

Strictly As Per
Boards
New Syllabus

STATE BOARD

My Favorite Guide on

CHEMISTRY

रसायनशास्त्र

आत्ता...
मिळवा
70 पैकी
70

फक्त
ज्ञानदा
मधून

STD - 12th (Science)



महाराष्ट्रात
प्रथमच...

11th आणि 12th (Science) ची पुस्तके
English व Scientific मराठी मधून...



DNYANADA PUBLICATION, PUNE

With Solutions of
Board Question Papers

Feb / March - 2022

Feb / March - 2023

Feb / March - 2024

Feb / March - 2025

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PUNE | LATUR PATTERN

TOPIC - 01 SOLID STATE

1.1 Introduction

The solid state of matter is characterized by strong interparticle forces of attraction. As a result most solids have definite shape and volume, which change only slightly with change in temperature and pressure. The smallest constituent particles of various solids are atoms, ions or molecules. All such smallest constituent particles of solids will be referred to as particles in this topic.

Q.1 What are the three most common states of matter?

Ans: The three common states of matter:

- i) Solid ii) Liquid iii) Gases

Q.2 How does solid state differ from the other two states?

Ans: Difference between Solids, Liquids and Gases:

No	Points	Solid	Liquid	Gas
i	Volume	Has definite volume	Has definite volume	Takes the volume of its container
ii	Shape	Has definite shape	Takes the shape of its container.	Takes the shape of its container
iii	Effect of a small change in temperature	Volume change is small	Moderate effect on volume change	Volume change is significantly high
iv	Effect of pressure	Practically non-compressible	Small compressibility	Compressible
v	Movement of constituent particles	Particles cannot move freely as they occupy fixed	Particles can move a small distance within the liquid.	Particles are in continuous random motion

		positions.		
vi	Interparticle forces	Strong	Less strong	Very weak

1.2 Types of Solids

Q.3 Give the types of solids.

Ans: Depending on the presence or absence of ordered arrangement of particles of solids, they can be classified as follow:

- 1) Crystalline solids 2) Amorphous solids

Q.4 Define:

i) Crystalline solids

ii) Amorphous solids. Give its examples

Ans: i) Crystalline solids: *It is a homogeneous solids in which the constituent particles (atoms, ions and molecules) are arranged in a definite repeating pattern.*
e.g. Ice, copper, diamond, NaCl, MgO, Fe₂O₃ etc.

ii) Amorphous Solids /Pseudo solids: *The substances which do not have well developed perfectly ordered crystalline structure are called amorphous solids.*
e.g. Glass, plastic, butter, tar etc.

Q.5 Give characteristic properties of crystalline solids.

Ans: Characteristic properties of crystalline solids:

- i) There is a regularity and periodicity in the arrangement of constituent particles in crystalline solids.
- ii) The ordered arrangement of particles extends over a long range.
- iii) The crystalline solids are made up of small crystals or unit cells which are having definite geometrical shape.
- iv) The Crystalline solids are anisotropic i.e. they exhibit directional difference in the properties.
- v) The physical properties like refractive index, electrical conductance are anisotropic properties which has different values when measured in different directions.
- vi) Crystalline solids have sharp melting points.
- vii) If we split or break crystalline solids new planes and smooth surfaces are generated.
- viii) Ice, salts such as NaCl, metals such as sodium, gold, copper and materials such as diamond, graphite, ceramics are examples of crystalline solids

Q.63 Explain:**a) Metal deficiency defect****b) Metal excess defect****OR****Q.63 Explain metal deficiency defect with example.****Write chemical equation for preparation of sulphur dioxide from sulphur. Write uses of sulphur.****(Feb/march-2022)-4M****a) Metal deficiency defect:**

i) This defect is possible only in compounds of metals that show variable oxidation states.

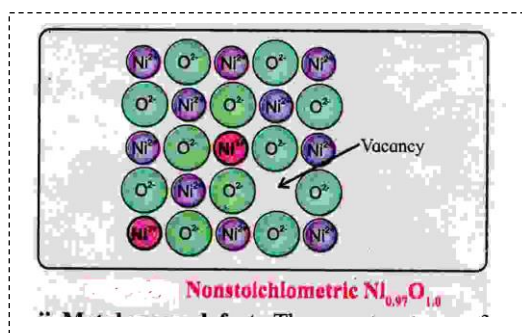
ii) In some crystals, positive metal ions are missing from their original lattice sites.

iii) The extra negative charge is balanced by the presence of cation of the same metal with higher oxidation state than that of missing cation.

e.g. In the compound NiO, one Ni²⁺ ion is missing creating a vacancy at its lattice site. The deficiency of two positive charges is made up by the presence of two Ni³⁺ ions at the other lattice sites of Ni²⁺ ions.

The composition of NiO then becomes Ni_{0.97}O_{1.0}

Fig: Nonstoichiometric Ni_{0.97}O_{1.0}

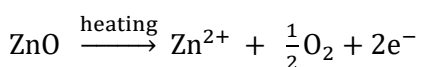
**b) Metal excess defect:**

There are two types of metal excess defects.

