Chemistry

Model Set - 3

Academic Year: 2020-2021 Marks: 70
Date: April 2021
Duration: 3h

1. The question paper is divided into four sections.
2. **Section A**: Q. No. 1 contains Ten multiple-choice type of questions carrying One mark each.
3. **Section A**: Q. No. 2 contains Eight very short answer type of questions carrying One mark each.
4. **Section B**: Q. No. 3 to Q. No. 14 contains Twelve short answer type of questions carrying Two marks each. **(Attempt any Eight)**.
5. **Section C**: Q. No.15 to Q. No. 26 contains Twelve short answer type of questions carrying Three marks each. **(Attempt any Eight)**.
6. **Section D**: Q.No. 27 to Q. No. 31 contains Five long answer type of questions carrying Four marks each. **(Attempt any Three)**.
7. Use of log table is allowed. Use of calculator is not allowed.
8. Figures to the right indicate full marks.
9. For each MCQ, correct answer must be written along with its alphabet.
   e.g., (a) ..... / (b) .... / (c) .... / (d) ..... Only first attempt will be considered for evaluation.
10. Draw well labeled diagrams and write balanced equations wherever necessary.
11. Given data:
    Atomic mass of C = 12, H = 1, O = 16
    Atomic number (Z): Mn = 25, Fe = 26, Ce = 58, Ar = 18,
    R = 8.314 J K^{-1} mol^{-1} or 0.083 L bar K^{-1} mol^{-1}

Q. 1 | Select and write the correct answer:

1.i The strongest base amongst the following is

1. Methanamine
2. N-Methylmethanamine
3. N-Methylaniline
4. N,N-Dimethylmethanamine

1.ii The following types of solids contain molecules as constituent particles?

1. molecular solids
2. Ionic solids
3. metallic solids

4. covalent network solids

1.iii The units of Henry's law constant are _____.

1. bar dm^3 mol^{-1}
2. mol L^{-1} bar^{-1}
3. L mol^{-1} bar^{-1}
4. bar L^{-1} mol^{-1}

1.iv Effect of catalyst in a chemical reaction is to change the _____.

1. activation energy
2. equilibrium concentration
3. final products
4. heat of a reaction

1.v The reagents used to convert phenol to 2,4,6-tribromophenol is _____

1. Br_2/CS_2
2. Br_2/CCl_4
3. Br_2/H_2O
4. KBr aq.

1.vi Write oxidation number of iron in $[Fe(CO)_5]$

Ans. The charge on complex $[Fe(CO)_5]$ is 0.

$\therefore$ (O.S. of Fe + charge on ligands) = 0

$\therefore$ (O.S. of Fe + 6 × charge of CO) = 0

$\therefore$ (O.S. of Fe + 6 × 0) = 0

Therefore, O.S. of Fe = 0

1.vii The type of mono halogen derivative in which a halogen atom is bonded to sp^3 hybridized carbon atom next to carbon-carbon double bond is _____

1. alkyl halide
2. allylic halide
3. vinylic halide
4. benzylic halide

1.viii The following pair of elements has half-filled d-orbitals.

1. Chromium and cobalt
2. Manganese and nickel
3. Chromium and manganese
4. Cobalt and nickel

1.ix The following reactants CANNOT be converted into carboxylic acid?

1. Dry ice
2. Cyclohexane
3. Toluene
4. Cyclohexene

1.x The Henry's law constant of a gas is 6.7×10^{-4} mol/(L bar). Its solubility when the partial pressure of the gas at 298 K is 0.65 bar is _____.

1. 4.355×10^{-4} mol/L
2. 4.355×10^{-2} mol/L
3. 2.225×10^{-6} mol/L
4. 2.225×10^{-2} mol/L

Q. 2 | Answer the following:

2.i Arrange the following compounds in increasing order of their boiling points.

Ethyl alcohol, Ethyl amine, Ethanoic acid, Ethane
Ans. Ethane < Ethyl amine < Ethyl alcohol < Ethanoic acid

2.ii State Raoult's law.

Ans. Raoult's law states that the partial vapour pressure of any volatile component of a solution is equal to the vapour pressure of the pure component multiplied by its mole fraction in the solution.

2.iii Write the IUPAC name of $[Fe(CN)_6]^{4-}$ ion.

Ans. IUPAC name: Hexacyanoferrate(II) ion

2.iv Name the reagent used to convert alkyl halide to ester.

Ans. The reagent used to convert alkyl halide to ester is silver carboxylate (RCOOAg).

2.v Name the solution which is formed by passing sulfur dioxide in water.

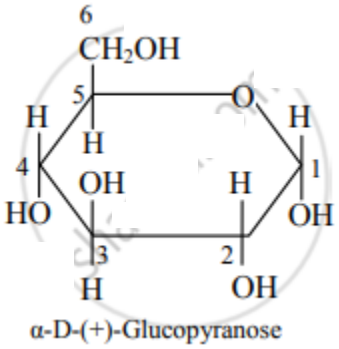
Ans. Sulfurous acid

2.vi Write the number of products when a mixture of ethanal and propanal is reacted with dilute alkali?

Ans. A mixture of ethanal and propanal on reaction with dilute alkali gives a mixture of four products.

2.vii Draw the structure of α-D glucopyranose.

Ans.



