Chemistry [Set 1]

Academic Year: 2017-2018 Marks: 70
Date: July 2018

All questions are compulsory.

1. Answers of both the sections should be written in same answer book.
2. Draw well labelled diagrams and write balanced equations wherever necessary.
3. Figures to the right indicate full marks.
4. Use of logarithmic table is allowed.
5. Every new question must be started on a new page.

Section 1

Question 1: Attempt any Six **[12]**

Question 1.i: What is the role of the following compound - **[2]**
CaF_2 in metallurgy of aluminum?

Solution: Role CaF_2 in metallurgy of aluminum:

1. CaF_2 makes alumina a good conductor of electricity.
2. It lowers the fusion temperature to around 1140 K.

Question 1.ii: Classify the following molecular solids into different types: **[2]**

a. HCl
b. CO_2
c. Solid ice
d. SO_2

Solution:

	Molecular solid	Type
a.	HCl	Polar molecular solid
b.	CO_2	Non-polar molecular solid
c.	Solid ice	Hydrogen bonded molecular solid
d.	SO_2	Polar molecular solid

Question 1.iii: Define the following terms : **[2]**
a. Cryoscopic constant
b. Resistivity

Solution: Cryoscopic constant:
Molal depression constant or cryoscopic constant is the depression in the freezing point of a solution containing one mole of the non - volatile solute in one kilogram of solvent.

Resistivity or specific resistance:
Resistivity is defined as the resistance of the conductor that is 1 m long and 1 m^2 in cross-sectional area.

Question 1.iv: Arrange the following oxyacids of chlorine in decreasing order of their thermal stability. Give reason. **[2]**
HOClO, HOCl, $HClO_4$, $HOClO_2$

Solution: Decreasing order of thermal stability of oxoacids of chlorine:
$HClO_4 > HClO_3 > HClO_2 > HClO$

Reason: With the decrease in the oxidation state of chlorine, the oxidizing power of its oxoacids increases and the thermal stability of oxoacids of chlorine decreases.

Question 1.v: Derive van't Hoff general solution equation **[2]**

Solution:
a. According to van't Hoff-Boyle's law, osmotic pressure of a dilute solution is inversely proportional to the volume containing 1 mole of solute at constant temperature and according to van't Hoff-Charles' law, osmotic pressure of a dilute solution is directly proportional to the absolute temperature, at constant concentration.

b. If π is the osmotic pressure, V is the volume of the solution and T is the absolute temperature, then

$\pi \propto \frac{1}{V}$ ...(1) ...[van't Hoff-Boyle's law at constant temperature]

$\therefore \pi V$ = constant

$\pi \propto T$ .....(2) ...[van't Hoff-Charles' law at constant concentration]

$\therefore \frac{\pi}{T}$ = constant

c. Combining (1) and (2) we get,

$\pi \propto \frac{T}{V}$

$\therefore \pi$ = Constant x $\frac{T}{V}$

$\therefore \pi V = R'T$, where R' is a constant.

d. This equation is parallel to the ideal gas equation PV = RT (n = 1)

d. This equation is parallel to the ideal gas equation PV = RT (n = 1)

Since, the calculated value of R' is almost same as R, the equation can be written as πV = RT (for 1 mole of solute)

e. This equation was derived for 1 mole of solute dissolved in V dm^3. If n moles of solute are dissolved in V dm^3 of solution, the equation becomes

πV = nRT

$\therefore \pi = \frac{nRT}{V}$

f. $C = \frac{n}{V}$

$\therefore \pi = CRT$

where,

π = osmotic pressure,

C = concentration of solution in moles/litre

R = gas constant = 0.082 L atm mol^{-1} K^{-1} or 8.314 J mol^{-1} K^{-1}

T = absolute temperature

n = number of moles of solute,

V = volume of the solution.

Question 1.vi: **[2]**

Represent a cell consisting of Mg^{2+} | Mg half cell and Ag^+ | Ag half cell and write the cell reaction.

$(E_{Ag} = 0.799V, E_{Mg} = -2.37V)$

Solution: The given data indicates that Mg undergoes oxidation and Ag^+ undergoes reduction. Hence, cell reaction is

$Mg(s) \rightarrow Mg^{2+}_{aq} + 2e^-$ ...(Oxidation half reaction at anode)

$2Ag^+_{aq} + 2e^- \rightarrow 2Ag_s$ ...(Reduction half reaction at cathode)

$Mg_s + 2Ag^+_{aq} \rightarrow Mg^2_{aq} + +2Ag_s$ ...(Overall cell reaction)

The cell representation is

$Mg_s|Mg^{2+}_{aq}(\times M)||Ag^+_{aq}(yM)|Ag_s$

Question 1.vii: Define the order of the chemical reaction. **[2]**

Solution: Order of chemical reaction:

The order of a chemical reaction with respect to each reactant is defined as the exponent to which the concentration term of that reactant, in the rate law, is raised.

OR

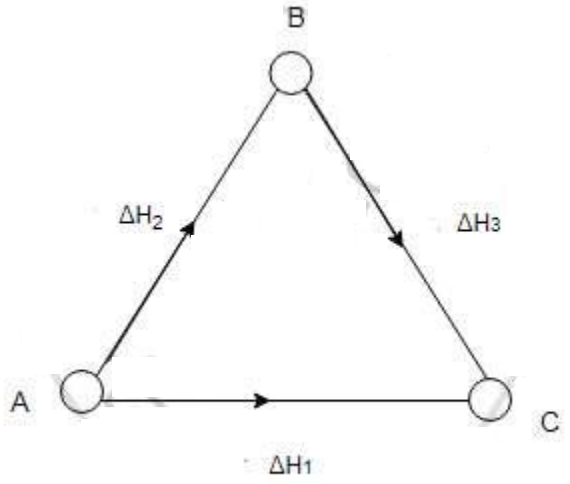
The overall order of the reaction is defined as the sum of the exponents to which the concentration terms in rate law are raised.

Question 1.viii: State and explain Hess's law of constant heat summation. **[2]**

1. **Solution: Hess's law** of constant heat summation states that," The change in enthalpy for a reaction is the same whether the reaction takes place in one or a series of steps".