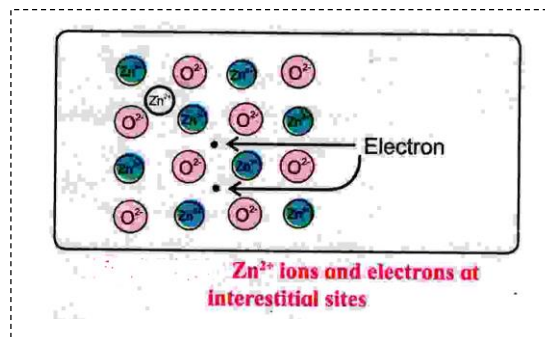
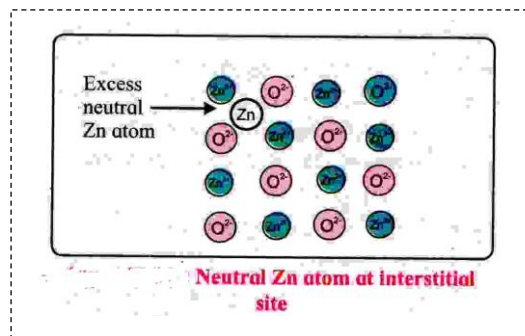
1) A neutral atom or an extra positive ion occupies interstitial position:

i) ZnO presents two ways of metal excess defect. In the first case, one neutral Zn atom is present in the interstitial space of ZnO lattice as shown in the figure.

ii) In the second case, when ZnO is heated it decomposes as:



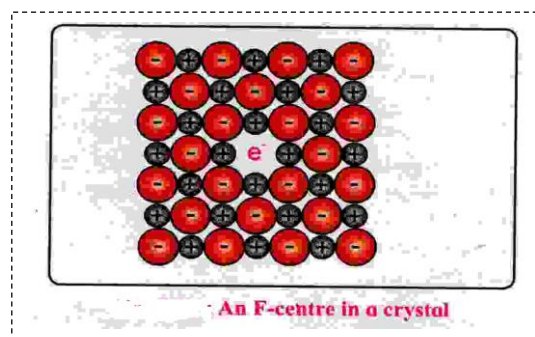
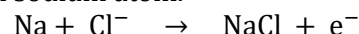
iii) The excess Zn²⁺ ions are trapped in interstitial site in the lattice. The electrons also diffuse in the crystal to occupy interstitial sites. In both the cases, nonstoichiometric formula of ZnO is Zn_{1+x}O_{1.0}

**2) By anion vacancies (Colour or F-centres):**

i) This type of defect imparts colour to the colourless crystal.

ii) For example, When NaCl crystal is heated in the atmosphere of sodium vapour, sodium atoms are deposited on the crystal surface.

iii) Cl⁻ ions diffuse to the crystal surface creating vacancies at their regular sites. These Cl⁻ ions combine with Na atoms on the surface to form NaCl, by releasing electron from sodium atom.



iv) The electrons released diffuse into the crystal and occupy vacant sites of anions. The anion vacant sites occupied by electrons are F-centres or colour-centres.

NaCl shows yellow colour due to the formation of F-centre. The crystal of NaCl has excess Na. The nonstoichiometric formula of NaCl is the Na_{1+x}Cl_{1.0}

Scientific मराठी स्पष्टीकरण:

Introduction

प्रस्तावना- द्रावण हे कमीत कमी दोन घटकांनी बनलेले असते, (विरघळलेला घटक आणि तो घटक ज्यामध्ये विरघळतो ते) द्रावकाच्या आंतर रेण्वीय आकर्षणच्या बलावर द्रावणाचे भौतिक गुणधर्म अवलंबून असतात. विरघळलेल्या द्रावणाच्या उपस्थितीमुळे intermolecular forces of attraction (आंतररेण्वीय आकर्षण बलावर) परिणाम होत असतो. भौतिक गुणधर्मांमध्ये बाष्पदाब, उत्कलन बिंदू, गोठणांक आणि परासरण दाब यांचा समावेश आहे. दोन किंवा अधिक घटकांच्या मिश्रणाला द्रावण असे म्हणतात. घटकांच्या आकारमानानुसार द्रावणाचे तीन प्रकार आहेत.

Solutions (द्रावण)- दोन किंवा अधिक घटक पदार्थांच्या एकजिनसी मिश्रणाला solution म्हणतात.

Solutions चे प्रामुख्याने तीन प्रकार पडतात.

i) Coarse mixture (स्थूल मिश्रण)- ह्या प्रकारच्या mixture मध्ये solution मधील particles ची size तुलनेने मोठी असते. म्हणजेच 10^{-4} cm पेक्षा मोठी असते. त्याचप्रमाणे हे homogeneous (एकजीव) mixture असते, ह्यामधील particles आकाराने मोठे असतील तर, द्रावणाच्या तळाशी साठून राहिलेले दिसतात.

उदा. Soil (माती) पाण्यामध्ये विरघळणे.

ii) Colloidal solution (कलीली अपस्करण)- ह्या प्रकारच्या द्रावणामध्ये विखुरलेल्या particles चे आकारमान 10^{-7} cm ते 10^{-4} cm असते. हे solution, heterogeneous (नैकविध) असते. Colloidal particles (कलीली कणांवर) positive किंवा negative charge असतो, ह्यामुळे colloidal solution ला stability (स्थिरता) मिळते.

उदा. ferric hydroxide चे द्रावण, arsenic sulphide चे द्रावण

iii) True solution (खरे द्रावण)- ज्या solution मधील particles ची size खुपच कमी म्हणजेच 10^{-8} cm इतकी असते, त्याला true solution असे म्हणतात. हे solution homogeneous असते, मात्र त्यामधील घटक सहजासहजी वेगळे करता येत नाहीत.

उदा. साखरेचे पाण्यातील विरघळणे.

i) True solution (खरे द्रावण)- दोन किंवा अधिक एकमेकांमध्ये न विरघळा-या पदार्थांचे असे homogeneous mixture कि, त्यांचे concentration एखाद्या certain limit मध्ये बदलता येऊ शकते, पदार्थांच्या अशा मिश्रणाला true solution असे म्हणतात.

ii) Solute (द्राव्य)- Solution मध्ये विरघळणा-या मात्र त्याच्यामध्ये वजनाने smaller proportion (कमी प्रमाणात) असणा-या घटकाला solute म्हणतात.

iii) Solvent (द्रावक)- Solution मध्ये विरघळणा-या मात्र त्याच्यामध्ये वजनाने large proportion (जास्त प्रमाणात) असणा-या घटकाला solvent म्हणतात.