α-D-(+)-Glucopyranose

2.viii If the total volume of a simple cubic unit cell is 6.817×10^{-23} cm^3, what is the volume occupied by particles in unit cell?

Ans. Volume occupied by particles in simple cubic unit cell

$$= \frac{(\pi a)^3}{6} = \frac{3.14 \times 6.817 \times 10^{-23} cm^3}{6} = 3.57 \times 10^{-23}\ cm^3$$

Q. 3 | Attempt any Eight:

Answer the following

Define the following term: Nanochemistry

Ans. Nanochemistry:

Nanochemistry is the combination of chemistry and nanoscience which deals with designing and synthesis of materials of nanoscale with different sizes and shape, structure and composition, and their organization into functional architectures.

Q. 4 Answer the following

Write the formula to calculate the % atom economy.

Ans.

$$\textbf{\% atom economy} = \frac{\text{Formula weight of the desired product}}{\text{Sum of formula weight of all the reactants used in the reaction}} \times 100$$

Q. 5 Explain the basic nature of amines with a suitable example.

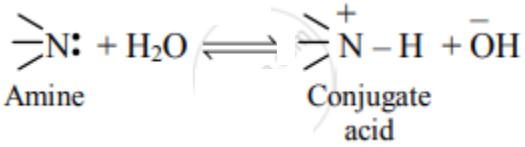
Ans. The basic nature of amines is due to the presence of a lone pair of electrons on the nitrogen atom.

i. Lewis theory: In terms of Lewis theory, amines are bases because they can share a lone pair of electrons on 'N' atom with an electron-deficient species.

For example, trimethylamine shares its lone pair of electrons with the electron-deficient boron trifluoride.

$Me_3N: + BF_3 \rightarrow Me_3N^+ - B^-F_3$

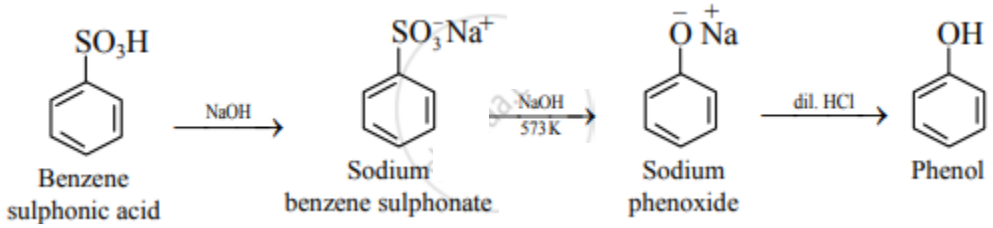
ii. Lowry-Bronsted theory: The basic nature of amines is explained by writing the following equilibrium.



a. In this equilibrium amine accepts H^+, hence an amine is a Lowry Bronsted base.
b. For a stronger base, this equilibrium shifts towards the right, thereby, for stronger bases, the K_b value is larger or the pK_b value is smaller.

Q. 6 Write the reactions involved in the preparation of phenol from benzene sulfonic acid.

Ans. Preparation of phenol from benzene sulfonic acid:



Q. 7 What is cell constant? Write its SI unit.

Ans. For a given cell, the ratio of separation (l) between the two electrodes divided by the area of cross section (a) of the electrode is called the cell constant.

$$\text{Cell constant} = \frac{l}{a}$$

1. The SI unit of cell constant is m^{-1}.

Q. 8 Derive the relationship between standard cell potential and equilibrium constant of cell reaction.

Ans. The relation between standard Gibbs energy change of cell reaction and standard cell potential is given by

$$-\Delta G^\circ = -nF E^\circ_{cell} \quad .....(1)$$

The relation between standard Gibbs energy change of a chemical reaction and its equilibrium constant as given in thermodynamics is:

$\Delta G^\circ = -RT \ln K$ .....(2)

Combining equations (1) and (2), we have

$$- nF E^{\circ}_{cell} = - RT \ln K$$

$$\therefore E^{\circ}_{cell} = \frac{RT}{nF} \ln K$$

$$= \frac{2.303RT}{nF} \log_{10} K$$

$$= \frac{0.0592}{n} \log_{10} K \text{ at } 25\ ^{\circ}C$$

Q. 9 Write four postulates of Werner's theory.

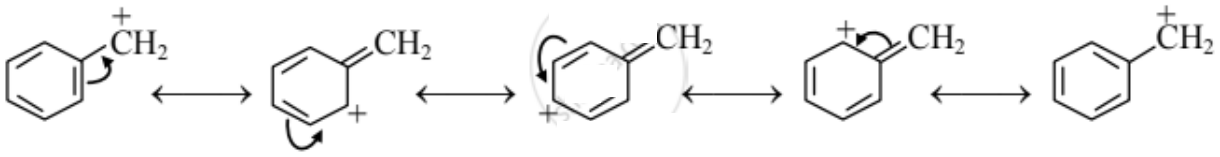
Ans. Postulates of Werner's theory:

i. **Postulate (1):** Unlike metal salts, the metal in a complex possesses two types of valencies: primary (ionizable) valency and secondary (nonionizable) valency.
ii. **Postulate (2):** The ionizable sphere consists of entities which satisfy the primary valency of the metal. Primary valencies are generally satisfied by anions.
iii. **Postulate (3):** The secondary coordination sphere consists of entities which satisfy the secondary valencies and are non ionizable. The secondary valencies for a metal ion are fixed and satisfied by either by anions or neutral ligands. Number of secondary valencies is equal to the coordination number
iv. **Postulate (4):** The secondary valencies have a fixed spatial arrangement around the metal ion.