2. The Hess's law is a direct consequence of fact that the enthalpy is a state function and so enthalpy change depends only on the initial and final states of the system and not on the path by which the reaction takes place.
   eg. The conversion of A to C can take place directly in a single step.
   $A \rightarrow C, \quad \Delta H^\circ = \Delta H_1$

3. The reaction can also take place in two steps for which ΔH° values are known.
   Step (1) $A \rightarrow B, \quad \Delta H^\circ = \Delta H_2$
   Step (2) $B \rightarrow C, \quad \Delta H^\circ = \Delta H_3$
   ———————————————
   Overall $A \rightarrow C, \quad \Delta H^\circ = \Delta H_2 + \Delta H_3$
4. According to Hess's law, $\Delta H_1 = \Delta H_2 + \Delta H_3$.
   The sequence of steps is represented in the figure.



Hess's law

Question 2. Attempt any THREE **[9]**

Question 2.i: Explain the following with the help of balanced chemical equation: **[3]**
a. Bleaching action of SO_2.

b. Dehydration of formic acid by concentrated H_2SO_4.
c. Burning of benzene in presence of excess of dioxygen.

Solution: a. Bleaching action of SO_2:
SO_2 is used as a bleaching agent in presence of moisture. It bleaches due to reduction and bleaching action is temporary.

$$\underset{\text{Sulphur dioxide}}{SO_2} + 2\,\underset{\text{water}}{H_2O} \longrightarrow \underset{\text{Sulphuric acid}}{H_2SO_4} + 2\,(H)$$

b. Dehydration of formic acid by concentrated H_2SO_4:

Concentrated H_2SO_4 acts as a powerful dehydrating agent due to strong affinity for water.

$$\underset{\text{Formic acid}}{HCOOH} \xrightarrow{\text{Conc. } H_2SO_4} \underset{\text{Carbon monoxide}}{CO} + \underset{\text{Water}}{H_2O}$$

c. Burning of benzene in presence of excess of dioxygen:

Combustion of benezene in excess of dioxygen (air) results in the formation of carbon dioxide and water.

$$\underset{\text{Benzene}}{C_6H_6} + \underset{\text{Dioxygen}}{\frac{15}{2}\,O_2} \longrightarrow \underset{\text{Carbon dioxide}}{6\,CO_2} + \underset{\text{Water}}{3\,H_2O}$$

Question 2.ii: The density of silver having an atomic mass of 107.8 g mol^{-1} is 10.8 g cm^{-3}. If the edge length of cubic unit cell is 4.05×10^{-8} cm, find the number of silver atoms in the unit cell. ($N_A = 6.022 \times 10^{23}$, 1 Å = 10^{-8} cm) **[3]**

Solution:

Given:
Density (d) = 10.8 g cm^{-3}
Edge length (a) = 4.05×10^{-8} cm
Molar mass = 107.8 g mol^{-1}
Avogadro's number (N_A) = 6.022×10^{23}

To find:
Number of atoms in the unit cell

Formula:

a. Mass of one atom = $\frac{\text{Atomic mass}}{\text{Avogadro number}}$

b. Volume of unit cell = a^3

c. Density = $\frac{\text{Mass of unit cell}}{\text{Volume of unit cell}}$

Calculation:

a) Mass of one Ag atom = $\frac{\text{Atomic mass of Ag}}{\text{Avogadro number}}$

Avogadro number

$= \frac{107.8}{6.022 \times 10^{23}}$

$= 1.79 \times 10^{-22}$ g

b) Volume of unit cell = a^3

$= (4.05 \times 10^{-8})^3$

$= 6.64 \times 10^{-23}$ cm^3

c)

Density (d) = $\frac{\text{Mass of unit cell}}{\text{Volume of unit cell}}$

$= \frac{\text{Number of atoms in unit cell x Mass of one atom}}{\text{Volume of unit cell}}$

$10.8 = \frac{\text{Number of atoms in unit cell} \times 1.79 \times 10^{-22}}{6.64 \times 10^{-23}}$

Number of atoms in unit cell = $\frac{10.8 \times 6.64 \times 10^{-23}}{1.79 \times 10^{-22}}$

$= 40.06 \times 10^{-1} = 4.0 \approx 4$

∴ The number of atoms in the unit cell of silver is 4.

Question 2.iii: How much quantity of electricity in coulomb is required to deposit 1.346×10^{-3} kg of Ag in 3.5 minutes from $AgNO_3$ solution? **[3]**
(Given: Molar mass of Ag is 108×10^{-3} kg mol^{-1})

Solution: Given:
Mass of Ag deposited = 1.346×10^{-3} kg
Time (t) = 3.5 min = 3.5 x 60s
Molar mass of Ag = 108×10^{-3} kg mol^{-1}

To find:
Quantity of electricity required in coulomb:

Formulae:

1. Mole ratio = $\frac{\text{Moles of product formed in half reaction}}{\text{Moles of electrons required in half reaction}}$

2. Mass of the substance produced = $\frac{\text{I(A)} \times \text{t(s)}}{96500(\text{C/mol e-}) \times \text{Mole ratio} \times \text{Molar mass of substance}}$

3. Quantity of electricity in coulomb (Q) = I (in amp) x t(in sec)

Calculation:

The half reaction for the formation of Ag is,

$Ag_{(aq)}^{+} + e^{-} \longrightarrow Ag_{(s)}$

From formula (1),

Mole ratio = $\frac{\text{Moles of Ag}}{\text{Moles of electrons}}$

= $\frac{1(\text{mol Ag})}{1(\text{mol}e^{-})}$

= 1 mol Ag/mol e^{-}

From formula (2),

1.346×10^{-3}

$= \frac{I \times 3.5 \times 60}{96500} \times 1 \times 108 \times 10^{-3}$

$\therefore I = \frac{1.346 \times 10 - 3 \times 96500}{3.5 \times 60 \times 108 \times 10^{-3}}$

$= \frac{129889 \times 10^{-3}}{22680 \times 10^{-3}}$

= 5.727 A

From formula (3),

Q = It = 5.727 x 3.5 x 60 = 1202.67 C

∴ The quantity of electricity required is 1202.67 C.