Concentration of solution (द्रावणाची संहती)- दिलेल्या solution किंवा solvent (द्रावणामध्ये किंवा द्रावकामध्ये) विरघळलेल्या solute (द्राव्याच्या) राशीला concentration of solution असे म्हणतात.

i) Standard solution (ज्ञातमुल्य द्रावण किंवा मानक द्रावण)- ज्या solution चे concentration माहित असते किंवा ज्ञात असते, अशा solution ला standard solution असे म्हणतात.

ii) Percent by weight (वस्तुमानानुसार शेकडेवारी) - १०० gram द्रावणामधील द्राव्याचे ग्रॅममधील वस्तुमानाला percent by weight असे म्हणतात. त्याचा formula प्रश्नामध्ये दिला आहे, त्याचे अवलोकन करा.

iii) Percent by volume (घनफळानुसार शेकडेवारी) - १०० भाग घनफळ द्रावणातील द्राव्याच्या घनफळ भागास घनफळ शेकडेवारी म्हणतात. त्याचा formula प्रश्नामध्ये पहा.

iv) Weight volume percent (वस्तुमान घनफळ शेकडेवारी) - १०० cm³ मधील solute च्या gram मधील वजनाला Weight volume percent म्हणतात. formula समजून घ्या.

v) Mole fraction (ग्रॅमरेणू अंश) - एखाद्या solute चा mole fraction म्हणजेच त्या solute मध्ये असणारे number of moles (ग्रॅम रेणू) आणि दिलेल्या solution आणि solute मधील एकूण ग्रॅम रेणू यांच्या ratio ला Mole fraction (ग्रॅमरेणू अंश) असे म्हणतात. प्रश्नातील formula पहा.

vi) Molarity (ग्रॅमरेणुता)- १ लिटर द्रावणातील द्राव्याच्या number of mole (ग्रॅम रेणूच्या अंशाला) Molarity (ग्रॅमरेणुता) असे म्हणतात. वरील प्रश्नातील formula पहा.

vii) Molality (मोललता) - प्रति १ किलो (१००० gm) solvent (द्रावकामध्ये) विरघळणा-या solute (द्राव्याच्या) number of moles (ग्रॅम रेणूला) Molality (मोललता) म्हणतात. प्रश्नातील formula पहा.

viii) Normality (प्रसामान्यता)- १ लिटर solution मधील solute च्या gram equivalents (ग्रॅम सममुल्य) च्या संख्येला Normality (प्रसामान्यता) म्हणतात. प्रश्नातील formula पहा.

ix) Parts per million (ppm) (दशलक्षांश) - द्राव्याच्या (वस्तुमान ग्रॅममध्ये किंवा घनफळ cm³ मध्ये) द्रावणामधील (वस्तुमान १०^६ ग्रॅम किंवा घनफळ १०^६ cm³) मधील प्रमाणाला ppm म्हणतात. प्रश्नातील formula पहा.

3.6 pH scale

Q.25 What is pH and pOH?

OR

Q.25 Define pH and pOH.

Ans: i) **pH:** The pH of the solution is defined as the negative logarithm to the base 10, of the concentration of H^+ ions in solution in mol dm^{-3} .

pH is expressed mathematically as,

$$\text{pH} = -\log_{10}[\text{OH}^-] \quad \text{or} \quad \text{pH} = -\log_{10}[\text{H}_3\text{O}^+]$$

ii) Similarly, **pOH** of a solution can be defined as the negative logarithm to the base 10, of the molar concentration of OH^- ions in solution.

$$\text{pOH} = -\log_{10}[\text{OH}^-]$$

Q.26 Derive the relation $\text{pH} + \text{pOH} = 14$.

OR

Q.26 Derive the relationship between pH and pOH.

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Ans: Relationship between pH and pOH:

The ionic product of water is given as:

$$K_w = [\text{H}_3\text{O}^+][\text{OH}^-]$$

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

$$\text{Thus, } [\text{H}_3\text{O}^+][\text{OH}^-] = 1.0 \times 10^{-14}$$

Taking logarithm of both sides, we write

$$\log_{10}[\text{H}_3\text{O}^+] + \log_{10}[\text{OH}^-] = -14$$

$$-\log_{10}[\text{H}_3\text{O}^+] + \{-\log_{10}[\text{OH}^-]\} = 14$$

$$\text{Now, } \text{pH} = -\log_{10}[\text{H}_3\text{O}^+] \quad \text{and} \quad \text{pOH} = -\log_{10}[\text{OH}^-]$$

$$\therefore \text{pH} + \text{pOH} = 14$$

Q.27 Explain the pH value of neutral, acidic and basic solutions.