Q. 10 Explain primary benzylic halide shows higher reactivity by S_N1 mechanism than other primary alkyl halide.

Ans.

i. S_N1 reaction involves the formation of a carbocation intermediate. The benzylic carbocation intermediate formed are resonance stabilized, and hence S_N1 mechanism is favoured.
ii. Resonance stabilization of benzylic carbocation can be represented as:



iii. Reactivity order of alkyl halides towards S_N1 mechanism is $3° > 2° > 1° > CH_3X$. That is, S_N1 mechanism is least favoured in primary alkyl halides.
iv. Benzylic carbocation formed is more stable than the primary carbocation; therefore, primary benzylic halide shows higher reactivity by S_N1 mechanism than other primary alkyl halide.

Q. 11 Write the features of reversible processes.

Ans.

1. The driving and opposing forces differ by an infinitesimal amount.
2. The process can be reversed by an infinitesimal change in conditions.
3. A reversible process proceeds infinitely slowly and takes place in an infinite number of steps.
4. At the end of every step of the process, the system attains mechanical equilibrium with the surroundings.

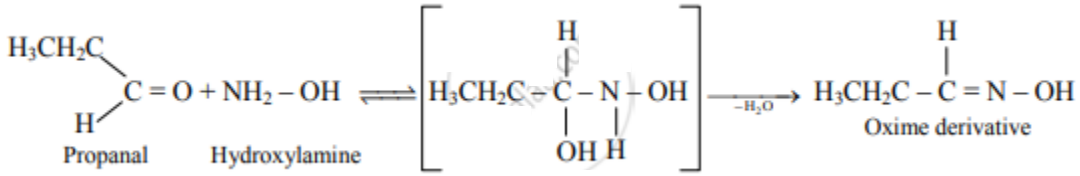
Q. 12. (A) What is the action of following on proponal?

Hydroxyl amine

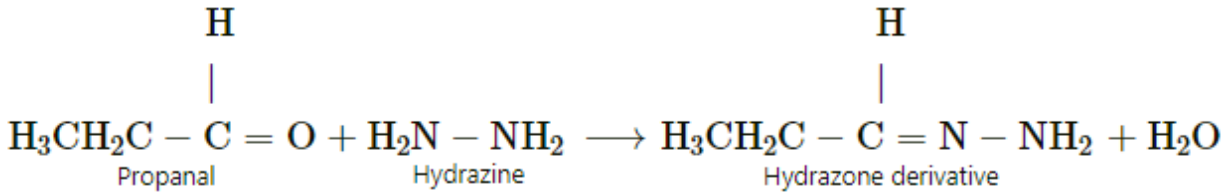
Q. 12. (B) What is the action of following on proponal?

Hydrazine

Ans. (A) Propanal will undergo an addition elimination reaction with hydroxyl amine to give corresponding oxime derivative containing C = N bonds (imine).



Ans. (B) Propanal will undergo an addition elimination reaction with hydrazine to give corresponding hydrazone derivative containing C = N bond (imine).



Q.13 For the reaction $2NOBr \rightarrow 2NO_2 + Br_2$, the rate law is rate = $k[NOBr]_2$. If the rate of a reaction is 6.5×10^{-6} mol L^{-1} s^{-1}, when the concentration of NOBr is 2×10^{-3} mol L^{-1}. What would be the rate constant of the reaction?

Ans. Given: Rate = $k[NOBr]_2 = 6.5 \times 10^{-6}$ mol L^{-1} s^{-1}

[NOBr] is 2×10^{-3} mol L^{-1}

To find: Rate constant (k)

Calculation: rate = $k[NOBr]^2$

$$k = \frac{\text{rate}}{[NOBr]^2}$$

$$= \frac{6.5 \times 10^{-6}\ \text{mol L}^{-1}\text{s}^{-1}}{\left(2 \times 10^{-3}\text{mol L}^{-1}\right)^2}$$

= 1.625 mol L^{-1} s^{-1}

Q. 14 The solubility product of $BaCl_2$ is 4.0×10^{-8}. What will be its molar solubility in mol dm^{-3}?

Ans. Given: Solubility product (K_{sp}) = 4.0×10^{-8}

To find: Molar solubility, S

Formula: $K_{sp} = x^x\ y^y\ S^{x+y}$

Calculation: Solubility equilibrium of $BaCl_2$ is:

$$BaCl_{2(s)} \rightleftharpoons Ba^{2+}_{(aq)} + 2\,Cl^{-}_{(aq)}$$

x = 1, y = 2

$$K_{sp} = x^x\ y^y\ S^{x+y} = (1)^1\ (2)^2\ S^{1+2} = 4S^3$$

The molar solubility (S) of $BaCl_2$ is

$$S = \sqrt[3]{\frac{K_{sp}}{4}} = \sqrt[3]{\frac{4.0 \times 10^{-8}}{4}} = \sqrt[3]{1.0 \times 10^{-8}} = 2.154 \times 10^{-3}\ \text{mol dm}^{-3}$$

Molar solubility (S) of $BaCl_2$ is **2.154×10^{-3} mol dm^{-3}**

Q. 15 | Attempt any Eight:

Define α-amino acids.

