- 4.8 L atm

W = -4.8 x 101.3 = -486.24 J

4. Assign the sign of work done (based on SI Convention) in the following chemical changes taking place against external atmospheric pressure:

(a) $3H_2(g) + N_2 (g) \rightarrow 2NH_3(g)$

(b) $CH_4(g) + 2O_2 (g) \rightarrow CO_{2(}g)+ 2H_2O(g)$

(c) $CaCO_3(S) \rightarrow CaO(S) + CO_2(g)$

(d) $NH_4HS(S) \rightarrow NH_3(g) + H_2S(g)$

(e) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$

(f) $C(s) + CO_2(g) \rightarrow 2CO(g)$

Ans. We shall consider actually Sign of

Δng = (moles of gaseous products – moles of gaseous reactants)

Δng = +ve means expansion

=- ve means contraction

=0 means no change

Chemical Change	Δng	ΔW = -P ΔV	Nature of work
(a)	-2	+ve	Work is done on the system.
(b)	0	0	-
(c)	+1	-ve	Work is done by the system.
(d)	+2	-ve	-do-
(e)	+1	-ve	-do-
(f)	+1	-ve	-do-

5. The enthalpy of combustion of graphite is 393.4 kJ. Calculate
(a) The amount of graphite needed to produce 196.7 KJ of heat.
(b) The number of moles of CO_2 formed when 196.7 KJ of heat is produced.
(c) The volume of oxygen required at S.T.P. to from 24.0 g of graphite in this process.
Ans. We are given

(i) $C(graphite) + O_2(g) \rightarrow CO_2(g)$; $\Delta H = -393.4 KJ$

(a) From the above equation, we know that 393.4 KJ of heat is produced by 12 g of graphite.

∴196.7 kj of heat is produced by

$\frac{12}{393.4}$ x 196.7= 6 g of graphite

(b) From equation (i) we can say that
Production of 393.4 KJ of heat is accompanied by the formation of 1 mole of CO_2.

∴ Production of 196.7 KJ of heat is accompanied by the formation of 0.5 mole of CO_2.

(C) Volume of oxygen required at S.T.P to burn 12 g of graphite = 22.4 litres.

Volume of oxygen required at S.T.P to burn 24 of graphite = 22.4 X 2 = 44.8 litres.

6. 150 mL of 0.5 N nitric acid solutions at 25.35^0C was mixed with 150 mL of 0.5 N sodium hydroxide solutions at the same temp. The final temperature was recorded to be 28.77^0C. Calculate the heat of neutralization of nitric acid with sodium hydroxide.

Ans. Total mass of solution = 150 + 150 = 300 g

Q = Total heat produced

= 300 x (28.77-25.35) cal

=300 x 3.42= 1026 cal

Heat of neutralization = $\frac{Q}{150}$ x 1000 x $\frac{1}{0.5}$ = 13.68 Kcal

Since heat is liberated, heat of neutralization should be negative. So heat of neutralization = -13.68 Kcal

7. Predict the sign of entropy change in each of the following :

(I) H_2 (at 298 K, 1 atm) →H_2 (at 298K, 10 atm)
(II) H_2O (at 298 K, 1 atm) →H_2O (at 330 K, 1 atm)
(III) $2NH_4NO_3(s) \rightarrow N_2(g) + 4H_2O(g) + 0_2(g)$
(IV) Crystallization of copper sulphate from its saturated solution.
(V) $2SO_2(g) + O_2(g) \leftrightarrow 2SO_3(g)$

Ans . Entropy is a measure of randomness or disorder of a system. If randomness increases entropy increases.

(I) Gas at lower pressure has greater randomness thanΔ at high pressure (compressed gas) at the same temperature. Hence, entropy decreases, i.e. ΔS is –ve.
(II) Molecules at higher temperature have greater randomness at the same pressure. Hence, ΔS is +ve.
(III) Gaseous molecules have greater randomness that the solid. Hence, ΔS is positive.
(IV) $CuSO_4$ crystals have ordered arrangement whereas ions in sol. Have greater randomness. Hence ΔS is –ve.
(V) There are 3 moles of two different gaseous reactants which have greater randomness than 2 moles of the only gaseous product, SO_3. Hence, randomness decreases i.e. ΔS is –ve.

8. Under what conditions will the reaction occur, if

(I) Both ΔH and ΔS are positive

(II) Both ΔH and ΔS are negative ?

Ans. ΔG = ΔH – TΔS. For a reaction to occur, ΔG should be – ve.

(i) If both ΔH and ΔS are positive, ΔG can be – ve only if TΔS > ΔH in magnitude. Thus, either ΔS has large +ve value so that even if T is low, TΔS is greater that ΔH or if ΔS is small, T should be high so that TΔS > ΔH.
(ii) If both ΔH and ΔS are negative, ΔG can be –ve only if TΔS < ΔH in magnitude or ΔH> TΔS in magnitude. This is possible only if either ΔH has large negative value or T is so low that TΔS< ΔH.

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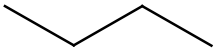
HYDROCARBONS

Q.1. Write the general formula for alkanes, alkenes and alkynes.

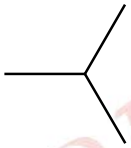
Ans. The general formula for alkanes is C_nH_{2n+2}, where n stands for number of carbon atoms and 2n+2 for number of hydrogen atoms in the molecule.
General formula for alkenes is C_nH_{2n}
General formula of alkynes is C_nH_{2n-2}.

Q.2. Write structures of different chain isomers of alkanes corresponding to the molecular formula C_4H_{10} and C_5H_{12}. Also write their IUPAC names.

Isomers of C_4H_{10}

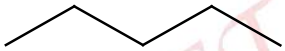


butane

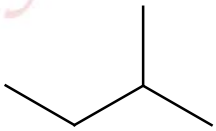


2-Methylpropane

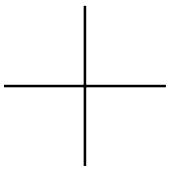
Isomers of C_5H_{12}



pentane



2-methylbutane



2,2-dimethylpropane

Q.3. Write IUPAC names of the following compounds :

(i) $(CH_3)_3CCH_2C(CH_3)_3$

(ii) $(CH_3)_2C(C_2H_5)_2$

(iii) tetra – *tert*-butylmethane

Ans.(i) 2,2,4,4-tetramethylpentane

(ii) 3, 3-Dimethylpentane

(iii) 3,3-Di-tert-butyl -2, 2, 4, 4 - tetramethylpentane

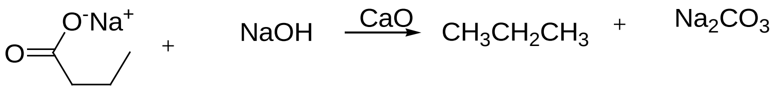
Q.4. Write structural formulas of the following compounds:

(i) 3-Methylhexane

(ii) 3-ethyl-2, 2–dimethylpentane

Q.5. Sodium salt of which acid will be needed for the preparation of propane ? Write chemical equation for the reaction.

Ans. Butanoic acid



Q.6. Define conformers/rotamers.

Ans. The spatial arrangements of atoms which can be converted into one another by rotation around a C-C single bond are called conformations or conformers or rotamers

Q.7. Write IUPAC names of the following compounds:

(i) $CH_3 - CH = CH_2$

(ii) $CH_3 - CH_2 - CH = CH_2$

(iii) $CH_3 - CH = CH{-}CH_3$

Ans:

(i)Propene (ii) But-1-ene (iii)But-2-ene

Q.8. Out of pentane, 2-methylbutane and 2,2-dimethylpropane which has the highest boiling point and why?

Ans. Pentane having a continuous chain of five carbon atoms has the highest boiling point (309.1K) whereas 2,2 – dimethylpropane boils at 282.5K. With increase in number of branched chains, the molecule attains the shape of a sphere. This results in smaller area of contact and therefore weak intermolecular forces between spherical molecules, which are overcome at relatively lower temperatures.