Ans: pH value of neutral, acidic and basic solutions:

i) Neutral solution: For pure water or any aqueous neutral solution at 298 K,

$$[\text{H}_3\text{O}^+] = [\text{OH}^-] = 1.0 \times 10^{-7} \text{ M}$$

$$\text{Hence, } \text{pH} = -\log_{10}[\text{H}_3\text{O}^+] = -\log_{10}[1 \times 10^{-7}] = 7$$

ii) Acidic solution: In acidic solution, there is excess of H_3O^+ ions, or $[\text{H}_3\text{O}^+] > [\text{OH}^-]$

$$\text{Hence, } [\text{H}_3\text{O}^+] > 1 \times 10^{-7} \text{ and } \text{pH} < 7$$

iii) Basic solution: In basic solution, there is excess of OH^- ions, or $[\text{H}_3\text{O}^+] < [\text{OH}^-]$

$$\text{Hence, } [\text{H}_3\text{O}^+] < 1.0 \times 10^{-7} \text{ and } \text{pH} > 7$$

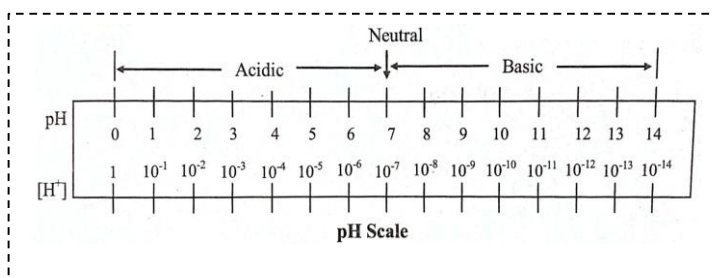
Q.28 Write a short note on pH scale.

Ans: pH Scale: Instead of writing concentration of H_3O^+ ions in mol dm^3 , sometimes it is convenient to express it on the logarithmic scale. This is known as pH scale.

$$\text{i) } \text{pH} = -\log_{10}[\text{H}_3\text{O}^+]$$

ii) Based on pH value, solutions are classified as acidic ($\text{pH} < 7$), basic ($\text{pH} > 7$) and neutral solution ($\text{pH} = 7$).

iii) pH scale is shown in the following figure:



3.7 Hydrolysis of salts

Q.29 What are the different types of salts? Give examples of each type.

Ans: Types of salts:

There are four types of salts.

i) Salts derived from strong acid and strong base.

e.g.: NaCl, Na_2SO_4 , NaNO_3 , KCl, KNO_3 .

ii) Salts derived from strong acid and weak bases.

e.g.: NH_4Cl , CuSO_4 , NH_4NO_3 , CuCl_2 .

iii) Salts derived from weak acids and strong bases.

e.g.: CH_3COONa , KCN, Na_2CO_3 .

iv) Salts derived from weak acids and strong bases.

e.g.: $\text{CH}_3\text{COONH}_4$, NH_4CN .

Solved and Unsolved Examples

Ex.01 The molar conductivity of 0.05 M BaCl₂ solution at 25 °C is 223 Ω⁻¹ cm² mol⁻¹. What is its conductivity? OR

Ex.01 Calculate molar conductivity for 0.5 M BaCl₂ if its conductivity at 298K is 0.01 Ω⁻¹ cm⁻¹.

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Solution: Given: Molar conductivity (Λ) of BaCl₂ = 223 Ω⁻¹ cm² mol⁻¹

Concentration of BaCl₂ solution (c) = 0.05M

Conductivity of BaCl₂ solution (k) = ?

We have Formula: $\Lambda = \frac{1000k}{c}$

Calculation: Using formula,

$$\Lambda = \frac{1000k}{c}$$

$$\therefore k = \frac{\Lambda c}{1000}$$

$$k = \frac{223 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1} \times 0.05 \text{ mol L}^{-1}}{1000 \text{ cm}^3 \text{ L}^{-1}}$$

$$= 0.01115 \Omega^{-1} \text{ cm}^{-1}$$

Ans: The conductivity of the BaCl₂ solution is 0.01115 Ω⁻¹ cm⁻¹.

Ex.02 What must be the concentration of a solution of silver nitrate to have the molar conductivity of 121.4 Ω⁻¹ cm² mol⁻¹ and the conductivity of 2.428 × 10⁻³ Ω⁻¹ cm⁻¹ at 25 °C ?

Solution: Given: Molar conductivity (Λ) of silver nitrate = 121.4 Ω⁻¹ cm² mol⁻¹,

Conductivity (k) = 2.428 × 10⁻³ Ω⁻¹ cm⁻¹

Concentration (c) = ?

We have Formula: $\Lambda = \frac{1000k}{c}$

Calculation: Using formula, $\Lambda = \frac{1000k}{c} \therefore c = \frac{1000 \times k}{\Lambda}$

$$c = \frac{1000 \times 2.428 \times 10^{-3}}{121.4} = 0.02 \text{ mol L}^{-1} = \mathbf{0.02M}$$

Ans: Concentration of the silver nitrate solution is 0.02 M

Ex.03 The molar conductivity of 0.01 M acetic acid solution at 25 °C is 16.5 Ω⁻¹ cm² mol⁻¹. What is its conductivity?

Solution: Given: Molar conductivity (Λ) of acetic acid solution = 16.5 Ω⁻¹ cm² mol⁻¹.

Concentration of acetic acid solution (c) = 0.01 M

Conductivity of acetic acid solution (k) = ?

We have Formula: $\Lambda = \frac{1000k}{c}$

Calculation: Using formula, $\Lambda = \frac{1000k}{c}$

$$\therefore k = \frac{\Lambda c}{1000}$$

$$k = \frac{16.5 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1} \times 0.01 \text{ mol L}^{-1}}{1000 \text{ cm}^3 \text{ L}^{-1}}$$

$$= 1.65 \times 10^{-4} \Omega^{-1} \text{ cm}^{-1}$$

Ans: The conductivity of the acetic acid solution is 1.65 × 10⁻⁴ Ω⁻¹ cm⁻¹

Ex.04. Calculate the molar conductivity of AgI at zero concentration if the molar conductivities of NaI, AgNO₃ and NaNO₃ at zero concentration are respectively, 126.9, 133.4 and 121.5 Ω⁻¹ cm² mol⁻¹.

Solution: Given: Limiting molar conductivity of NaI = 126.9 Ω⁻¹ cm² mol⁻¹

Limiting molar conductivity of AgNO₃ = 133.4 Ω⁻¹ cm² mol⁻¹

Limiting molar conductivity of NaNO₃ = 121.5 Ω⁻¹ cm² mol⁻¹

Limiting molar conductivity of AgI = ?