Ans. α-Amino acids are carboxylic acids having an amino ($-NH_2$) group bonded to the α-carbon, that is, the carbon next to the carboxyl (–COOH) group.

Q. 16 Derive the expression for molar mass of solute in terms of boiling point elevation of solvent.

Ans. The boiling point elevation is directly proportional to the molality of the solution. Thus,

$\Delta T_b = K_b\, m$ ....(1)

Suppose we prepare a solution by dissolving W_2 g of solute in W_1 g of solvent. Moles of solute in W_1 g of solvent =

$$\frac{W_2}{M_2}$$

where, M_2 is the molar mass of solute.

$$\text{Mass of solvent} = W_1 \text{ g} = \frac{W_1 g}{1000 g/kg} = \frac{W_1}{1000} kg$$

The molality is expressed as,

$$m = \frac{\text{Moles of solute}}{\text{Mass of solvent in kg}}$$

$$m = \frac{W_2/M_2 \text{ mol}}{W_1/1000 \text{ kg}}$$

$$m = \frac{1000 W_2}{M_2 W_1} \text{ mol kg}^{-1} \quad ....(2)$$

Substituting equation (2) in equation (1), we get,

$$\Delta T_b = \frac{1000 K_b W_2}{M_2 W_1}$$

Hence,

$$M_2 = \frac{1000\, K_b W_2}{\Delta T_b W_1}$$

Q. 17 For the reaction $2A + B \rightarrow C$, rate of disappearance of A 0.076 mol s^{-1}.

1. What is the rate of formation of C?
2. What is the rate of consumption of B?
3. What is the rate of the overall reaction?

Ans.

Given: Rate of disappearance of $A = -\frac{d[A]}{dt} = 0.076 \text{ mol } s^{-1}$

To find:

1. Rate of formation of C
2. Rate of consumption of B
3. Rate of the overall reaction

Calculation:

$$\text{Rate of reaction} = -\frac{1}{2}\frac{d[A]}{dt} = -\frac{d[B]}{dt} = \frac{d[C]}{dt}$$

$$\text{Rate of formation of C} = \frac{d[C]}{dt} = -\frac{1}{2}\frac{d[A]}{dt}$$

$$= \frac{1}{2} \times 0.076 \text{ mol s}^{-1}$$

$= 0.038 \text{ mol s}^{-1}$

$$\text{Rate of consumption of B} = -\frac{d[B]}{dt} = -\frac{1}{2}\frac{d[A]}{dt}$$

$$= \frac{1}{2} \times 0.076 \text{ mol s}^{-1}$$

$= 0.038 \text{ mol s}^{-1}$

$$\text{Rate of reaction} = \frac{d[C]}{dt} = \mathbf{0.038 \text{ mol s}^{-1}}$$

1. Rate of formation of C= **0.038 mol s^{-1}**
2. Rate of consumption of B = **0.038 mol s^{-1}**
3. Rate of the overall reaction = **0.038 mol s^{-1}**

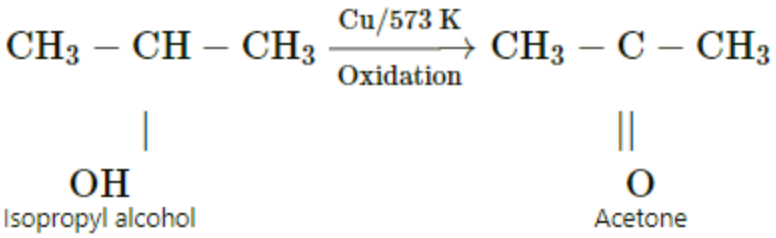
Q. 18 (A) How will you bring about the following conversions?

isopropyl alcohol to acetone

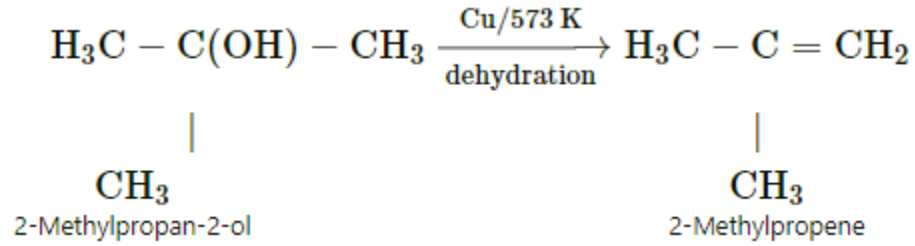
Q. 18 (B) How will you bring about the following conversions?
2-methyl propan-2-ol to 2-methylpropene

Q. 18 (C) How will you bring about the following conversions?
acetone to 2-methylpropan-2-ol

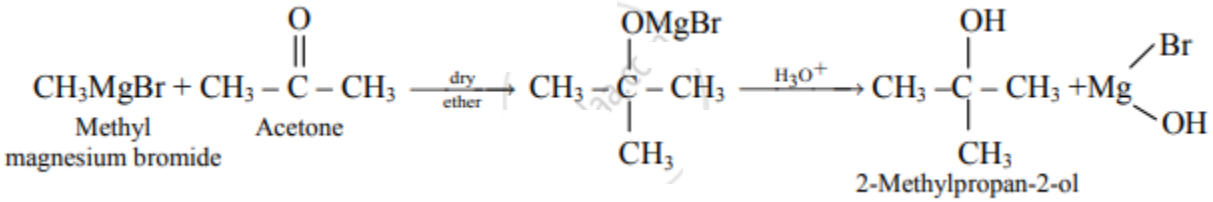
Ans. (A) When isopropyl alcohol is heated at 573 K in presence of Cu acetopne is formed.