Q.9. Calculate number of sigma (σ) and pi (π) bonds in the following

(i) $CH_2 = C\ (CH_2CH_2CH_3)_2$

(ii) $CH_2 = CH - CH - CH_3$
with CH_3 attached (|) to the second CH

(iii) $CH_3 - CH = CH{-}CH_3$

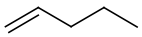
(i)Sigma bonds=23, pi bonds=1

(ii)Sigma bonds=14, pi bonds=1

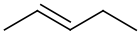
(iii)Sigma bonds=11, pi bonds=1

Q.10. Write structures and IUPAC names of different structural isomers of alkenes corresponding to C_5H_{10}.

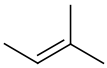
Ans.



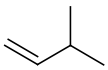
pent-1-ene



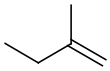
pent-2-ene



2-methylbut-2-ene



3-methylbut-1-ene



2-methyl-but-1-ene

Q.11. Discuss about structural isomerism and stereoisomerism.

Ans. Structural Isomerism: Compounds having the same molecular formula but different structure i.e. different arrangement of atoms within the molecule are called structural isomers and the phenomenon is called as structural isomerism.

Types:

- Chain isomerism
- Position isomerism
- Functional isomerism
- Metamerism
- Tautomerism

❖ **Stereoisomerism**: Isomers which have the same structural formula but have different relative arrangement of atoms or groups in space are called stereoisomers and the phenomenon is called as stereoisomerism.

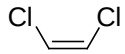
Q.12. Draw cis and trans isomers of the following compounds. Also write their IUPAC names :

(i) CHCl = CHCl

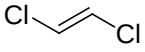
(ii) $C_2H_5CCH_3 = CCH_3C_2H_5$

Ans.

(i)

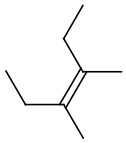


cis-1,2-dichloroethene

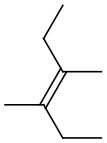


trans-1,2-dichloroethene

(ii)



cis-3,4-dimethyl-hex-3-ene



trans-3,4-dimethyl-hex-3-ene

Q.13. Which of the following compounds will show *cis-trans* isomerism?

(i) $(CH_3)_2C = CH - C_2H_5$
(ii) $CH_2 = CBr_2$
(iii) $C_6H_5CH = CH - CH_3$
(iv) $CH_3CH = CCl\ CH_3$

Ans. (iii) and (iv). In structures (i) and (ii), two identical groups are attached to one of the doubly bonded carbon atom.

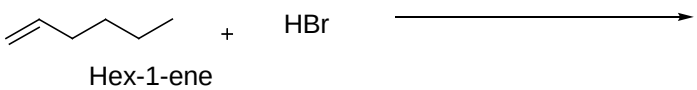
Q.14. Write IUPAC names of the products obtained by addition reactions of HBr to hex-1-ene

(i) in the absence of peroxide and

(ii) in the presence of peroxide.

Ans.

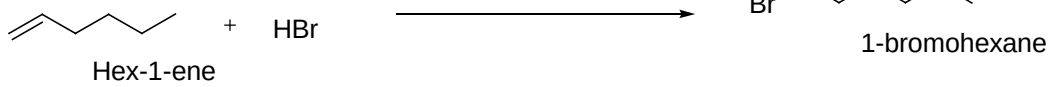
(i)



Hex-1-ene

2-bromohexane

(ii)

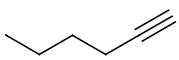


Hex-1-ene

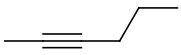
1-bromohexane

Q.15. Write structures of different isomers corresponding to the 5th member of alkyne series. Also write IUPAC names of all the isomers.

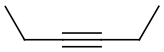
Ans.5th member of alkyne has the molecular formula C_6H_{10}. The possible isomers are:



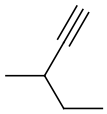
Hex-1-yne



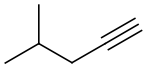
Hex-2-yne



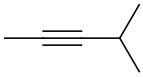
Hex-3-yne



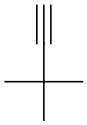
3-methylpent-1-yne



4-methylpent-1-yne

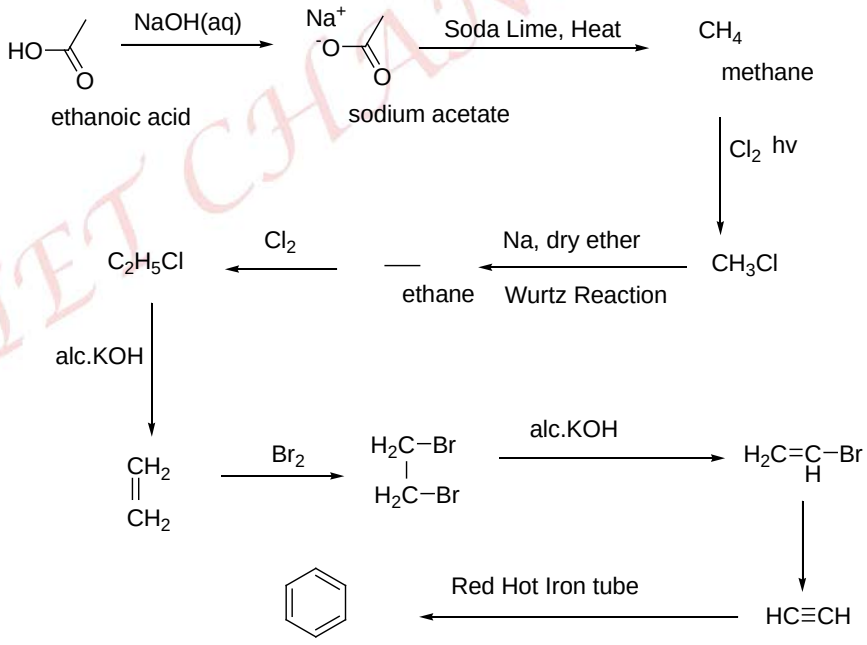


4-methylpent-2-yne



3,3-dimethyl-but-1-yne

Q.16. Write down the conversion of ethanoic acid into benzene?



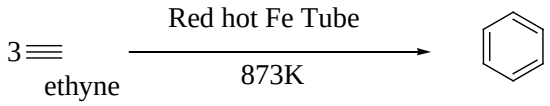
Q.17. Define Hückel rule.

Ans. Huckel Rule gives information about the aromaticity. According to this rule, the necessary and sufficient conditions for a molecule to be aromatic are:

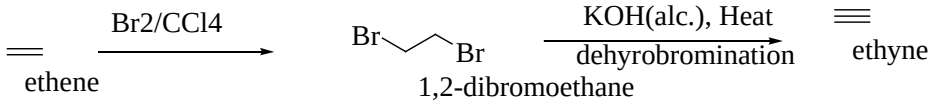
- ❖ Planarity
- ❖ Complete decolisation of the pi electrons in the ring.
- ❖ Presence of (4n+2) pi electrons in the ring where n is an integer (n= 0,1,2…)

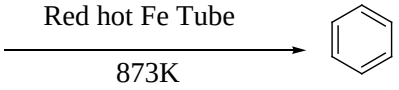
Q.18. How would you convert the following into benzene?

(i)Ethyne (ii) Ethene (iii) Hexane

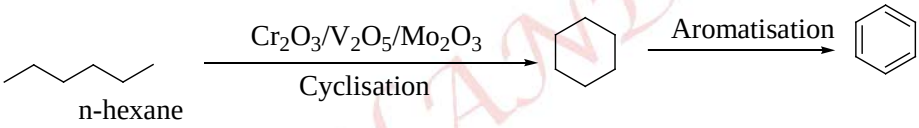
(i) 

(ii) Ethene is first converted to ethyne and then to benzene :



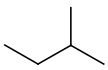


(iii) when vapours of hexane are passed over heated catalyst consisting of Cr_2O_3, Mo_2O_3 and V_2O_5 at 773K under 10-20 atm pressure, cyclisation and aromatisation occurs simultaneously to afford benzene.