Question 2.iv: 5 moles of helium expand isothermally and reversibly from a pressure 40 × 10^{-5} N m^{-2} to 4 × 10^{-5} N m^{-2} at 300 K. Calculate the work done, change in internal energy and heat absorbed during the expansion. (R = 8.314 J K^{-1} mol^{-1}). **[3]**

Solution: Given:
Number of moles of helium gas (n) = 5
Initial pressure (P_1) = 40 x 10^{-5} Nm^{-2}

Final pressure (P_2) = 4 x 10^{-5} Nm^{-2}
Temperature (T) = 300 K
R = 8.314 J K^{-1} mol^{-1}

To find:

a. Work done (W)

b. Change in internal energy (ΔU)

c. Heat absorbed (q)

Formulae:

a. $W_{max} = -2.303\ nRT \log 10 \frac{P_1}{P_2}$

b. $\Delta U = q + W$

Calculation:

a. From formula (a),

$W_{max} = -2.303\ nRT \log 10 \frac{P_1}{P_2}$

$= -2.303 \times 5 \times 8.314 \times 300 \frac{\log_{10}(40 \times 10^{-5})}{4 \times 10^{-5}}$

$= -2.303 \times 5 \times 8.314 \times 300 \log_{10} 10$

$= -28720.71$ J

$= -28.72$ kJ

∴ Work done (W) = - 28.72 KJ

b. Form formula (b),
According to first law of thermodynamics, ΔU = q + W
In isothermal process, ΔT = 0, hence ΔU = 0.
∴ Change in internal energy (ΔU) = 0

c. From formula (b),
0 = q + W
∴ q = - W
= - (- 28.72 kJ)
= 28.72 kJ
∴ Heat absorbed (q) = 28.72 kJ.

Question 3: Answer the following: **[7]**

Question 3.i: Write structure and molecular formula for the following compounds: [2]

a. Orthophosphoric acid

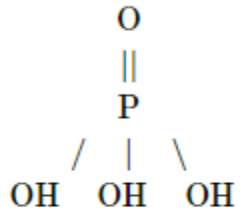
b. Sulphurous acid

Solution:

a. Orthophosphoric acid:

Molecular formula: H_3PO_4

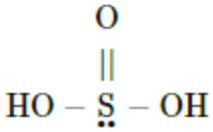
Structural formula:



b. Sulphurous acid:

Molecular formula: H_2SO_3

Structural formula:



Question 3.ii: What is the 'Ellingham diagram'? Write any 'two points' of its significance. [2]

Solution: Ellingham diagram:

The graphical representation showing the variation of Gibbs energy with increase of temperature for the formation of oxide (oxidation) is known as Ellingham diagram.

OR

The Ellingham diagram is the plot of free energy change $\Delta G°$ against temperature for the reaction of metal and other elements with one mole of gaseous oxygen at 1 atmosphere.

Significance of Ellingham diagram:

1. The positive slope of metal oxides shows that their stabilities decrease with increase in temperature. The decrease in their stabilities is due to an increase in $\Delta G°$ value.

2. The sudden change in the graph shows a phase change, that is, change from solid to liquid or from liquid to vapour.

3. The negative slope of CO shows that it becomes more stable with increase in temperature (this is the opposite of that taking place in metal oxides).

4. The relative tendency of the metals to undergo oxidation is in the order, as shown below:
   Mg > Al > Cr > Fe > Hg > Ag.
   This is due to the increase in the negative free energy change of the formation of oxide in the order given below:
   MgO > Al_2O_3 > Cr_2O_3 > FeO > Ag_2O.

Question 3.iii: In a first-order reaction A → product, 80% of the given sample of compound decomposes in 40 min. What is the half-life period of the reaction? **[2]**

Solution: Given:
Reaction type = first order
The percentage of substance decomposed = 80 %
Time taken to decompose (t) = 40 min

To find:
Half life period ($t_{1/2}$)

Formulae:

1. $k = \frac{2.303}{t} \log_{10} \frac{a}{a-x}$

2. $k = \frac{0.693}{t_{\frac{1}{2}}}$

Calculation:

80 % decomposition means, x = 80 % of a = 0.80a

As the reaction is 1st order, from formula (1),

$$k = \frac{2.303}{t} \log_{10} \frac{a}{a-x}$$

$$= \frac{2.303}{40} \log_{10} \frac{a}{a-0.8a}$$

$$= \frac{2.303}{40} \log_{10} \frac{1}{0.2}$$

$$= \frac{2.303}{40} \times 0.6990$$

$= 4.02 \times 10^{-2}\ min^{-1}$

For first order reaction, from formula (2),

$$t_{\frac{1}{2}} = \frac{0.693}{k} = \frac{0.693}{4.02 \times 10^{-2}} = 17.24 \text{ min}$$

∴ The half life period ($t_{1/2}$) of the reaction is 17.24 min.

OR

Question 3.iv: Answer the following: [2]

Write features of a reversible process.

Solution: Features of a reversible process:

1. The driving and opposing forces differ from each other, only infinitesimally.
2. During the course of the process, it can be reversed at any point, by making infinitesimal change in conditions.
3. The process takes place in an infinite number of steps.
4. The system attains mechanical equilibrium at the end of every step of the process.
5. A reversible process results in obtaining maximum work.
6. The process takes place so slowly that, the system is always in temperature-pressure equilibrium with its surroundings.

Question 3.v: Write any 'four points' of difference between fluorine and other halogens. [2]

Solution:

	Fluorine	**Other halogens**
Reactivity	Fluorine is much more reactive due to its small atomic size, high nuclear charge and low F - F bond dissociation energy	Other halogens are less reactive than fluorine.
Hydrogen bonding	Hydrogen bonding is present in hydrides of fluorine.	Hydrogen bonding is not present in hydrides of other halogens.
Oxidation state	Due to the highest electronegativity and absence of the vacant d-orbitals in the valence shell, fluorine shows only -1 oxidation state in all its compounds.	Other halogens show -1, + 1, + 3, +5 and + 7 oxidation states.
Polyhalide ions	Due to absence of vacant d-orbitals in the valence shell, fluorine does not form any polyhalide ion.	Other halogens form polyhalide ions such as I_3^-, Br_3^-, Cl_3^-.

Question 3.vi: What is the freezing point of a liquid? The freezing point of pure benzene is 278.4 K. Calculate the freezing point of the solution when 2.0 g of a solute having molecular weight 100 g mol^{-1} [3]
is added to 100 g of benzene.
(K_f of benzene = 5.12 K kg mol^{-1}.)

Solution: a) Freezing point: The freezing point of a liquid may be defined as the temperature at which the vapour pressure of solid is equal to the vapour pressure of liquid. A liquid freezes at a temperature at which the liquid and its solid coexist in equilibrium.

b) Solution:
Given:
Freezing point of pure solvent (T°) = 278.4 K
Mass of solute (W_2) = 2 g = 2 x 10^{-3} kg
Molar mass of solute (M_2) = 100 g mol^{-1} = 100 x 10^{-3} kg mol^{-1}
Mass of solvent (W_1) = 100 g = 100 x 10^{-3} kg
Molal depression constant (K_f)= 5.12 K kg mol^{-1}.