We have Formula: $\Lambda_0 = \lambda_{+}^0 + \lambda_{-}^0$

Calculation:

According to Kohlrausch law,

$$\text{i) } \Lambda_0 (\text{NaI}) = \lambda_{\text{Na}^+}^0 + \lambda_{\text{I}^-}^0 = 126.9 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

$$\text{ii) } \Lambda_0 (\text{AgNO}_3) = \lambda_{\text{Ag}^+}^0 + \lambda_{\text{NO}_3^-}^0 = 133.4 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

$$\text{iii) } \Lambda_0 (\text{NaNO}_3) = \lambda_{\text{Na}^+}^0 + \lambda_{\text{NO}_3^-}^0 = 121.5 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

Eq. (i) + eq. (ii) – eq. (iii) gives

$$\Lambda_0 (\text{NaI}) + \Lambda_0 (\text{AgNO}_3) - \Lambda_0 (\text{NaNO}_3)$$

$$= \lambda_{\text{Na}^+}^0 + \lambda_{\text{I}^-}^0 + \lambda_{\text{Ag}^+}^0 + \lambda_{\text{NO}_3^-}^0 - \lambda_{\text{Na}^+}^0 - \lambda_{\text{NO}_3^-}^0$$

$$= \lambda_{\text{Ag}^+}^0 + \lambda_{\text{I}^-}^0 = \Lambda_0 (\text{AgI})$$

$$= 126.9 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1} + 133.4 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1} - 121.5 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}$$

$$= \mathbf{138.8 \Omega^{-1} \text{ cm}^2 \text{ mol}^{-1}}$$

Ans: Molar conductivity of AgI at zero concentration is 138.8 Ω⁻¹ cm² mol⁻¹

Multiple Choice Questions

i) The value of $[H_3O^+]$ in mol lit⁻¹ of 0.001 M acetic acid solution ($K_a = 1.8 \times 10^{-5}$) is -----

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- a) 1.34×10^{-1} b) 1.34×10^{-2}
c) 1.34×10^{-3} d) 1.34×10^{-4}

Ans: d) 1.34×10^{-4}

ii) Which of the following correctly represents integrated rate law equation for a first order reaction in gas phase:

(Feb/March-2023)

- a) $k = \frac{2.303}{t} \times \log_{10} \frac{P_i}{P_i - P}$ b) $k = \frac{2.303}{t} \times \log_{10} \frac{P_i}{2P_i - P}$
c) $k = \frac{2.303}{t} \times \log_{10} \frac{2P_i}{P_i - P}$ d) $k = \frac{2.303}{t} \times \log_{10} \frac{P_i - P}{2P_i}$

Ans: b) $k = \frac{2.303}{t} \times \log_{10} \frac{P_i}{2P_i - P}$

iii) If unit of rate constant is mol dm⁻³s⁻¹, the order of reaction would be _____. (Feb/March-2024)

- a) zero b) 1
c) 2 d) 3

Ans: a) zero

1) $A \rightarrow B$ is a first order reaction with rate $6.6 \times 10^{-5} \text{ Ms}^{-1}$ when $[A]$ is 0.6 M, rate constant of the reaction is

- a) $1.1 \times 10^{-5} \text{ s}^{-1}$ b) $1.1 \times 10^{-4} \text{ s}^{-1}$
c) $9 \times 10^{-5} \text{ s}^{-1}$ d) $9 \times 10^{-4} \text{ s}^{-1}$

2) The rate constant for a first order reaction is 100 s^{-1} . The time required for completion of 50% of reaction is

- a) 0.0693 milliseconds b) 6.93 milliseconds
c) 0.693 milliseconds d) 69.3 milliseconds

3) A 1st order reaction is 60% complete in 20 min. How long will the reaction take to be 84% complete?

- a) 54 min b) 68 min c) 40 min d) 76 min

4) Consider the reaction, $2A + B \rightarrow C + 2D$. If the concentration of A is doubled at constant (B), the rate of the reaction is doubled. If the reaction is increased by 4, so rate law of given reaction will be

- a) $r = k[A][B]$ b) $r = k[A]^2[B]^2$
c) $r = k[A]^2[B]$ d) $r = k[A][B]^2$

5) The rate of reaction for certain reaction is expressed as $\frac{1}{3} \frac{d[A]}{dt} = -\frac{1}{2} \frac{d[B]}{dt} = -\frac{d[C]}{dt}$ the reaction is

- a) $3A \rightarrow 2B + C$ b) $2B \rightarrow 3A + C$
c) $2B + C \rightarrow 3A$ d) $3A + 2B \rightarrow C$

6) For the reaction $2N_2O_{5(g)} \rightarrow 4NO_{2(g)} + O_{2(g)}$ in liquid bromine, which of the following rate equation is incorrect?

- a) $-\frac{1}{2} \frac{d[N_2O_5]}{dt}$ b) $-\frac{1}{4} \frac{d[NO_2]}{dt}$
c) $\frac{d[O_2]}{dt}$ d) $\frac{1}{4} \frac{d[NO_2]}{dt}$

7) Higher order (>3) reaction are rate due to

- a) low probability of simultaneous collision of all the reacting species
b) increase in entropy and activation energy as more molecules are involved.
c) shifting of equilibrium toward reactants due to elastic collisions
d) loss of active species on collision.

8) $A + 2B \rightarrow C$, the equation for this reaction is given as $\text{Rate} = k[A][B]$. If the concentration of A is kept same but that of B is doubled, what will happen to the rate itself?