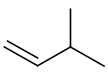
Q.19. Write structures of all the alkenes which on hydrogenation give 2-methylbutane?

Ans. The basic skeleton of 2-methylbutane is :

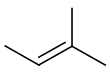


2-methylbutane

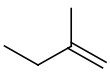
On hydrogenation of 2-methylbutane, the structures of various alkenes are:



3-methylbut-1-ene



2-Methylbut-2-ene



2-methylbut-1-ene

Q.20. Arrange the following set of compounds in order of their decreasing relative reactivity with an electrophile, E^+

(a) Chlorobenzene, 2,4-dinitrochlorobenzene, *p*-nitrochlorobenzene

(b) Toluene, *p*-$H_3C - C_6H_4 - NO_2$, *p*-$O_2N - C_6H_4 - NO_2$.

Ans. Chlorobenzene> p-nitrochlorobenzene> 2,4-dinitrochlorobenzene

Toluene> p-$H_3C - C_6H_4 - NO_2 > p$-$O_2N - C_6H_4 - NO_2$

Q.21. Out of benzene, *m*–dinitrobenzene and toluene which will undergo

nitration most easily and why?

Ans. -CH_3 group is electron donating while –NO_2 group is electron withdrawing. Therefore, maximum electron density will be in toluene , followed by benzene and at least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene> benzene> m-dinitrobenzene

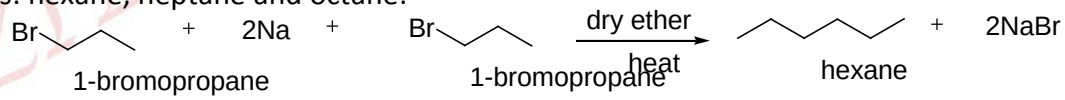
Q.22. Suggest the name of a Lewis acid other than anhydrous aluminium chloride which can be used during ethylation of benzene.

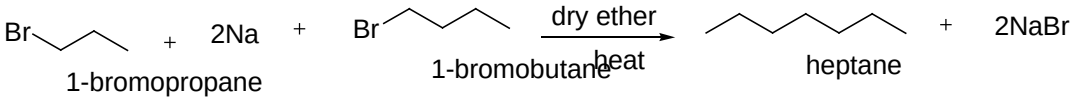
Ans. Anhydrous $FeCl_3$, $SnCl_4$, BF_3.

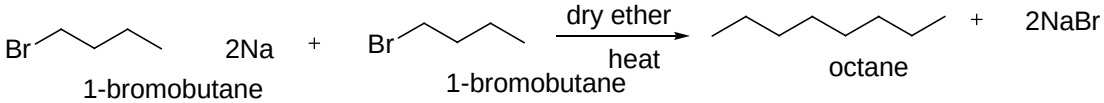
Q.23. What effect does branching of an alkane chain has on its boiling point?**Ans.** As the branching increases, the surface area of an alkane approaches that of a sphere. Since a sphere has minimum surface area, therefore, vander Waal forces of attraction are minimum and hence the boiling point of the alkane decreases with branching.

Q.24. Why is Wurtz reaction not preferred for the preparation of alkanes containing odd number of carbon atoms? Illustrate your answer by taking one example.

Ans. For the preparation of alkanes containing odd number of carbon atoms, a mixture of two alkyl halides has to be used. Since two alkyl halides can react in three different ways, therefore, a mixture of three alkanes instead of the desired alkane would be formed.For eg. Wurtz reaction between i-bromopropane and 1-bromobutane gives a mixture of three alkanes: hexane, heptane and octane:

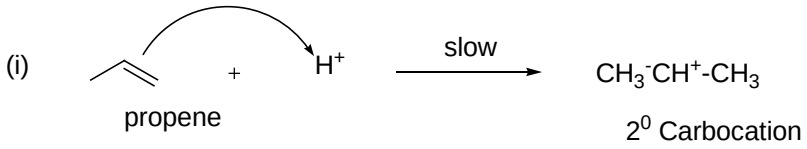


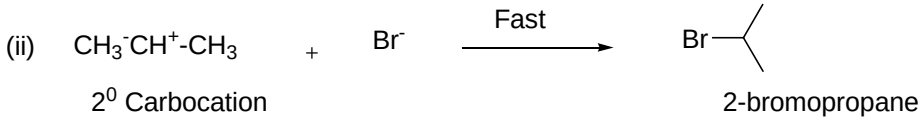




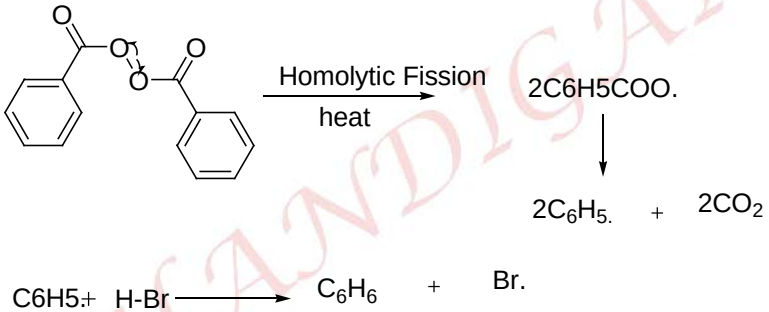
Q.25. Addition of HBr to propene yields 2-bromopropane, while in the presence of benzoyl peroxide, the same reaction yields 1-bromopropane. Explain and give mechanism.

Ans. Addition of HBr to propene is an ionic electrophilic addition reaction in which the electrophile i.e. H^+first adds to give a more stable 2^0 Carbocation which is readily attacked by the nucleophile Br^- ion to give 2-bromopropane.

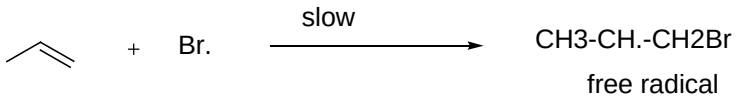


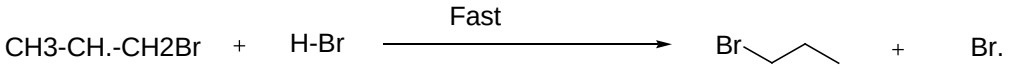


In the presence of benzoyl peroxide, the reaction is still electrophilic but electrophile here is $Br^{\cdot}$ free radical which is obtained by the action of benzoyl peroxide on HBr



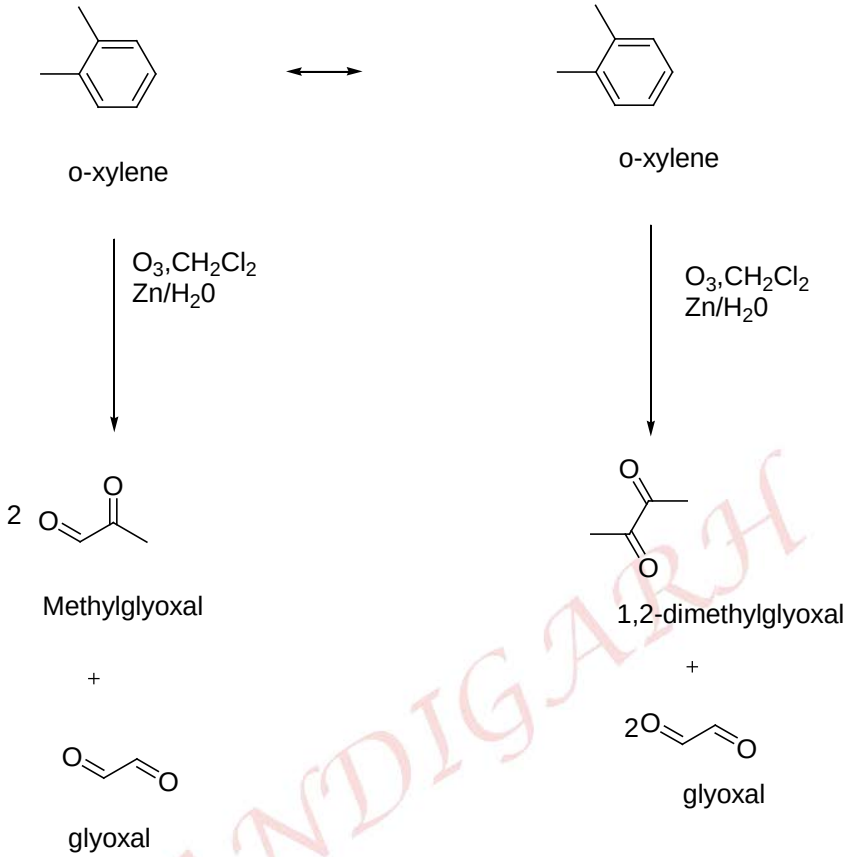
In the first step, $Br^{\cdot}$ radical adds to propene in such a way to as to generate the more stable secondary carbocation. In the second step, the free radical thus obtained rapidly abstracts a hydrogen atom from HBr to give 1- bromopropane.