To find: Freezing point of solution (T)

Formulae:
1. $\Delta T_f = T° - T$

2. $\Delta T_f = \frac{K_f W_2}{M_2 W_1}$

Calculation:

From formula (2),

$$\Delta T_f = \frac{K_f W_2}{M_2 W_1}$$

$$\Delta T_f = \frac{5.12 \times 2 \times 10^{-3}}{100 \times 10^{-3} \times 100 \times 10^{-3}}$$

$$= \frac{5.12 \times 2}{10}$$

= 1.024 K

From formula (1),

$\Delta T_f = T° - T$

$\therefore T = T° - \Delta T_f$

$\therefore T = 278.4 - 1.024 = 277.376$ K

∴ Freezing point of the given benzene solution is 277.376 K.

Question 4: Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

Question 4.i: A substance which shows the highest entropy is _____. **[1]**

$SrCO_{3(s)}$
$Cu_{(s)}$
$NaCl_{(aq.)}$

$Cl_{2(g)}$

Solution: A substance which shows the highest entropy is **$Ch_{(g)}$**.

$Ch_{(g)}$ shows the highest entropy among the given substances due to its gaseous state.

Question 4.ii: The process of extracting a soluble material from an insoluble solid by dissolving out in a suitable solvent is known as _____. **[1]**

calcination
roasting
leaching
smelting

Solution: The process of extracting a soluble material from an insoluble solid by dissolving out in a suitable solvent is known as **leaching**.

Question 4.iii: **[1]**

The kinetic order for the following reaction is _____.

$$2\,N_2O_{(g)} \xrightarrow{Pt} 2\,N_{2(g)} + O_{2(g)}$$

zero
first
second
third

Solution: The kinetic order for the following reaction is **zero.**

The decomposition of N_2O on platinum surface follows zero order kinetics. Most of the N_2O molecules (which remain in gaseous phase) are unreactive while those which occupy all the active sites on metal surface take part in reaction. Thus, the reaction rate is independent of total concentration of N_2O.

Question 4.iv: Which of the following compounds of chlorine is used as refrigerant? **[1]**

CCl_3NO_2
CCl_2F_2
$COCl_2$
CCl_4

Solution: CCl_2F_2

Question 4.v: 4.0 grams of NaOH (Molar mass = 40.0 g mol^{-1}) is dissolved in 500 cm^3 of water. What is the molarity of NaOH solution? **[1]**

1 M
0.8 M
0.5 M

0.2 M

Solution:

0.2 M

$$\text{Molarity} = \frac{4}{40 \times 0.5} = \frac{1}{5} = 0.2\text{M}$$

Question 4.vi: Number of types of orthorhombic unit cell is _____. **[1]**

7
3
4
2

Solution: Number of types of orthorhombic unit cell is **4.**

Four types of orthorhombic unit cell are:

1. Primitive or simple orthorhombic
2. Body centred orthorhombic
3. End centred orthorhombic
4. Face centred orthorhombic

Question 4.vii: The S.I. unit of cell constant for conductivity cell is _____. **[1]**

m^{-1}
S m^{-2}
cm^{-2}
S dm^2 mol^{-1}

Solution: The S.I. unit of cell constant for conductivity cell is **m^{-1}**.

SECTION II

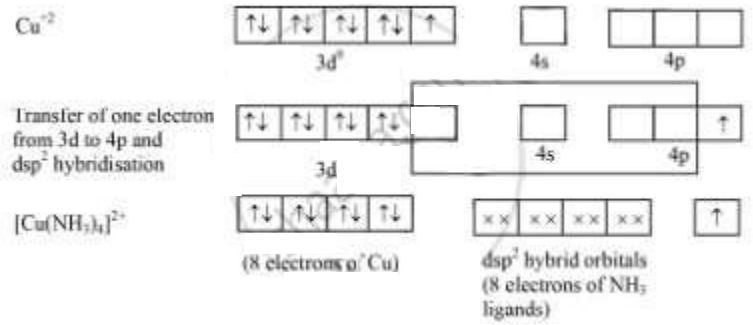
Question 5: Attempt any SIX: **[12]**

Question 5.i: Explain the geometry of $[Cu(NH_3)_4]^{2+}$ on the basis of hybridisation [At. No. Cu = 29]. **[2]**

Solution:

a. The oxidation state of Cu in $[Cu(NH_3)_4]^{2+}$ is + 2. The electronic configuration of Cu^{2+} is $3d^9 4s^0$.
b. dsp^2 hybridisation of one d, one s and two p orbitals result in square planar geometry.

c. Coordinate bonds are formed by overlap of metal dsp2 hybrid orbitals.



d. Due to presence of one unpaired electron, $[Cu(NH_3)_4]^{2+}$ is paramagnetic. The magnetic moment, μ is 1.73 B.M.

Question 5.ii: What are 'd' and 'f' block elements? **[2]**

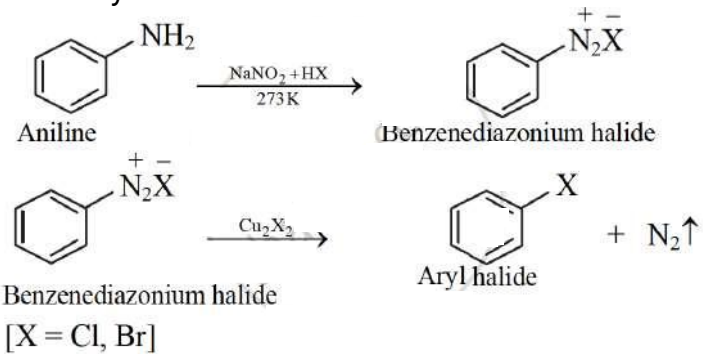
Solution:

a. **d - Block elements:** The elements in which the last electron enters the d - orbital of the penultimate shell i.e; (n - 1)d - orbital, where, 'n' is the outermost shell, are called d-block elements.

b. **f - Block element:** The elements in which the last electron enters into (n - 2) f - orbital of the atoms are called f - block elements.