- a) Halved b) Same c) Doubled d) Quadrupled

9) For a reaction $O_{3(g)} + O_{(g)} \rightarrow 2O_{2(g)}$, if the law expression is, $\text{rate} = k[O_3][O]$, The molecularity and order of the reactions are respectively

- a) 2 and 2 b) 2 and 1.33 c) 2 and 1 d) 1 and 2

10) Half life period of a first order reaction, $A \rightarrow \text{product}$ is 6.93 hour. What is the value of the constant?

- a) 1.596 h^{-1} b) 0.1 h^{-1} c) 4.802 h^{-1} d) 10 h^{-1}

11) Inversion of cane sugar in aqueous solution to glucose and fructose is an example of

- a) fast reaction b) slow reaction
c) spontaneous reaction d) instantaneous reaction

12) Chemical kinetics is a branch of physical chemistry, deals with

- a) Heat changes in a reaction
b) Physical changes in a reaction
c) Rates of reaction
d) Structure of molecules

Enthalpy of vaporisation (बाष्पीभवनाची एन्थाल्पी)- एक mole इतक्या liquid चे gaseous state मध्ये रुपांतर झाल्यावर त्या instant ला असलेल्या ह्या liquid च्या boiling point ला enthalpy of vaporisation असे म्हणतात. हि enthalpy Δ_{vap} ह्या अक्षराने दर्शवितात.

उदा. एक mole इतके water, vapour किंवा steam मध्ये 373K ला convert होते, त्यावेळेस system ने absorb केलेली एकूण heat 40.7kJ इतकी असते. त्यामुळे water ची enthalpy of vaporisation 40.7kJmol⁻¹ इतकी असेल. Enthalpy of vaporisation ची किंमत liquid मधील intermolecular forces of attraction (आंतर रेण्वीय आकर्षण बलांवर) अवलंबून असते.

Enthalpy of sublimation (संप्लवनाची एन्थाल्पी)- एखाद्या स्थिर तापमानाला 1 mole solid चे liquid मध्ये रुपांतर न होता, सरळ gaseous state (वायु आवस्थेत) रुपांतर होते, त्यावेळेस त्या solid चे temperature त्याच्या melting point पेक्षा कमी असते, त्याला enthalpy of sublimation म्हणतात.

$\Delta_{\text{sub}}H$ ह्या अक्षराने हि enthalpy दर्शवितात.

Solid चे gas मध्ये होणारे sublimation हि एक endothermic process आहे. प्रश्नामध्ये solid sodium metal ची enthalpy of sublimation दिली आहे. त्याचे अवलोकन करा.

Enthalpy of ionization (आयनीभवन एन्थाल्पी)- 1 mole (ग्रॅमरेणु) gas च्या प्रत्येक atom किंवा ion मधील एक electron काढण्यासाठी लागणाऱ्या change in enthalpy ला enthalpy of ionisation असे म्हणतात. एक mole इतक्या gaseous, sodium atom चे ionisation होऊन एक mole इतका gaseous sodium ions तयार होण्यासाठी लागणारी उर्जा 494 kJ इतकी असेल तर त्याची enthalpy of ionisation हि 494 kJ/mole इतकी असते.

Enthalpy of atomization (अणुकरणाची एन्थाल्पी)- एक mole gaseous पदार्थांमधील सर्व रेणुंचे gaseous atoms (वायुरूप अणूंमध्ये) dissociation (विचरण) होण्यासाठी लागलेल्या enthalpy change ला enthalpy of atomization असे म्हणतात.

म्हणजेच gaseous पदार्थाचे त्याच्या gaseous state मधील atoms मध्ये पूर्णपणे होणाऱ्या breakdown ला enthalpy of atomization असे म्हणतात. प्रश्नामध्ये Hydrogen molecule ची enthalpy of atomization दिली आहे. त्यामध्ये एक mole hydrogen चे hydrogen atoms मध्ये breakdown होण्यासाठी लागणाऱ्या energy ला enthalpy of atomization असे म्हणतात.

Enthalpy of solution (द्रावणाची एन्थाल्पी)- एक mole पदार्थ हा जास्त प्रमाणांमध्ये solvent मध्ये विरघळल्यानंतर, नंतरच्या dissolution (विरघळण्याने) त्या solution च्या enthalpy मध्ये बदल

होत नाही, म्हणून एक mole पदार्थ dissolution साठी लागणाऱ्या enthalpy change ला enthalpy of solution असे म्हणतात.

उदा. एक mole solid crystalline KCl हे water मध्ये जास्त प्रमाणत विरघळले असता, त्यामुळे घडणाऱ्या वेगवेगळ्या steps आणि त्यासाठीची enthalpy value प्रश्नामध्ये दिली आहेत, त्याचे व्यवस्थीत अवलोकन करा.

Thermochemistry (उष्मासायनिक शास्त्र)- chemical reactions (रासायनिक अभिक्रियांमुळे) heat मध्ये बदल होतात, ह्या उष्णता बदलाचा अभ्यास करणाऱ्या physical chemistry च्या branch ला Thermochemistry असे म्हणतात.