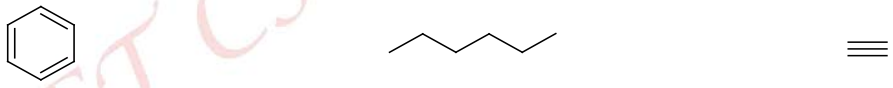


Q.26. Write down the products of ozonolysis of 1,2-dimethylbenzene (*o*-xylene). How does the result support Kekulé structure for benzene?

Ans. O-xylene may be regarded as a resonance hybrid of the following two Kekule structure. Ozonolysis of each one of these gives two products as shown below:



Q.27. Arrange benzene, *n*-hexane and ethyne in decreasing order of acidic behaviour. Also give reason for this behaviour.



Benzene	Hexane	Ethyne
sp^3	sp^2	sp

Since s-electrons are close to the nucleus, therefore as the s-character of the orbital making the C-H bond increases, the electrons of C-H bond lie closer and closer to the carbon atom. In other words, the partial positive charge on the H-atom and hence the acidic character increases as the s character of the orbital increases.

Thus the acidic character decreases in the order:

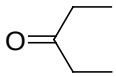
Ethyne> Benzene> Hexane

Q.28. Why does benzene undergo electrophilic substitution reactions easily and nucleophilic substitutions with difficulty?

Ans. Due to the presence of an electron cloud containing 6 pi electrons above and below the plane of the ring, benzene is a source of electrons. Consequently, it attracts the electrophiles towards it and repels nucleophiles. As a result, benzene undergoes electrophilic substitution reactions easily and nucleophilic substitution with difficulty.

Q.29. An alkene 'A' on ozonolysis gives a mixture of ethanal and pentan-3-one. Write structure and IUPAC name of 'A'.

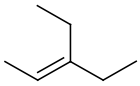
Ans. The products obtained from ozonolysis of A



pentan-3-one

ethanal

Remove the oxygen atoms and join the two ends by a double bond,the structure of the Alkene is:

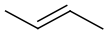


3-ethylpent-2-ene

Q.30. An alkene 'A' contains three C – C, eight C – H σ bonds and one C – C π bond. 'A' on ozonolysis gives two moles of an aldehyde of molar mass 44 u. Write IUPAC name of 'A'.

Ans. An aldehyde with molar mass of 44u is ethanal, $CH_3CH=O$.

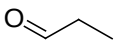
By removing the oxygen atoms from the ethanal and join them by a double bond, the structure of alkene is



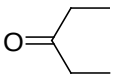
But-2-ene

Q.31. Propanal and pentan-3-one are the ozonolysis products of an alkene? What is the structural formula of the alkene?

Ans. Product obtained from the alkene:

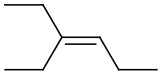


Propanal



Pentan-3-one

Remove oxygen atoms and joins the two fragments by a double bond, the structure of the alkene is:



3-ethylhex-3-ene

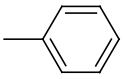
Q.32. Write chemical equations for combustion reaction of the following hydrocarbons:

(i) Butane (ii) Pentene (iii) Hexyne (iv) Toluene

(i) C_4H_{10} (Butane) + $13/2O_2$ ⟶ $4CO_2$ + $5H_20$

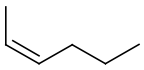
(ii) C_5H_{10} (Pentene) + $15/2O_2$ ⟶ $5CO_2$ + $5H_20$

(iii) C_6H_{10} (Hexyne) + $17/2O_2$ ⟶ $6CO_2$ + $5H_20$

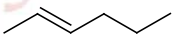
(iv)  (Toluene) + $9O_2$ ⟶ $7CO_2$ + $4H_20$

Q.33. Draw the cis and trans structures of hex-2-ene. Which isomer will have higher b.p. and why?

Ans.



cis-Hex-2-ene



Trans-Hex-2-ene

The dipole moment of a molecule depends upon dipole-dipole interactions. Since cis-isomer has higher dipole moment, therefore it has higher boiling point.

Q.34. Explain the extra ordinarily stability of benzene though it contains three double bonds?

Ans. Resonance or delocalisation of electrons usually leads to stability. Since in benzene all the six pi electrons of the three double bonds are completely delocalised to form one lowest molecular orbital which surrounds all the carbon atoms of the ring, therefore, it is extra-ordinarily stable.

Q.35. What are the necessary conditions for any system to be aromatic?

Ans. The necessary conditions for a molecule to be aromatic are:

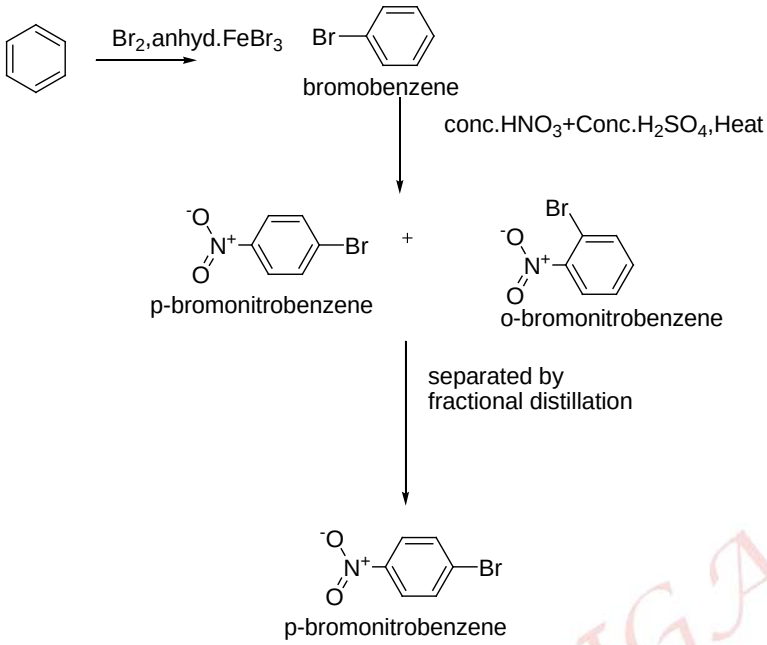
(i)It should have a single cyclic cloud of delocalised pi electrons above and below the plane of the molecule.

(ii)It should be planar. This is because complete delocalisation of pi electrons is possible only if the ring is planar to allow cyclic overlap of p-orbitals.

(iii)It should contain Huckel number of electrons, i.e. (4n+2) pi electrons where n=0,1,2,3….etc.

A molecule which does not satisfy any one or more of the above condition is said to be non aromatic

Q.36. How will you convert benzene into *p*-nitrobromobenzene ?