Question 5.iii: Write a short note on Sandmeyer's reaction. **[2]**

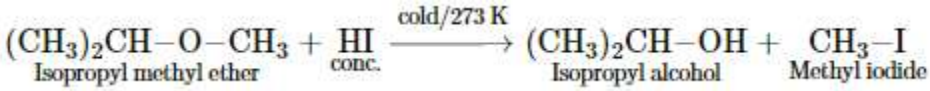
Solution: Sandmeyer's reaction:
When a primary aromatic amine, dissolved or suspended in aqueous mineral acid, is treated with sodium nitrite, a diazonium salt is formed. Mixing solution of freshly prepared diazonium salt with cuprous chloride or cuprous bromide, results in the replacement of the diazonium group by - Cl or - Br. This reaction is known as Sandmeyer' s reaction



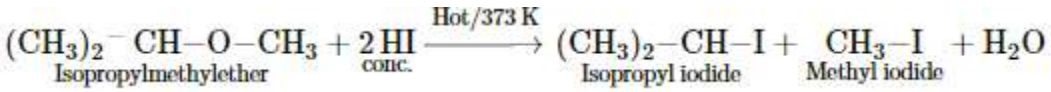
eg.

Question 5.iv: What is the action of the following on isopropyl methyl ether? [2]
a. Cold HI
b. Hot HI

Solution: (A) Action of cold HI on isopropyl methyl ether:
When isopropyl methyl ether (mixed ether) is reacted with cold and conc. HI, methyl iodide (lower alkyl halide) and isopropyl alcohol (higher alcohol) is formed.

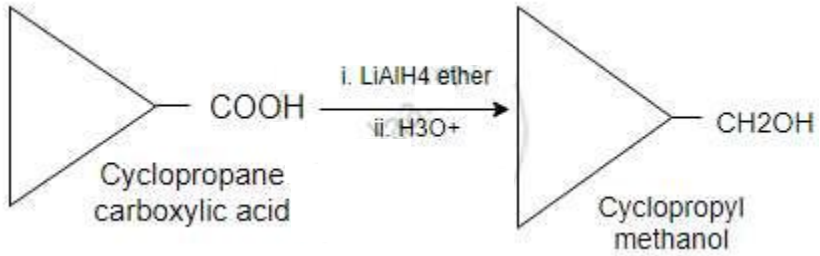


(B) Action of hot HI on isopropyl methyl ether:
When isopropyl methyl ether (mixed ether) is reacted with hot and conc. HI at about 373 K, a mixture of isopropyl iodide and methyl iodide is obtained due to cleavage of both C - O bond.

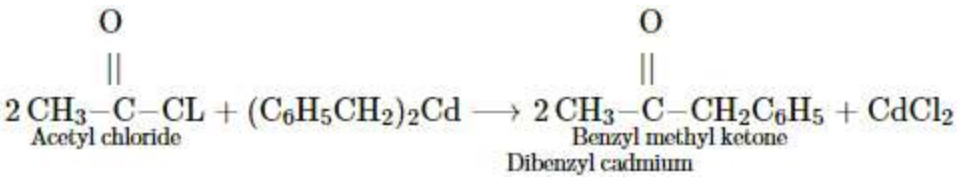


Question 5.v: Write balanced equation for the following conversion: [2]
a. Cyclopropane carboxylic acid to cyclopropylmethanol.
b. Acetyl chloride to benzyl methyl ketone using dialkyl cadmium.

Solution: a. Cyclopropane carboxylic acid to cyclopropyl methanol:
Strong reducing agent like lithium aluminium hydride or diborane reduces cyclopropane carboxylic acid to cyclopropyl methanol.



b. Acetyl chloride to benzyl methyl ketone using dialkyl cadmium:

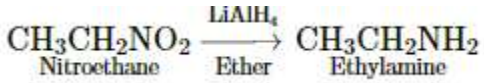


Question 5.vi: What is the action of lithium aluminum hydride in the presence of ether on the following compounds? [2]

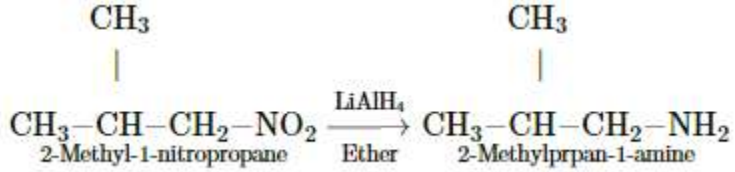
a. Nitroethane

b. 2-Methyl-1-nitropropane

Solution: a. Nitroethane is reduced to ethylamine by the action of lithium aluminium hydride in the presence of ether.



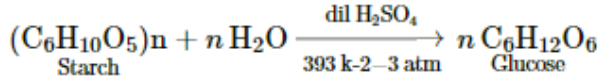
b. 2 - Methyl - 1 - nitropropane is reduced to 2 - methylpropan - 1 - amine by the action of lithium aluminium hydride in the presence of ether.



Question 5.vii: How is glucose prepared from starch? [2]

Solution: Preparation of glucose from starch:

1. Commercially, glucose is obtained on a large scale by hydrolysis of starch, by boiling at 393 K with dilute sulphuric acid under pressure.



2. Excess sulphuric acid is neutralized by adding chalk powder.
3. Activated charcoal is used for the removal of coloured impurities.
4. The solution is cooled, resulting in the separation of glucose crystals, which are filtered and removed.

Question 5.viii: Define: [2]

a. Analgesics

b. Antimicrobials

Solution: a. Analgesics: The drugs which relieve pain by acting on the central nervous system without loss of consciousness or disturbance of the nervous system are called analgesics.

b. Antimicrobials:
The drugs used to kill or stop the growth of micro-organisms like fungi, bacteria, and virus are called antimicrobial drugs.

Question 6: Attempt any THREE [9]

Question 6.i: Complete and rewrite the balanced chemical equation for the following reactions: [3]

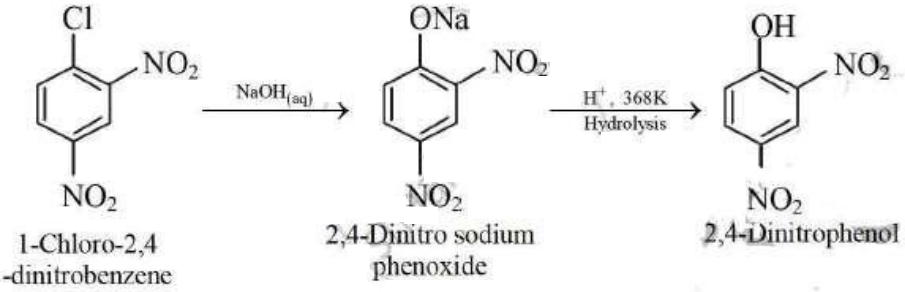
a. 1-chloro-2, 4-dinitrobenzene $\xrightarrow[368\ K,\ H^+]{aq\cdot alkali}$?

b. Benzaldehyde $\xrightarrow{50\%\ KOH}$?