Enthalpy of chemical reaction (रासायनिक अभिक्रियेची एन्थाल्पी)- chemical reactions मधील products आणि reactants च्या enthalpies च्या बेरजेतील फरक आणि reaction मधील सर्व पदार्थ एका निश्चित physical state (भौतिक स्थितीत) आणि निश्चित moles (ग्रॅम रेणु) च्या राशीमध्ये असायला हव्यात, आणि ह्या राशी balanced equation (समतोलाच्या समीकरणात) गुणांकाने दाखवलेल्या असायला हव्यात. ह्या सर्व प्रक्रियेमध्ये होणाऱ्या enthalpy च्या बदलास enthalpy of chemical reaction असे म्हणतात.

i) Exothermic reactions (उष्मादायी अभिक्रिया)- ज्या chemical reaction मध्ये heat बाहेर टाकली जाते, त्या reactions ला exothermic reactions असे म्हणतात. हि एक spontaneous (उत्स्फूर्त) reaction आहे. ह्या reaction मध्ये तयार होणाऱ्या products ची enthalpy ही reaction च्या enthalpy पेक्षा कमी असतो. Reactants पेक्षा products हे जास्त stable असतात.

ii) Endothermic reactions (उष्माग्राही अभिक्रिया)- ज्या chemical reaction मध्ये heat शोषून घेतली जाते, त्या reactions ला endothermic reactions असे म्हणतात. हि एक non-spontaneous reaction आहे. ह्या reaction मध्ये products ची enthalpy हि reactants च्या enthalpy पेक्षा जास्त असते. products पेक्षा reactants हे जास्त stable असतात.

Standard enthalpy of reaction (रासायनिक अभिक्रियेची प्रमाण एन्थाल्पी)- Reaction मध्ये अमावेश असणारे सगळे पदार्थ त्यांच्या standard states (प्रमाण स्थितीत) असतील, तेव्हा अशा reactions मध्ये सहगामी होणाऱ्या enthalpy बदलास standard enthalpy of reaction असे म्हणतात.

Q.44 Distinguish between rhombic sulfur and monoclinic sulfur.

Ans: Difference between rhombic (α -sulfur) and monoclinic (β -sulfur):

No	Rhombic sulfur (α -sulfur)	monoclinic sulfur (β -sulfur)
i	It is pale yellow coloured solid.	It is bright yellow solid
ii	If forms orthorhombic crystals	It forms needle shaped monoclinic crystals
iii	Its melting point is 385.8 K.	Its melting point is 393 K.
iv	Its density is 2.06 g/cm ³	Its density is 1.98 g/cm ³
v	It is insoluble in water and soluble in CS ₂ .	Soluble in CS ₂ .
vi	It is stable below 369 K and transforms to β -sulfur above this temperature.	It is stable below 369 K and transforms into α -sulfur below this temperature.
vii	It is prepared by evaporation of rolls sulfur in CS ₂ .	It is prepared from rhombic sulfur

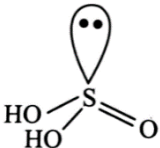
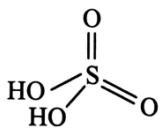
7.8 Oxoacids

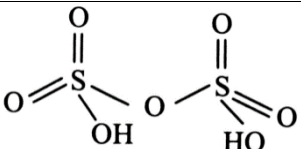
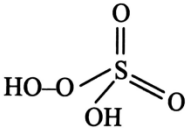
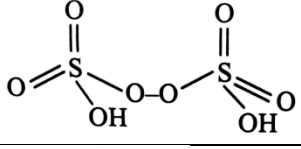
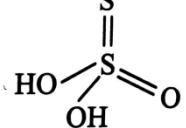
Q.45 Explain: Oxoacids of sulfur.

Q.45 Draw structures of the following compounds
 peroxy disulphuric acid (Feb/March-2023)-1M
 (Feb/March-2024)-1M

Ans: Oxoacids of sulfur:

Sulfur forms a number of oxoacids. Some of them are unstable and cannot be isolated. They are known to exist in aqueous solutions or in the form of their salts. Some important oxoacids of sulfur and their structures are given below:

i	Sulfurous acid, H ₂ SO ₃	
ii	Sulfuric acid, H ₂ SO ₄	

iii	Disulfuric acid or pyrosulfuric acid, H ₂ S ₂ O ₇	
iv	Peroxy monosulfuric acid, H ₂ SO ₅	
v	Peroxydisulfuric acid, H ₂ S ₂ O ₈	
vi	Thiosulfuric acid, H ₂ S ₂ O ₃	

Q.46 What is the oxidation state of 'S' in H₂SO₄?

Ans: (Oxidation number of H) + (Oxidation number of S) + (Oxidation number of O) = 0

$$2 \times (+1) + (\text{Oxidation number of S}) + 4 \times (-2) = 0$$

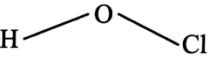
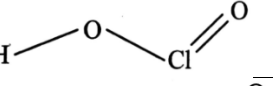
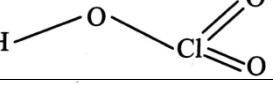
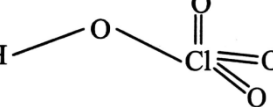
$$\text{Oxidation number of S} + 2 - 8 = 0$$

$$\text{Hence, oxidation number of 'S' in H}_2\text{SO}_4 = +6$$

Q.47 Write the names and structural formulae of oxoacids of chlorine.

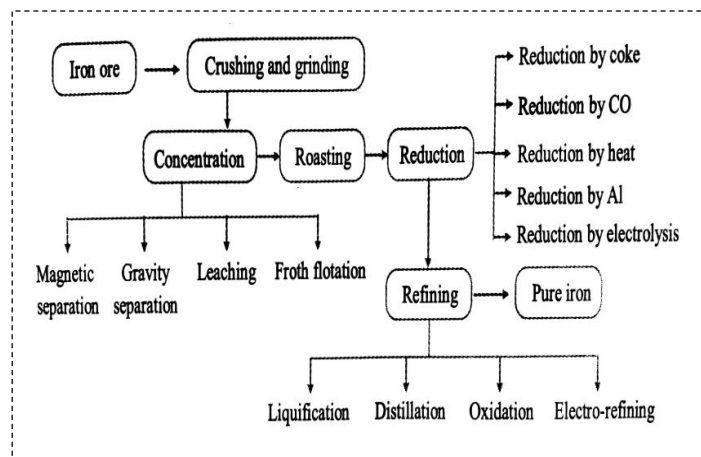
Q.47 Draw structures of the following compounds
 chloric acid (Feb/March-2023)-1M

Ans:

i	Hypochlorous acid, HOCl	
ii	Chlorous acid, HOClO or HClO ₂	
iii	Chloric acid, HClO ₃	
iv	Perchloric acid, HClO ₄	

Q.47 Draw a flowchart showing the extraction of iron.