Q.37. In the alkane $H_3C - CH_2 - C(CH_3)_2 - CH_2 - CH(CH_3)_2$, identify 1°,2°,3° carbon atoms and give the number of H atoms bonded to each one of these.

Ans. 15 H attached to five 1^0 carbon.

4H attached to ten 2^0 carbons

1H attached to one 3^0 carbon.

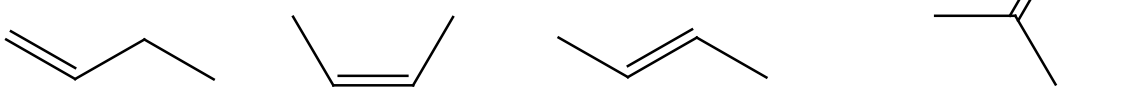
Q.38. Name two reagents which can be used to distinguish between ethene and ethyne ?

Ans. Tollen's Reagent and ammonical CuCl solution.

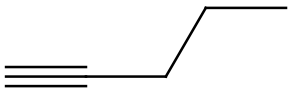
Q.39. For the following compounds, write structural formulas and IUPAC names for all possible isomers having the number of double or triple bond as indicated :

(a) C_4H_8 (one double bond) (b) C_5H_8 (one triple bond)

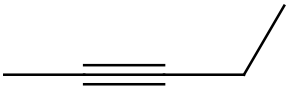
Ans. (a) Isomers of C_4H_8 having one double bond are:



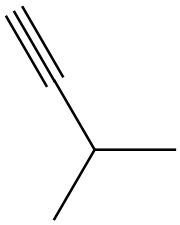
(b) Isomers of C_5H_8 having one triple bond are:



pent-1-yne



pent-2-yne



3-methyl-but1-yne

Q.40. Write IUPAC names of the following compounds :

(a) $CH_3CH=C(CH_3)_2$ (b) $CH_2=CH-C\equiv C-CH_3$

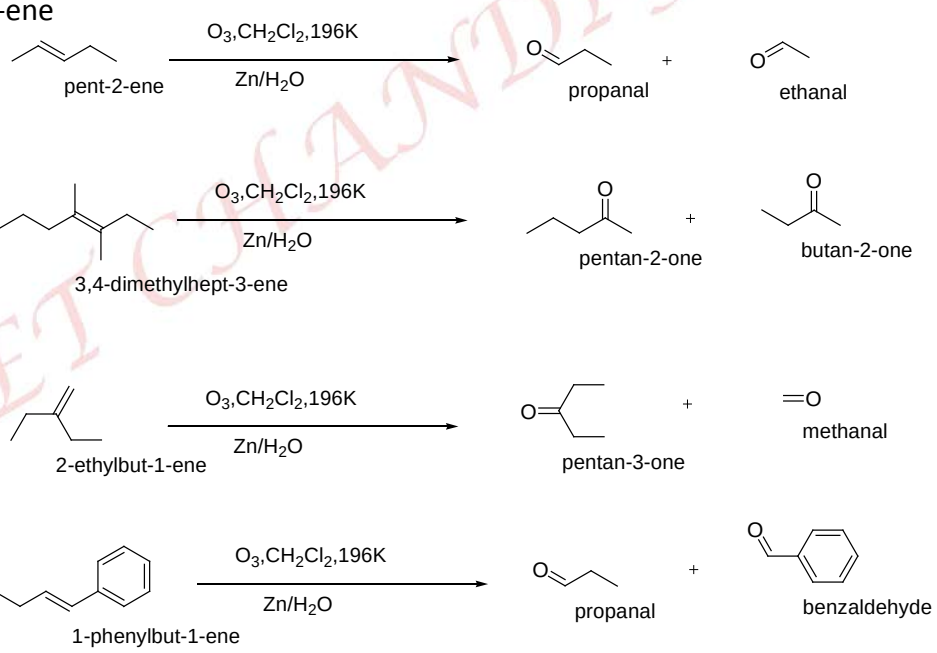
Ans. (a) 2-Methylbut-2-ene

(b) Pent-1-en-3-yne

Q.41. Write IUPAC names of the products obtained by the ozonolysis of the following compounds :

(i)Pent-2-ene (ii) 3,4-Dimethyl-hept-3-ene (iii) 2-Ethylbut-1-ene

(iv)1-Phenylbut-1-ene



Q.42. How will you detect the presence of unsaturation in an organic compound?

Ans. Either by Baeyer's reagent or by Br_2 in CCl_4

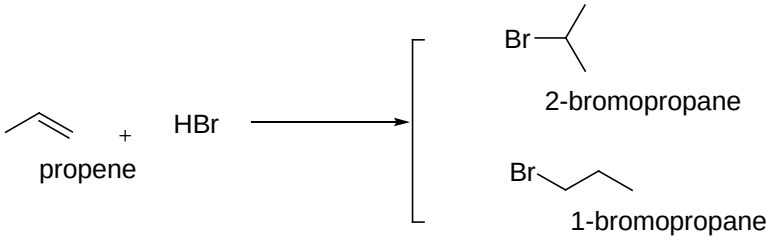
Q.43. How will you separate propene from propyne?

Ans. By passing the mixture through amm. AgNO3 solution or ammon. CuCl solution when propyne reacts while propene passes over.

Q.44. Explain briefly Markovnikov's rule.

Ans. Markovnikov's rule states that negative part of the adding molecule gets attached to that carbon atom which possesses lesser number of hydrogen atoms.

For Example:



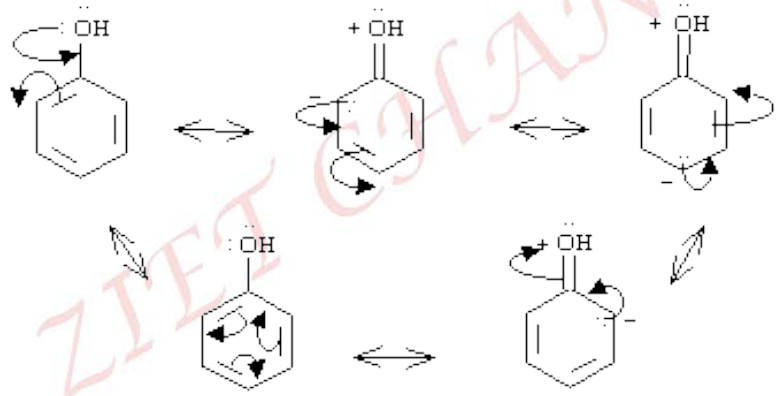
Q.45. What is a Lindlar's catalyst? What is it used for?

Ans. Pd deposited over CaCO3 or BaSO4 and partially poisoned by addition of lead acetate or sulphur or quinoline. It is used for partial reduction of alkynes to cis-alkenes.

Q.46. Explain the influence of different functional groups on monosubstitution of benzene.

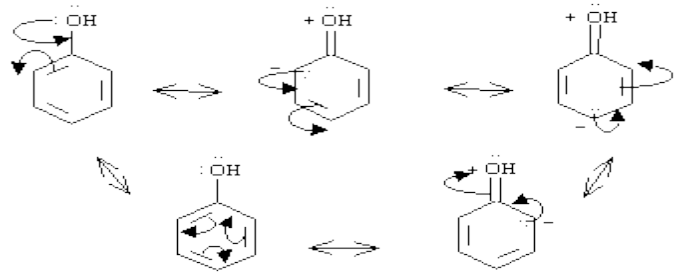
Ans. When monosubstituted benzene is subjected to further substitution, three possible disubstituted products are not formed in equal amounts. Two types of behaviour are observed. Either *ortho and para products or meta* product is predominantly formed.

For example: Phenol gives ortho and para substitution.