Ans. (B) 2-Methylpropan-2-ol undergoes dehydration when passed over hot copper at 573 K.

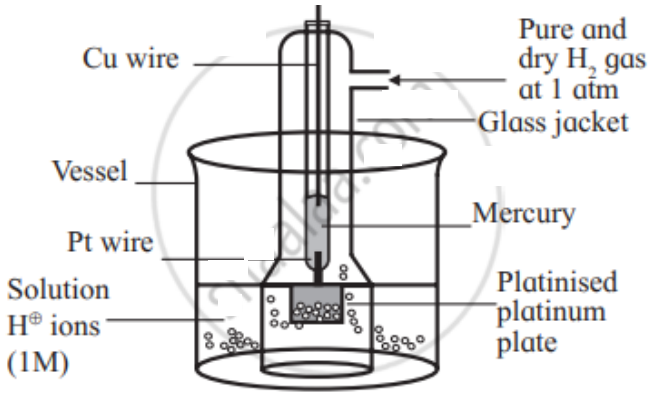


Ans. (C) Grignard reagent, methyl magnesium bromide reacts with acetone to form an adduct which on hydrolysis with dilute acid gives 2-methylpropan-2-ol.



Q. 19 Draw a neat and well labelled diagram of Standard Hydrogen Electrode. Also write its one application.

Ans.



Standard hydrogen electrode

Application of Standard Hydrogen Electrode (SHE):

SHE is used as a primary reference electrode to determine the standard potentials of other electrodes.

e.g. To determine the standard potential of Zn^{2+} (1 M) | $Zn_{(s)}$ electrode, it is combined with SHE to a galvanic cell.

$Zn_{(s)}$ | Zn^{2+} (1 M) || H^+ (1 M) | H_2(g, 1atm) |Pt

The standard cell potential, E°_{cell} , is measured.

$E^\circ_{cell} = E^\circ_{H_2} - E^\circ_{Zn} = -E^\circ_{Zn}$, because $E^\circ_{H_2}$ is zero.

Thus, the measured emf of the cell is equal to standard potential of Zn^{2+} (1 M) | $Zn_{(s)}$ electrode.

Q. 20 Answer the following question.

What are the types of ligands? Give one example of each type.

Ans. Depending upon the number of electron donor atoms present, ligands are classified as:

i. Monodentate ligands: A monodentate ligand is the one where a single donor atom shares an electron pair to form a coordinate bond with the central metal ion.

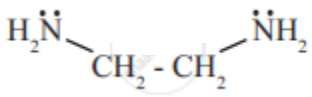
e.g. Cl^-, OH^-, CN^-, etc.

ii. Polydentate ligands: A polydentate ligand has two or more donor atoms linked to the central metal ion. Based on the number of donor atoms, polydentate ligands are further classified as:

a. Bidentate ligands: The ligands which bind to central metal through two donor atoms are called bidentate ligands.

e.g.

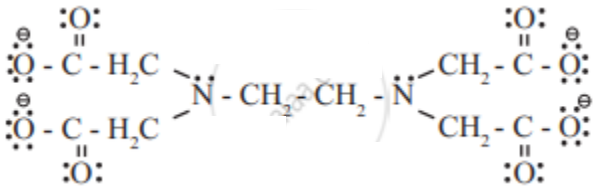
1. Ethylenediammine binds to the central metal atom through two nitrogen atoms.



2. Similarly, Oxalate ligand $\left(C_2O_4^{2-}\right)$ utilizes electron pair on each of its negatively charged oxygen atoms on linking with central metal.

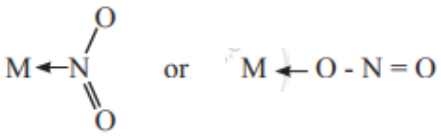
b. Hexadentate ligands: The ligands which bind to central metal through six donor atoms are called hexadentate ligands.

e.g. Ethylenediaminetetraacetate ion $(EDTA)^{4-}$ binds to metal by electron pairs of four oxygen and two nitrogen atoms.



iii. Ambidentate ligands: The ligands which have two donor atoms and use the electron pair of either donor atoms to form a coordinate bond with the metal ion are called ambidentate ligands.

e.g.



a. The ligand NO_2^- links to the metal ion through nitrogen or oxygen.

b. SCN^- has two donor atoms nitrogen and sulphur either of which links to metal M ← SCN^- or M ← NCS^-.