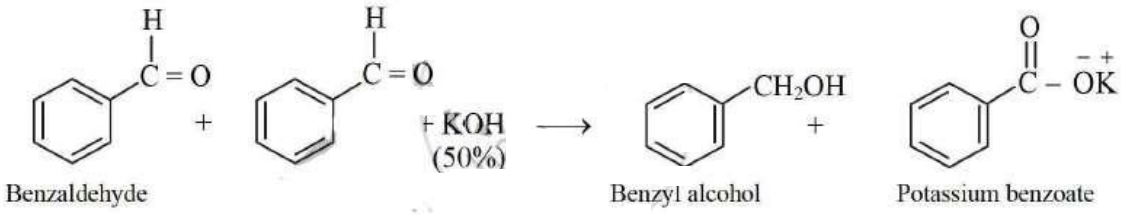
c. Acetone + phenylhydrazine $\xrightarrow{H^+}$?

Solution:

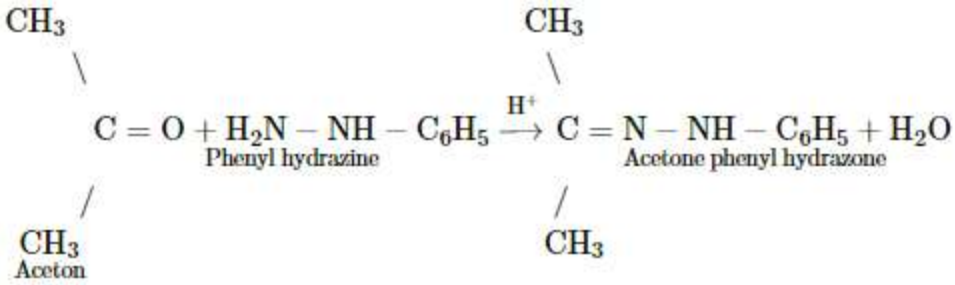
a. When l-chloro-2, 4-dinitrobenzene is heated with aqueous alkali (aq. NaOH), 2, 4-dinitro sodium phenoxide is formed which on hydrolysis with dilute HCl gives 2, 4-dinitrophenol.



b. Two molecules of benzaldehyde react in the presence of 50‰ KOH, the products formed are benzyl alcohol and potassium benzoate. The reaction is called cannizzaro reaction.



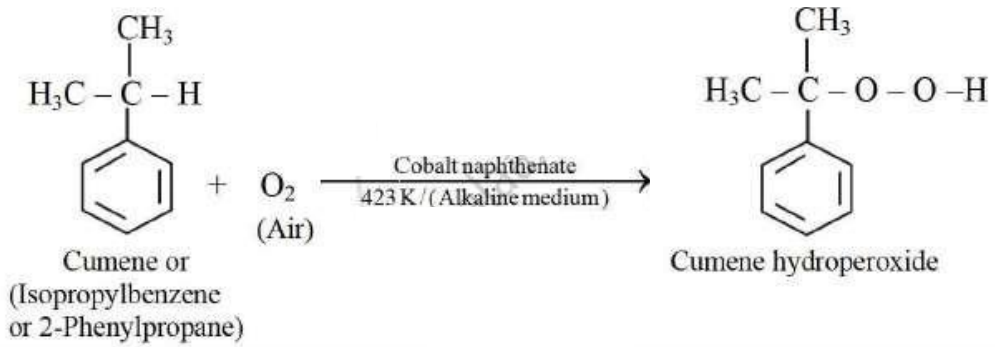
c. Acetone reacts with phenyl hydrazine to give addition product which on dehydration gives acetone phenyl hydrazone. This reaction occurs in the presence of an acid catalyst.



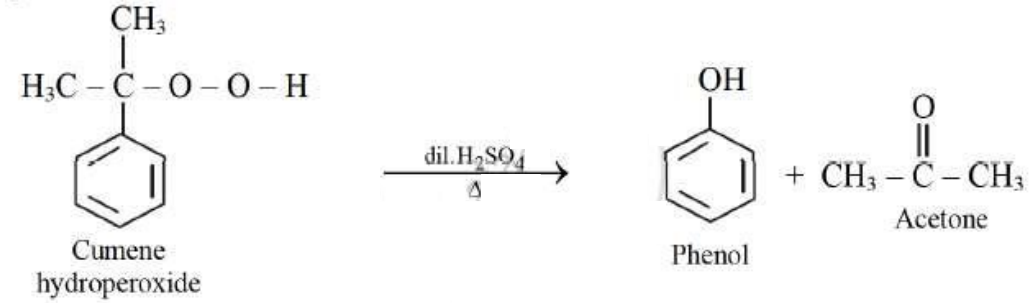
Question 6.ii: Write a preparation of phenol from cumene? What happens when phenol is heated with zinc dust? **[3]**

Solution: a. Preparation of phenol from cumene:

1. When an alkaline solution of cumene (isopropylbenzene or 2-phenylpropane) in sodium carbonate is oxidised by passing air or oxygen in the presence of cobalt naphthenate as a catalyst at 423 K, cumene hydroperoxide is obtained.

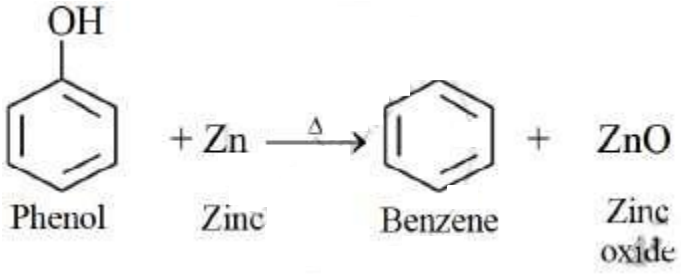


2. Auto oxidation:
Cumene hydroperoxide on heating with dilute H_2SO_4 decomposes forming phenol and acetone.



In this method, acetone is obtained as an important byproduct which is separated by distillation.

b. Heating of phenol with zinc dust:
When phenol is heated with zinc dust, benzene is formed.



Question 6.iii: What are racemates? **[3]**

Solution: Racemic mixture or Racemates:
A mixture of equimolar amounts of dextro and laevo rotatory forms of same optically active substance is called racemic mixure or racemates. It is optically inactive due to external compensation. It is represented as (±) or 'dl'.
eg. dl - lactic acid or (±)- lactic acid.