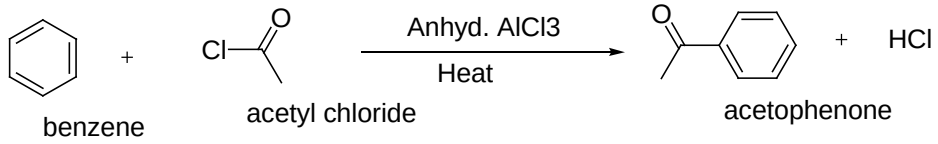
Q.47. Give one examples of *o* and *p* directing group.

Ans. The groups which direct the incoming group to ortho and para positions are called ortho and para directing groups. For example: Phenol



Q.48. What is Friedel-Crafts acylation reaction. Explain with example.

Ans. The reaction of benzene with an acyl halide or acid anhydride in the presence of Lewis acids ($AlCl_3$) yields acyl benzene is known as Friedel-Crafts acylation reaction.



benzene acetyl chloride acetophenone

Q.49. trans-Pent-2-ene is polar while trans-but-2-ene is non polar. Explain.

Ans. In trans-but-2-ene, the dipole moment of two C-CH_3 bonds are equal and opposite and hence they exactly cancel out each other. Thus trans-but-2-ene is non polar.

In trans-pent-2-ene, the dipole moments of C-CH_3 and C-CH_2CH_3 bonds are unequal. Although these two dipoles oppose each other, yet they do not exactly cancel out each other and hence trans-pent-2-ene has a small but finite dipole moment and thus is a polar.

Q.50. Out of benzene, m-dinitrobenzene and toluene which will undergo nitration most easily and why?

Ans. -CH_3 group is electron releasing while –NO_2 group is electron withdrawing. Therefore, maximum electro density will be in toluene followed by benzene and least in m-dinitrobenzene. Therefore, the ease of nitration decreases in the order:

Toluene> benzene> m-dinitrobenzene

ORGANIC CHEMISTRY – SOME BASIC PRINCIPLES AND TECHNIQUES

Q.1. What is the influence of hybridization on the bond strength and bond length?

Ans. Hybridisation influences the bond length and bond enthalpy (strength) in organic compounds. The sp hybrid orbital contains more s character and hence it is closer to its nucleus and forms shorter and stronger bonds than the sp^3 hybrid orbital. The sp^2 hybrid orbital is intermediate in s character between sp and sp^3 and, hence, the length and enthalpy of the bonds it forms, are also intermediate between them.

Q.2. How does hybridization affect the electronegativity of carbon?

Ans. The greater the s character of the hybrid orbitals, the greater is the electronegativity. Thus, a carbon atom having an sp hybrid orbital with 50% s character is more electronegative than that possessing sp^2 or sp^3 hybridised orbitals. **Q.3.** How many σ and π bonds are present in each of the following molecules?

(a) $HC\equiv CCH=CHCH_3$ (b) $CH_2=C=CHCH_3$

Ans. (a) σC – C: 4; σC–H : 6; πC=C :1; π C≡C:2

(b) σC – C: 3; σC–H: 6; πC=C: 2

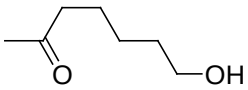
Q.4.What is the type of hybridisation of each carbon in the following compounds?

CH_3Cl, (b) $(CH_3)_2CO$, (c) CH_3CN, (d) $HCONH_2$, (e) $CH_3CH=CHCN$

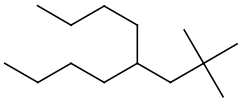
Ans. (a) sp^3, (b) sp^3, sp^2, (c) sp^3, sp, (d) sp^2, (e) sp^3, sp^2, sp^2, sp

Q.5. Derive the structure of

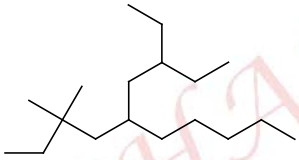
(a) 7-hydroxyheptan-2-one (b) 5-(2,2-Dimethylpropyl)nonane (c) 5-(2-Ethylbutyl)-3,3-dimethyldecane



7-hydroxyheptan-2-one



5-(2,2-Dimethylpropyl)nonane



5-(2-Ethylbutyl)-3,3-dimethyldecane

Q.6. Define electrophile and nucleophile. Give two examples also.

Ans.A reagent that brings an electron pair is called a **nucleophile** (Nu:) i.e., nucleus seeking and the reaction is then called nucleophilic.

Examples of nucleophiles are the negatively charged ions with lone pair of electrons such as hydroxide (HO^-), cyanide (NC^-) ions and carbanions ($R_3C:^-$).

A reagent that takes away an electron pair is called **electrophile** (E^+) i.e., electron seeking and the reaction is called electrophilic.

Examples of electrophiles include carbocations (CH_3^+) and neutral molecules having functional groups like carbonyl group (>C=O) or alkyl halides(R_3C-X, where X is a halogen atom).

Q.7. A liquid has three components. Which technique will you employ to separate them.

Ans. Column chromatography

Q.8. Explain electromeric effect, resonance effect and hyperconjugation.

❖ **Electromeric effect** is defined as the complete transfer of a shared pair of π-electrons to one of the atoms joined by a multiple bond on the demand of an attacking reagent. It is represented by E and the shifting of the electrons is shown by a curved arrow .

❖ **The resonance effect** is defined as 'the polarity produced in the molecule by the interaction of two π-bonds or between a π-bond and lone pair of electrons present on an adjacent atom'. The effect is transmitted through the chain.

❖ **Hyperconjugation** involves delocalisation of σ electrons of C—H bond of an alkyl group directly attached to an atom of unsaturated system or to an atom with an unshared p orbital. The σ electrons of C—H bond of the alkyl group enter into partial conjugation with the attached unsaturated system or with the unshared p orbital. Hyperconjugation is a permanent effect.

Q.9. Explain why $(CH_3)_3C^+$ is more stable than $CH_3C^+H_2$ and C^+H_3 is the least stable cation.

Ans. Greater the number of alkyl groups attached to a positively charged carbon atom, the greater is the hyperconjugation interaction and stabilisation of the cation.

Q.10. Give atleast two methods of purification of organic compounds.

Ans. Sublimation

Crystallization

Q.11. Explain Thin layer chromatography (TLC) and Partition chromatography.

Thin layer chromatography (TLC) is type of adsorption chromatography, which involves separation of substances of a mixture over a thin layer of an adsorbent coated on glass Plate.

Partition chromatography is based on continuous differential partitioning of components of a mixture between stationary and mobile phases.

Q.12. Distinguish between qualitative and quantitative analysis.

Ans. **Qualitative analysis** means is to detect the various elements present in it.

Quantitative Analysis means is to determine the percentage of each element.

Q.13. On complete combustion, 0.246 g of an organic compound gave 0.198g of carbon dioxide and 0.1014g of water. Determine the percentage composition of carbon and hydrogen in the compound.

Ans. Percentage of carbon= 12*0.198*100/44*0.246

= 21.95%

Percentage of hydrogen= 2*0.1014*100/18*0.246

= 4.58%

Q.14. During estimation of nitrogen present in an organic compound by Kjeldahl's method, the ammonia evolved from 0.5g of the compound in Kjeldahl's estimation of nitrogen, neutralized 10 mL of 1 M H_2SO_4. Find out the percentage of nitrogen in the compound.

Ans. 1M of 10 mL H_2SO_4=1M of 20 mL NH_3

1000 mL of 1M ammonia contains 14 g nitrogen

20 mL of 1M ammonia contains14*20/1000 g nitrogen

Percentage of nitrogen = 14*20*100/ 1000 *0.5 =56.0%

Q.15. Which of the following represents the correct IUPAC name for the compounds concerned ? (a) 2,2-Dimethylpentane or 2-Dimethylpentane (b) 2,4,7-Trimethyloctane or 2,5,7-Trimethyloctane (c) 2-Chloro-4-methylpentane or 4-Chloro-2-methylpentane (d) But-3-yn-1-ol or But-4-ol-1-yne.