Q. 21. (A) How are the following conversions carried out?

propene to 1-iodopropane

Q. 21. (B) How are the following conversions carried out?

propene to 2-nitropropane

Q. 21. (C) How are the following conversions carried out?

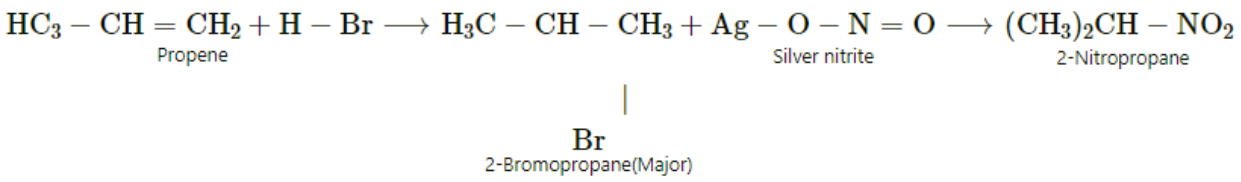
benzene to biphenyl

Ans. (A)

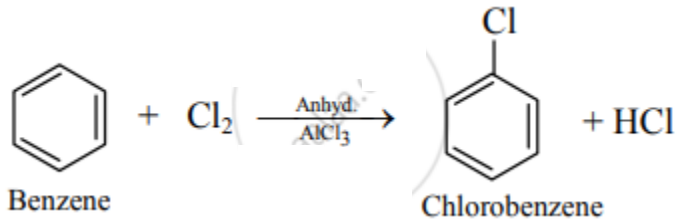
$$\underset{\text{Propene}}{H_3C-CH=CH_2} + HBr \xrightarrow{\text{Peroxide}} \underset{\text{1-Bromopropane}}{H_3C-CH_2-CH_2Br}$$

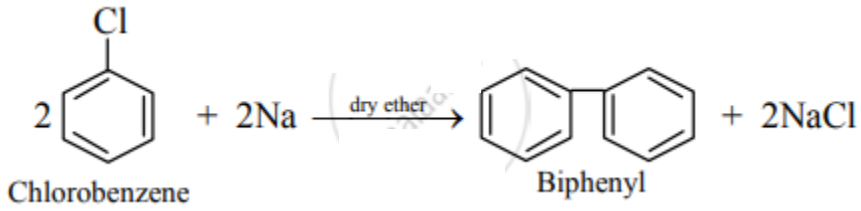
$$\underset{\text{1-Bromopropane}}{H_3C-CH_2-CH_2Br} + NaI \xrightarrow{\text{Acetone}} \underset{\text{1-Iodopropane}}{CH_3CH_2CH_2I} + NaBr\downarrow$$

Ans. (B)



Ans. (C)





Q. 22 (A) Define the Enthalpy of vaporization.

Q. 22 (B) Define the Standard enthalpy of combustion.

Q. 22 (C) Why work done in vacuum is zero?

Ans. (A) Enthalpy of vaporization is the enthalpy change accompanying the vaporization of one mole of liquid without changing its temperature at constant pressure.

Ans. (B) The standard enthalpy of combustion of a substance is the standard enthalpy change accompanying a reaction in which one mole of the substance in its standard state is completely oxidized.

Ans. (C) A free expansion means expansion against zero opposing force. Such expansion occurs in a vacuum. When the gas expands in a vacuum, there is no opposing force, that is, $P_{ext} = 0$. The work done by a system during such expansion is $W = - P_{ext} \Delta V = 0$.
Thus, work done in a vacuum is zero.

Q. 23 Write three physical properties of sulfuric acid.

Ans. Physical properties of sulfuric acid are-

1. Sulfuric acid is a colourless, dense, oily liquid.
2. It has a density (specific gravity) of 1.84 g/cm^3 at 298 K.

3. It freezes at 283 K and boils at 611 K.
4. It is highly corrosive and produces severe burns on the skin.

Q. 24 Answer the following

Give the similarities and differences in elements of 3d, 4d, and 5d series.

Ans.

- **Similarities in physical properties:**

1. All d block elements are lustrous and shining.
2. They are hard and have a high density.
3. They have high melting and boiling points.
4. They are good electrical and thermal conductors.
5. They have high tensile strength and malleability.
6. They can form alloys with transition and non-transition elements.
7. Many metals and their compounds are paramagnetic.
8. Most of the metals are efficient catalysts.

- **Similarities in chemical properties:**

1. All d block elements are electropositive metals.
2. They exhibit variable valencies and form coloured salts and complexes.
3. They are good reducing agents.
4. They form insoluble oxides and hydroxides.
5. Iron, cobalt, copper, molybdenum, and zinc are biologically important metals.
6. They catalyse biological reactions.

- **Differences:**
  Although most properties exhibited by d block elements are similar, the elements of the first row differ from second and third rows in the stabilization of higher oxidation states in their compounds.

Q. 25 A substance crystallizes in fcc structure. The unit cell edge length is 367.8 pm. Calculate the molar mass of the substance if its density is 21.5 g/cm^3.

Ans. Given: Edge length (a) = 367.8 pm = 3.678×10^{-8} cm, Density = 21.5 g/cm^3

To find: Molar mass (M)

Formula: $\text{Density } (\rho) = \dfrac{M\,n}{a^3\,N_A}$

Calculation: For an fcc lattice, number of atoms per unit cell is 4.

$\therefore n = 4$

From formula,

$$\text{Molar mass, M} = \frac{a^3 N_A \rho}{n}$$

$$M = \frac{\left(3.678 \times 10^{-8}\right)^3 \text{cm}^3 \times 6.022 \times 10^{23} \text{ atom mol}^{-1} \times 21.5 \text{g cm}^{-3}}{4 \text{ atom}}$$

Calculation using log table:

$$\frac{\left(3.678 \times 10^{-8}\right)^3 \times 6.022 \times 10^{23} \times 21.5}{4}$$

$$= \frac{(3.678)^3 \times 6.022 \times 2.15}{4}$$

$= \text{Antilog}_{10} [3 \times \log_{10} 3.678 + \log_{10} 6.022 + \log_{10} 2.15 - \log_{10} 4]$

$= \text{Antilog}_{10} [3 \times 0.5657 + 0.7797 + 0.3324 - 0.6021]$

$= \text{Antilog}_{10} [1.6971 + 0.5100]$

$= \text{Antilog}_{10} [2.2071]$

$= 161.1$

$= \mathbf{161.1 \text{ g mol}^{-1}}$

Molar mass of the substance is 161.1 g mol^{-1}.