Question 6.iv: What are elastomers? **[3]**

Solution: Elastomers: The polymers that have elastic character like that of rubber are called elastomers
e.g. Neoprene

Question 7: Answer the following: **[7]**

Question 7.i: What is the action of the following on lanthanoids? **[2]**
a. water
b. Sulphur, heat
c. nitrogen, heat

Solution:

a. **Action of water on lanthanoids:** Reaction of water with lanthanoids gives ionic and basic lanthanide hydroxides ($Ln(OH)_3$) with liberation of H_2 gas.
$Ln + 3H_2O \rightarrow Ln(OH)_3 + 3H_2$

b. **Action of sulphur on lanthanoids:** Heating of sulphur with lanthanoids gives lanthanide sulphide (Ln_2S_3).

$$2\,Ln + 3\,S \xrightarrow{\Delta} Ln_2S_3$$

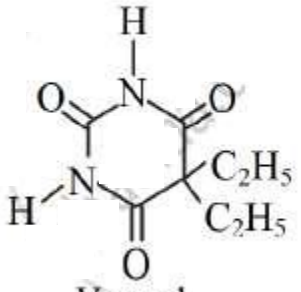
c. **Action of nitrogen on lanthanoids:** Reaction of nitrogen with lanthanoide gives lanthanide nitride (LnN).

$$2\,Ln + N_2 \xrightarrow{\Delta} 2\,LnN$$

Question 7.ii: Draw the structures of veronal and thymine. **[3]**

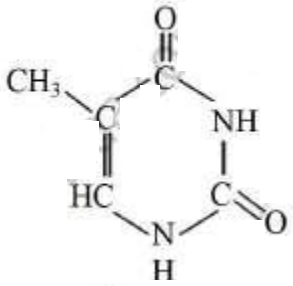
Solution:

Structure of veronal



Veronal

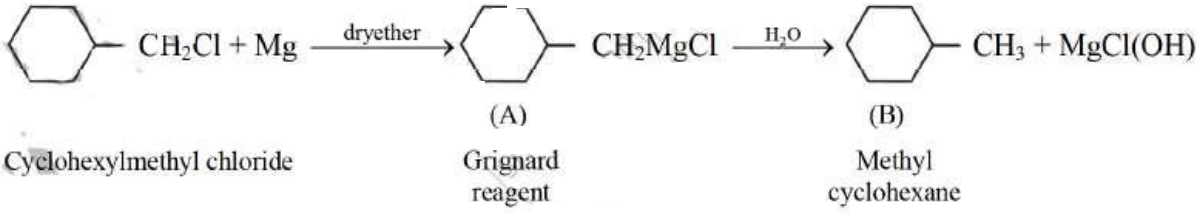
Structure of thymine



Thymine (T)

Question 7.iii: Identify A and B from the following reaction and rewrite complete reaction: [3]

Solution:



OR

Question 7.iv: Write the preparation of benzoic acid from the following: [3]

a. styrene

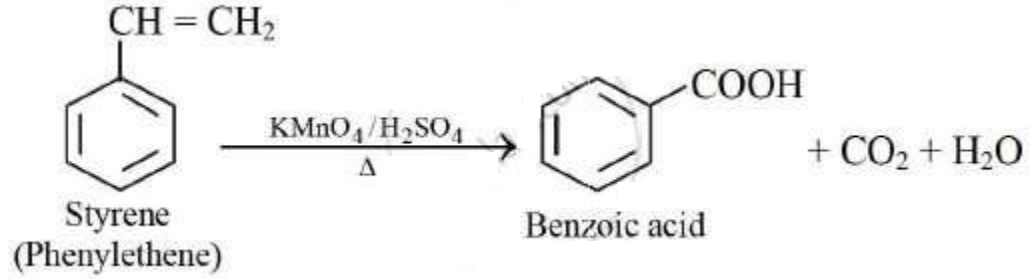
b. benzamide

c. dry ice

Solution: a. Preparation of benzoic acid from styrene:

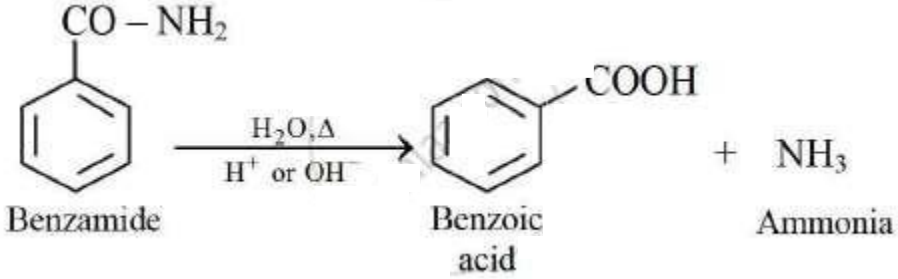
Acidic potassium dichromate or acidic potassium permanganate oxidizes styrene

(phenylethene) into benzoic acid.



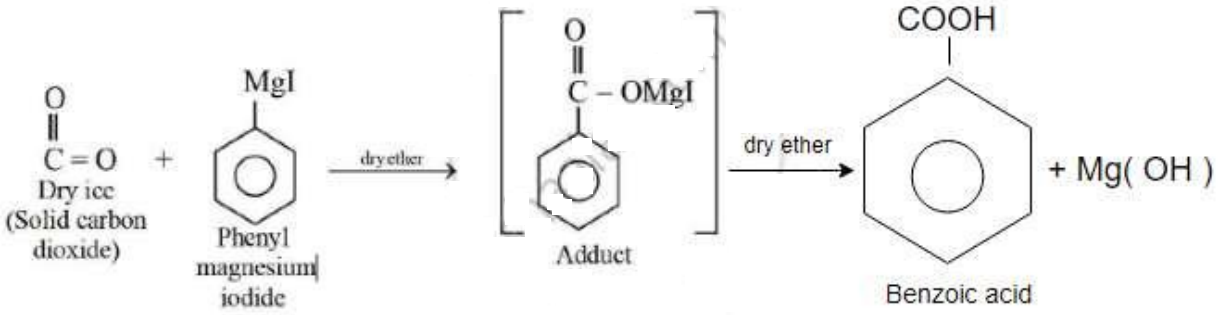
b. Preparation of benzoic acid from benzamide:

Benzamide on hydrolysis in dilute acidic or alkaline medium gives benzoic acid.