Ans. (a) 2,2-Dimethylpentane

(b) 2,4,7-Trimethyloctane

(c) 2-Chloro-4-methylpentane

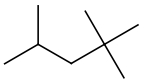
(d) But-3-yn-1-ol

Q.16. Give condensed and bond line structural formulas:

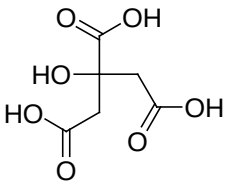
(a) 2,2,4-Trimethylpentane

(b) 2-Hydroxy-1,2,3-propanetricarboxylic acid

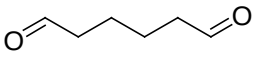
(c) Hexanedial



2,2,4-trimethylpentane



2-Hydroxy-1,2,3-propanetricarboxylic acid



Hexanedial

Q.17. Explain the method used for the detection of halogens.

Ans. The sodium fusion extract is acidified with nitric acid and then treated with silver nitrate. A white precipitate, soluble in ammonium hydroxide shows the presence of chlorine, a yellowish precipitate, sparingly soluble in ammonium hydroxide shows the presence of bromine and a yellow precipitate, insoluble in ammonium hydroxide shows the presence of iodine.

$X^- + Ag^+ \longrightarrow AgX$

X represents a halogen – Cl, Br or I.

Q.18. Which of the two: $O_2NCH_2CH_2O-$ or CH_3CH_2O- is expected to be more stable & why ?

Ans. $O_2NCH_2CH_2O-$ is more stable than CH_3CH_2O- because NO_2 group has –I effect and hence it tends to disperse the negative charge on the oxygen atom. In contrast, CH_3CH_2 has +I effect. It, therefore, tends to intensify the negative charge and hence destabilizes it.

Q.19. Describe the method, which can be used to separate two compounds with different solubilities in a solvent S.

Ans. Two compounds with different solubilities in a solvent S can be separated by fractional crysatllisation. When a hot saturated solution of these two compounds is alloed to cool, the less soluble compound crystallises out first while the more soluble remains in the solution. The crystals are separated from the mother liquor and the mother liquor is again concentrated and the hot solution is allowed to cool when the crystals of the second compound are obtained. These are again filtered and dried.

Q.20. What conclusion would you draw if during Lassainge's test a blood red coloration is obtained?

Ans. The formation of blood red colouration during Lassainge's Test indicates the presence of both N or S.

Q.21. Why is nitric acid added to sodium extract before adding silver nitrate for testing halogens?

Ans. Sodium extract is boiled with nitric acid to decompose NaCN and Na_2S, if present, otherwise these

$NaCN + HNO_3 \longrightarrow NaNO_3 + HCN$

$Na_2S + 2HNO_3 \longrightarrow 2NaNO_3 + H_2S$

Will react with $AgNO_3$ and hence will interfere with test as shown below:

$NaCN + AgNO_3 \longrightarrow AgCN + NaNO_3$

$Na_2S + 2AgNO_3 \longrightarrow Ag_2S + 2NaNO_3$

Q.22. Explain the reason for the fusion of an organic compound with metallic sodium for testing nitrogen, sulphur and halogens.

Ans. The organic compound is fused with sodium metal to convert these elements which are precent in the covalent form to ionic form

Q.23. Name a suitable technique of separation of the components from a mixture of calcium sulphate and camphor.

Ans. A mixture of camphor and $CaSO_4$ can be separated as:

(a) Camphor is sublimable but $CaSO_4$ is not, therefore, sublimation of the mixture gives camphor on the sides of the funnel while $CaSO_4$ is left in the china dish.

(b) Camphor is soluble in organic solvents like $CHCl_3$, CCl_4 etc. while $CaSO_4$ is not. Therefore, when the mixture is shaken with the solvent, camphor goes into the solution while $CaSO_4$ remains as residue. It is filtered and evaporation of the solvent gives camphor.

Q.24. An organic compound contains 69% carbon and 4.8% hydrogen, the remainder being oxygen. Calculate the masses of carbon dioxide and water produced when 0.20 g of this substance is subjected to complete combustion.

Ans. % of carbon = 12/44* Mass of CO_2 formed/Mass of substance taken*100

69=12/44*Mass of CO_2 formed/ 0.2*100

Mass of CO_2 formed=0.506g

% of hydrogen= 2/18* Mass of H_2O formed/ Mass of substance taken *100

4.8= 2/18 * Mass of H_2O formed/6.2*100

= 0.0864g

Q.25. In the organic compound $CH_2 = CH - CH_2 - CH_2 - C \equiv CH$, the pair of hydridised orbitals involved in the formation of: $C_2 - C_3$ bond is: (a) $sp - sp^2$ (b) $sp - sp^3$ (c) $sp^2 - sp^3$ (d) $sp^3 - sp^3$

Ans. When both double bond and triple bonds are present, double bond is given preference while numbering the chain.

Thus option © is correct.

Q.26. A sample of 0.50 g of an organic compound was treated according to Kjeldahl's method. The ammonia evolved was absorbed in 50 ml of 0.5 M H_2SO_4. The residual acid required 60 mL of 0.5 M solution of NaOH for neutralisation. Find the percentage composition of nitrogen in the compound.

Ans. % of nitrogen= 1.4*Molarity of the acid*Basicity of the acid* Volume of the acid used/Mass of the substance taken

= 1.4*1*2*10/0.5

= 56.0

Q.27. Why is a solution of potassium hydroxide used to absorb carbon dioxide evolved during the estimation of carbon present in an organic compound?

Ans. CO_2 is acidic in nature, therefore, it reacts with the strong base KOH to form K_2CO_3.

$2KOH + CO_2 \rightarrow K_2CO_3 + H_2O$

The increase in the mass of U-tube containing KOH then gives the mass of CO_2 produced and from its mass, the percentage of carbon in the organic compound and can be estimated by using the equation:

% of Carbon = 12/44* Mass of CO_2 formed/ Mass of substance formed*100

Q.28. Why is it necessary to use acetic acid and not sulphuric acid for acidification of sodium extract for testing sulphur by lead acetate test?

Ans. For testing sulphur, the sodium extract is acidified with acetic acid because lead acetate is soluble and does not interfere with the test. If H_2SO_4 were used, lead acetate itself will react with H_2SO_4 to form white ppt. of lead sulphate which will interfere with the test.

$Pb(OCOCH_3)_2 + H_2SO_4 \rightarrow PbSO_4 + 2CH_3COOH$

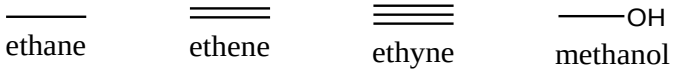
Q.29. A reaction is carried out using aniline as a reactant as well as solvent. How will you remove unreacted aniline?

Ans. Steam of distillation

Q.30. An organic compound decomposes below its boiling point. How will you purify it?

Ans. Distillation under reduced pressure, i.e. vacuum distillation

Q.31. Write the complete structural formulas for the following compounds ethane (C_2H_6), ethene (C_2H_4), ethyne (C_2H_2) and methanol (CH_3OH)



Q.32. Give a method for the qualitative detection of nitrogen.

Ans. The sodium fusion extract is boiled with iron(II) sulphate and then acidified with concentrated sulphuric acid. The formation of Prussian blue colour confirms the presence of nitrogen. Sodium cyanide first reacts with iron(II) sulphate and forms sodium hexacyanoferrate(II). On heating with concentrated sulphuric acid some iron(II) ions are oxidised to iron(III) ions which react with sodium hexacyanoferrate(II) to produce iron(III) hexacyanoferrate(II) (ferriferrocyanide) which is Prussian blue in colour.

$6CN^- + Fe^{2+} \rightarrow [Fe(CN)_6]^{4-}$

$3[Fe(CN)_6]_4- + 4Fe3^+$ $Fe_4[Fe(CN)_6]_3.xH_2O$

Prussian blue

Q.33. Differentiate between the principle of estimation of nitrogen in an organic compound by (i) Dumas method and (ii) Kjeldahl's method.