Q. 26 Three moles of an ideal gas are expanded isothermally from 15 dm^3 to 20 dm^3 at a constant external pressure of 1.2 bar, calculate the amount of work in Joules.

Ans. Given: Initial volume (V_1) = 15 dm^3

Final volume (V_2) = 20 dm^3

External pressure (P_{ext}) = 1.2 bar

To find: Amount of work in Joules

Formula: $W = -P_{ext} \Delta V = -P_{ext} (V_2 - V_1)$

Calculation: From formula,

$W = - P_{ext} \Delta V = - P_{ext} (V_2 - V_1)$

$W = - 1.2 \text{ bar } (20 \text{ dm}^3 - 15 \text{ dm}^3)$

$= - 1.2 \text{ bar} \times 5 \text{ dm}^3 = -6 \text{ dm}^3 \text{ bar}$

Now, $1 \text{ dm}^3 \text{ bar} = 100 \text{ J}$

$$\text{Hence, } W = - 6 \text{ dm}^3 \text{ bar} \times \frac{100 \text{J}}{1 \text{ dm}^3 \text{ bar}} = - 600 \text{ J}$$

The work done is **– 600 J**.

Q. 27 | Attempt any Three:

27.i Distinguish between strong electrolyte and weak electrolyte.

Ans.

	Strong electrolyte	Weak electrolyte
1.	The electrolytes ionizing completely or almost completely are strong electrolytes.	The electrolytes which dissociate to a smaller extent in aqueous solution are weak electrolytes
2.	In strong electrolytes, there is no equilibrium between the ions and the nonionized molecules.	In weak electrolytes, an equilibrium exists between the ions and the nonionized molecules.
3.	A reaction arrow (→) between the ions and nonionized molecules of the strong electrolyte is used to represent the ionization reaction	A double arrow (⇌) between the ions and nonionized molecules of the weak electrolyte is used to represent the ionization reaction.
4.	**e.g.** Strong acids, strong bases and salts.	**e.g.** Weak acids and weak bases

27.ii Derive the equation pH + pOH = 14.

Ans. The ionic product of water is given as:

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

Now, $K_w = 1 \times 10^{-14}$ at 298 K

Thus, $[H_3O^+][OH^-] = 1.0 \times 10^{-14}$

Taking logarithm of both the sides, we write

$\log_{10}[H_3O^+] + \log_{10}[OH^-] = -14$

$-\log_{10}[H_3O^+] + \{- \log_{10}[OH^-]\} = 14$

Now, pH = $-\log_{10}[H_3O^+]$ and pOH = $-\log_{10}[OH^-]$

$\therefore$ pH + pOH = 14

Q.28 (A) What happens when chlorine reacts with?

Al

Q.28 (B) What happens when chlorine reacts with?

Na

Q.28 (C) What happens when chlorine reacts with?

S_8

Q.28 (D) What happens when chlorine reacts with?

P_4

Ans. (A) Chlorine reacts with aluminium to form aluminium chloride.

$$\underset{\text{Aluminium}}{2\,Al} + \underset{\text{Chlorine}}{3\,Cl_2} \xrightarrow{\Delta} \underset{\text{Aluminium chloride}}{2\,AlCl_3}$$

Ans. (B) Chlorine reacts with sodium to form sodium chloride.

$$\underset{\text{Sodium}}{2\,Na} + \underset{\text{Chlorine}}{Cl_2} \longrightarrow \underset{\text{Sodium chloride}}{2\,NaCl}$$

Ans. (C) Chlorine reacts with sulfur to form sulfur monochloride.

$$\underset{\text{Sulfur}}{S_8} + \underset{\text{Chlorine}}{4\,Cl_2} \longrightarrow \underset{\text{Sulfur monochloride}}{4\,S_2Cl_2}$$

Ans. (D) Chlorine reacts with phosphorus to form phosphorus trichloride.

$$\underset{\text{Phosphorus}}{P_4} + \underset{\text{Chlorine}}{6\,Cl_1} \longrightarrow \underset{\text{Phosphorus trichloride}}{4\,PCl_3}$$

Q. 29. (A) Write two applications of lanthanoids.

Q. 29. (B) Write two applications of actinoids.

Ans. (A)

1. The lanthanoid compounds are present in every household. It is inside the colour television tubes. When electrons are bombarded on certain mixed lanthanoid compounds, they emit visible light over a small wavelength range. Therefore, the

inside surface of a television tube or computer monitor is coated with tiny patches of three different lanthanoid compositions to give three colours that make the colour image.
For example, a mixed oxide of europium and yttrium $(Eu, Y)_2O_3$ releases an intense red colour when bombarded with high energy electrons.