c. Preparation of benzoic acid from dry ice:

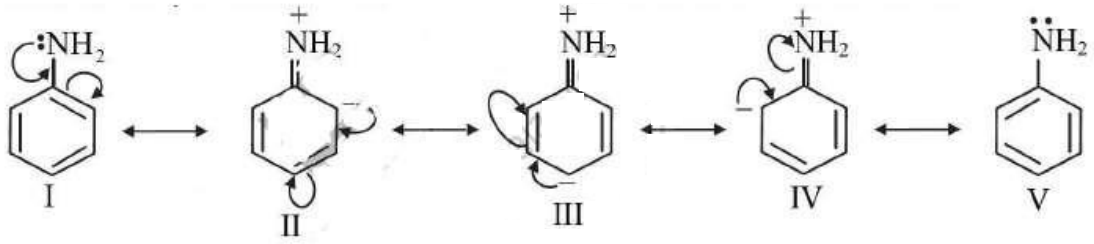
When the solution of phenyl magnesium iodide in dry ether is added to dry ice (solid CO_2), it gives a complex (magnesium salt of carboxylic acid), which on acid hydrolysis gives benzoic acid.



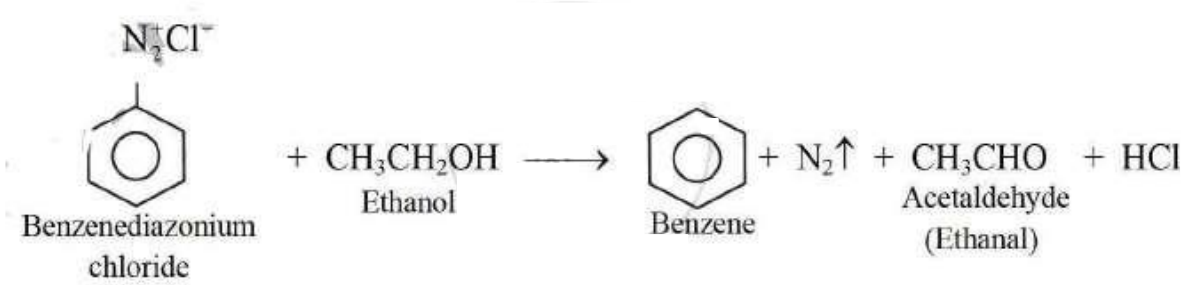
Question 7.v: Write resonance structures of aniline. What is the action of benzene diazonium chloride on ethanol? [3]

Solution: a. Resonance structure of aniline:

In aniline and other arylamines, the amino group is directly attached to benzene ring. Conjugation of lone pair of electrons stabilizes aniline. The lone pair is not easily available for protonation. Five resonance structures of aniline are as follows:



b. Action of benzene diazonium chloride on ethanol:
Reduction of benzene diazonium chloride in the presence of ethanol gives benzene. The ethanol gets oxidized to ethanal.



Question 7.vi: Write the formula for pentaamminechlorocobalt (III) sulphate. **[3]**

Solution: Formula of pentaamminechlorocobalt (111) sulphate: $[Co(NH_3)_5Cl]SO_4$

Question 8: Select and write the most appropriate answer from the given alternatives for each sub-question: **[7]**

Question 8.i: A polymer which contains ester linkage is_____. **[1]**

teflon
buna-N
dextron
neoprene

Solution: A polymer which contains ester linkage is **dextron.**
Dextron is a copolymer of lactic acid and glycolic acid and it contains an ester linkage.

Question 8.ii: An antihistamine drug is _____. **[1]**

salvarsan
chloramphenicol
seldane
prontosil

Solution: Seldane
Seldane or terfenadine is an antihistamine drug.

Question 8.iii: [1]

Identify A and B respectively in the following reaction:

$$\text{tert-butyl alcohol} \xrightarrow[363\ K]{20\%\ H_2SO_4} A + H_2O \xrightarrow[H_2O_2]{HBr} B$$

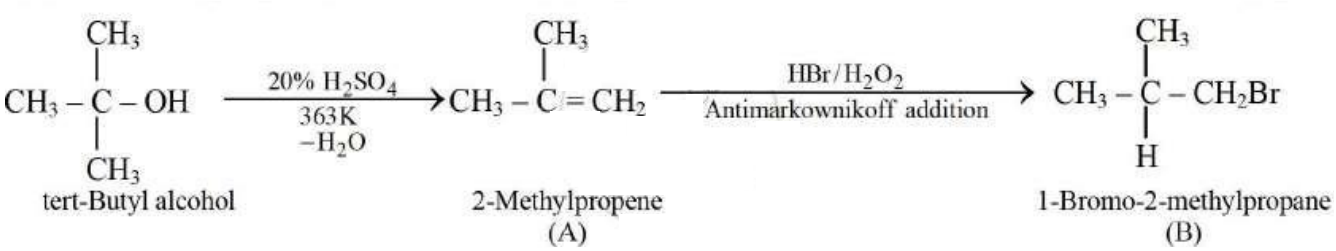
2 - Methylpropene, 1- bromo - 2 - methylpropane

2 - Methylpropene, 2 - bromo - 2 - methylpropane

2 - Methylpropane, 1 - bromo - 2 - methylpropane

2 - Methylpropane, 2 - bromo - 2 - methylpropane

Solution: 2 - Methylpropene, 1- bromo - 2 - methylpropane



tert-Butyl alcohol — 2-Methylpropene (A) — 1-Bromo-2-methylpropane (B)

Question 8.iv: The ligand triethylenetetramine is _____. [1]

monodentate
bidentate
tridentate
tetradentate

Solution: The ligand triethylenetetramine is **tetradentate.**

Question 8.v: Pyrolusite ore is _____. [1]

MnO
MnO_2
Mn_2O_7
Mn_2O_3

Solution: Pyrolusite ore is **MnO_2.**

Question 8.vi: [1]

$$C_2H_5 - Br + NaI \xrightarrow{\text{dry acetone}} C_2H_5 - I + NaBr$$

The above reaction is _____.

Wurtz reaction

Balz-Schiemann reaction

Swarts reaction

Finkelstein reaction

Solution: Pyrolusite ore is **MnO_2.**

Question 8.vii: The functional group present in triacylglycerol is _____. **[1]**

alcohol
ether
ester
amine

Solution: The functional group present in triacylglycerol is **ester.**
Triacylglycerol is a triester of glycerol with higher fatty acids.