Ans. Dumas method: The nitrogen containing organic compound, when heated with copper oxide in an atmosphere of carbon dioxide, yields free nitrogen in addition to carbon dioxide and water.

CxHyNz + (2x + y/2) CuO –→ x CO2 + y/2 H2O + z/2 N2 + (2x + y/2) Cu

Traces of nitrogen oxides formed, if any, are reduced to nitrogen by passing the gaseous mixture over a heated copper gauze. The mixture of gases so produced is collected over an aqueous solution of potassium hydroxide which absorbs carbon dioxide.Nitrogen is collected in the upper part of the graduated tube.

Kjedahl Method: The compound containing nitrogen is heated with concentrated sulphuric acid. Nitrogen in the compound gets converted to ammonium sulphate . The resulting acid mixture is then heated with excess of sodium hydroxide. The liberated ammonia gas is absorbed in an excess of standard solution of sulphuric acid. The amount of ammonia produced is determined by estimating the amount of sulphuric acid consumed in the reaction. It is done by estimating unreacted sulphuric acid left after the absorption of ammonia by titrating it with standard alkali solution. The difference between the initial amount of acid taken and that left after the reaction gives the amount of acid reacted with ammonia.

Q.34. What type of reaction intermediates are formed by homolytic cleavage?

Ans. Free Radicals

Q.35. What is the order of stability of free radicals?

Ans. The stability of free radicals is as:

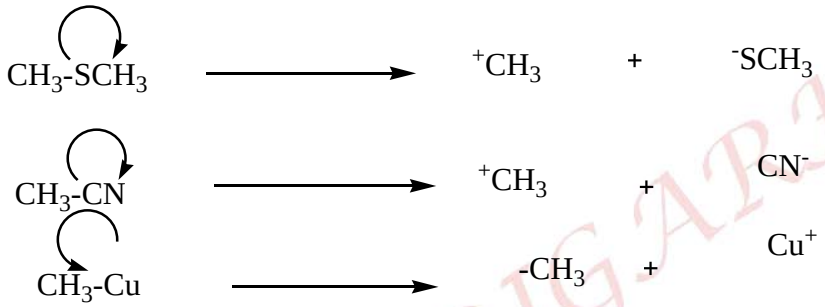
$3^0 > 2^0 > 1^0$

It is explained on the basis of hyperconjugation.

Greater the number of alkyl groups attached to the carbon atom carrying the odd electron, greater is the delocalisation of the odd electron and hence more stable is the free radical.

Q.36. Using curved-arrow notation, show the formation of reactive intermediates when the following covalent bonds undergo heterolytic cleavage.

(a)$CH_3–SCH_3$, (b) $CH_3–CN$, (c) $CH_3–Cu$



Q.37. In Dumas' method for estimation of nitrogen, 0.3g of an organic compound gave 50mL of nitrogen collected at 300K temperature and 715mm pressure. Calculate the percentage composition of nitrogen in the compound. (Aqueous tension at 300K=15 mm).

Ans. Volume of nitrogen collected at 300K and 715mm pressure is 50 mL

Actual pressure = 715-15 =700 mm

Volume of nitrogen at STP =273 *700 *50/300 *760

= 41.9 mL

22,400 mL of N2 at STP weighs = 28 g

41.9 mL of nitrogen weighs=28 *41.9 /22400g

Percentage of nitrogen =28 *41.9* 100/22400* 0.3

=17.46%

Q.38. In Carius method of estimation of halogen, 0.15 g of an organic compound gave 0.12 g of AgBr. Find out the percentage of bromine in the compound.

Ans. Mass of the substance taken=0.15g

Mass of AgBr= 0.12g

1 mole of AgBr=1 g atom of Br

188g of AgBr = 80 g of Br

0.12 g of AgBr contain bromine= 80/188*0.12

But this much amount of bromine is present in 0.15g of the organic compound

Therefore, percentage of bromine= 80*0.12*100/188*0.15

= 34.04

Q.39. In sulphur estimation, 0.157 g of an organic compound gave 0.4813 g of barium sulphate. What is the percentage of sulphur in the compound?

Ans. Here, mass of the substance taken= 0.157g

Mass of BaSO4 ppt. formed= 0.4813g

1 mole of BaSO4 is equivalent to 1 g atom of S

(137+32+64)= 233g of BaSO4=32g of S

0.4813g of BaSO4 will contain sulphur=32/233*0.4813

% of sulphur in the compound= 32/233*0.4813*100/0.157

= 42.10

Q.40. Explain, why an organic liquid vaporises at a temperature below its boiling point in its steam distillation ?

Ans. In steam distillation, the mixture consisting of the organic liquid and water boils at a temperature when the sum of the vapour pressure of the liquid (p1) and that of water (p2) becomes equal to the atmospheric pressure(p) i.e.,p=p1+p2.

Since the vapor pressure of the water around the boiling point of the mixture is quite high and that of the liquid is quite low(10-15mm), therefore, the organic liquid distils at a pressure much lower than the atmospheric pressure that means, the organic liquid vaporises at a temperature much lower than its normal boiling point.

Q.41. Will CCl_4 give white precipitate of AgCl on heating it with silver nitrate? Give reason for your answer.

Ans. When CCl_4 is heated with $AgNO_3$ solution, white ppt. of AgCl will not be formed. The reason being that CCl_4 is a covalent compound, therefore, it does not ionize to give Cl^- ions needed for the formation of ppt. of AgCl.

Q.42. Write the state of hybridisation of carbon in the following compounds and shapes of each of the molecules.

(a) $H_2C=O$, (b) CH_3F, (c) $HC\equiv N$.

Ans. (a) In $H_2C=O$, C is sp^2 hybridised, hence formaldehyde is trigonal planar.

(b) In CH_3F, C is sp3 hyybridised, hence methyl fomaldehyde is tetrahedral.

(c) In $HC\equiv N$, C is sp hybridised, hence HCN is a linear molecule.

Q.43. In which C–C bond of $CH_3CH_2CH_2Br$, the inductive effect is expected to be the least?

Ans. The magnitude of inductive effect decreases with distance and hence the effect is least in C_2-C_3 bond.

Q.44. Write resonance structures of $CH_2=CH–CHO$. Indicate relative stability of the contributing structures.

$CH_2=CH-CH=O$ ⟷ $^{+}CH_2-CH=CH-O^{-}$ ⟷ $^{-}CH_2-CH=CH-O^{+}$

I II III

Structure I is most stable since each C and O atom has an octet of electrons and none of these atom carries any charge. Structures II and III both involve separation of charge and

hence both are less stable than structure I. However, Structures II is more stable than structure(III) since it carries a negative charge on the more electronegative O atom and positive charge on the less electronegative C atom while in structure (III), the more electronegative O atom carries the positive charge while the less electronegative C atom carries the negative charge.

Thus, the decreasing order of stability:

I>II>III

Q.45. What type of hybridization is involved in i) planar and ii) linear molecules?

(i) sp^2

(ii) sp

Q.46. Name two compounds which do not contain halogen but give positive Beilstein test.

Ans. Urea and thiourea give positive Beilstein test due to the formation of volatile cupric cyanide.

Q.47. Suggest a suitable technique of separating naphthalene from kerosene oil present in a mixture.

Ans. Simple distillation

Q.48. How will you separate a mixture of two organic compounds which have different solubilities in the same solvent.

Ans. By Fractional Crystallisation.

Q.49. Write the metamer of diethyl ether. What is its IUPAC name?

Ans.1-methoxypropane, $CH_3OCH_2CH_2CH_3$ or

2-methoxypropane,$CH_3OCH(CH_3)_2$

Q.50. How will you separate a mixture of o-nitrophenol and p-nitrophenol?

Ans.Steam distillation.

O-nitrophenol being volatile distils over along with water while p-nitrophenol being non-volatile remains in the flask.

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