2. The optoelectronics applications use lanthanoid ions as active ions in luminescent materials. The most notable application is the Nd: YAG laser (Nd: YAG = neodymium-doped yttrium aluminium garnet).
3. Erbium-doped fibre amplifiers are significant devices in optical fibre communication systems.
4. Lanthanoids are used in hybrid cars, superconductors and permanent magnets.

Ans. (B)

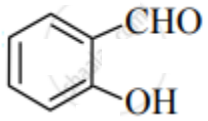
1. The half-lives of natural thorium and uranium isotopes are so long that we get very negligible radiation from these elements. So, we find them in everyday use.
2. Th(IV) oxide, ThO_2 with 1% CeO_2 was used as a major source of indoor lighting before incandescent lamps came into existence only because these oxides convert heat energy from burning natural gas to intense light. Even today, there is a great demand for these lights for outdoor camping.

Q. 30. (A) Draw structure of salicylaldehyde.

Q. 30. (B) Write reaction for preparation of acetophenone from benzoyl chloride.

Q. 30. (C) Explain the acidic nature of carboxylic acids.

Ans. (A)

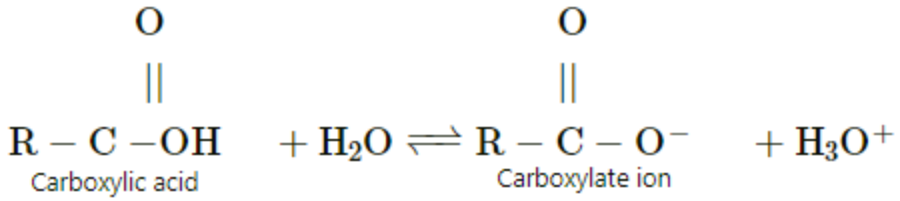


Ans. (B)

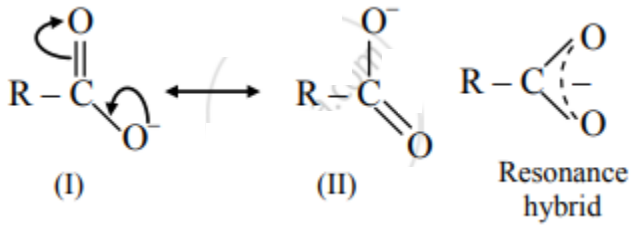
$$\underset{\text{Benzoyl chloride}}{2\,C_6H_5-COCl} + \underset{\text{Dimethyl cadmium}}{(CH_3)_2Cd} \longrightarrow \underset{\text{Acetophenone}}{C_6H_5-CO-CH_3} + CdCl_2$$

Ans. (C) Acidic nature of carboxylic acids:

i. The carboxyl group (–COOH) imparts an acidic character to carboxylic acids.
ii. A carboxyl group is made of –OH group bonded to a carbonyl group.
iii. In aqueous solution, the H atom in OH of carboxyl group dissociates as proton and carboxylate ion is formed as the conjugate base,



i. Carboxylate ion is resonance stabilized by two equivalent resonance structures as shown below.



ii. Carboxylate ion has two resonance structures (I) and (II) and both of them are equivalent to each other.

iii. This gives good resonance stabilization to carboxylate ion, which in turn gives an acidic character to carboxylic acids.

Q. 31 Explain the reactions involved in the preparation of viscose rayon.

Ans.

i. Viscose rayon is a semisynthetic fibre which is regenerated cellulose.

ii. Cellulose in the form of wood pulp is transformed into viscose rayon. Cellulose is a linear polymer of glucose units and has the molecular formula $[(C_6H_{10}O_5)_n]$. A modified representation of the molecular formula of cellulose is Cell-OH.

iii. **Method of preparation:**
a. Cellulose in the form of wood pulp is treated with concentrated NaOH solution to get fluffy alkali cellulose.
b. It is then converted to xanthate by treating with carbon disulphide.
c. On mixing with dilute NaOH, it gives viscose solution which is extruded through spinnerets of the spinning machine into the acid bath when regenerated cellulose fibres precipitate.

iv. Reactions involved in the preparation of viscose rayon:

$$\underset{\text{(Cellulose pulp wood)}}{\text{Cell} - \text{OH} + \text{NaOH}} \longrightarrow \underset{\text{(Akali cellulose)}}{\text{Cell} - \text{O}^- \text{Na}^+} + \text{H}_2\text{O}$$

$$\text{Cell} - \text{O}^- \text{Na}^+ + \text{CS}_2 \longrightarrow \underset{\text{(Cellulose xanthate)}}{\text{Cell} - \text{O} - \overset{\overset{\text{S}}{\|}}{\text{C}} - \text{S}^- \text{Na}^+}$$

$$\text{Cell} - \text{O} - \overset{\overset{\text{S}}{\|}}{\text{C}} - \text{S}^- \text{Na}^+ + \text{H}_2\text{O} \longrightarrow \text{Cell} - \text{O} - \overset{\overset{\text{S}}{\|}}{\text{C}} - \text{SH} + \text{NaOH}$$

$$\text{Cell} - \text{O} - \overset{\overset{\text{S}}{\|}}{\text{C}} - \text{SH} + \text{H}_2\text{O} \longrightarrow \underset{\text{(Viscose rayon)}}{\overset{\overset{\text{S}}{\|}}{\text{Cell} - \text{OH}}} + \underset{\text{(Regenerated cellulose filaments)}}{\text{CS}_2}$$