Ans: The flow chart showing the extraction of iron is given below:



Q.48 Give the Summary of reactions taking place in blast furnace at different temperature zones.

Ans:

Temp. K	Changes taking place	Reaction
500	Loss of moisture from ore	--
900	Reduction of ore by CO	$\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$
1200	Decomposition of lime	$\text{CaCO}_3 \xrightarrow{\Delta} \text{CaO} + \text{CO}_2$
1500	Reduction of ore by C	$\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$
2000	Fusion of iron	$\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$
	Slag formation	$12\text{CaO} + 2\text{Al}_2\text{O}_3 \rightarrow 4\text{Ca}_3\text{AlO}_3 + 3\text{O}_2$

Q.49 What are the factors which govern the choice of extraction technique?

Ans: The choice of extraction technique is governed by the following factors:

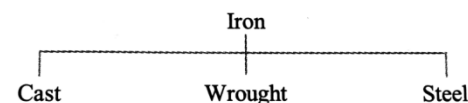
- Nature of ore
- Availability and cost of reducing agent, generally cheap coke is used.
- Availability of hydraulic power.

iv) Purity of product (metal) required.

v) Value of byproducts. For example, SO_2 obtained during roasting of sulphide ores is vital for manufacture of H_2SO_4 .

Q.50 What are the commercial forms of iron?

Ans: Commercial forms of iron:



Q.51 What are the differences between cast iron, wrought iron and steel?

Ans: Differences between cast iron, wrought iron and steel:

No	Cast iron	Wrought iron	Steel
i	Hard and brittle	Very soft	Neither too hard nor too soft.
ii	Contains 4% carbon.	Contains less than 0.2% carbon	Contains 0.2 to 2% carbon
iii	Used for making pipes, manufacturing automotive parts, pots, pans, utensils, etc.	Used for making pipes, bars for stay bolts, engine bolts and rivets, etc.	Used in buildings infrastructure, tools, ships, automobiles, weapons, etc.

8.6 Inner transition (f - block) elements

Q.52 What are f-block elements? Give properties of f-block elements.

Ans: f-block elements: Elements whose *f* orbitals get filled up by electrons, are called *f* block elements.

i) These elements are placed separately at the bottom of the periodic table. They are a subset of 6th and 7th periods.

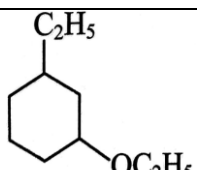
ii) These elements have 1 to 14 electrons in their *f* orbital, 0 or 1 in the penultimate energy level and 2 electrons in the outermost orbital.

Properties of f-block elements:

- Properties are similar to d block elements
- Electrons are added to *f* subshells of (n-2) level

iii) Placed between (n-1)d and ns block elements.

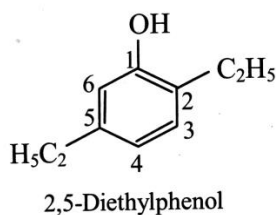
Common names and IUPAC names of some of the ethers:

N o	Formula	Common Name	IUPAC Name
i	$\text{CH}_3 - \text{O} - \text{CH}_3$	Dimethyl ether	Methoxymethan e
ii	$\text{CH}_3\text{CH}_2 - \text{O} - \text{CH}_2\text{CH}_3$	Diethyl ether	Ethoxyethane
iii	$\text{CH}_3 - \text{O} - \text{CH}_2\text{CH}_3$	Ethyl methyl ether	Methoxyethane
iv	$\text{CH}_3 - \text{O} - \text{CH}_2\text{CH}_2\text{CH}_3$	Methyl n- propyl ether	1-Methoxypropane
v	$\text{CH}_3 - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_3$	Methyl isopropyl ether	2-Methoxypropane
vi	$\text{CH}_3\text{CH}_2 - \text{O} - \text{CH}_2\text{CH}_2\text{CH}_3$	Ethyl n- propyl ether	1-Ethoxypropane
vii	$\text{CH}_3 - \text{O} - \underset{\text{CH}_3}{\text{CH}} - \text{CH}_2 - \text{CH}_3$	Isobutyl methyl ether	1-Methoxy--2 methylpropane
viii	$\text{CH}_3 - \text{O} - \underset{\text{CH}_3}{\overset{\text{CH}_3}{\text{C}}} - \text{CH}_3$	tert-Butyl methyl ether	2-Methoxy--2 methylpropane
ix	$\text{CH}_3\text{CH}_2 - \text{O} - \text{CH}_2 - \text{CH}_2 - \text{CH}_2 - \text{Cl}$	3-Chloropro- pyl ethyl ether	3-Chloro - 1 ethoxypropane
x		-	1 -Ethoxy -3- ethylcyclohexa ne

Q.15 Draw structures of following compounds.

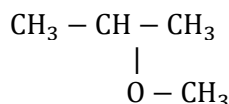
- i) 2, 5- Diethylphenol ii) Prop-2-en-1-ol
iii) 2- Methoxypropane iv) Phenylmethanol

Ans: i) 2, 5- Diethylphenol:

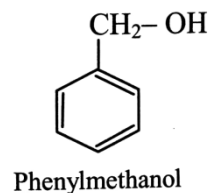


ii) Prop-2-en-1-ol: $\text{H}_2\text{C} = \overset{3}{\text{CH}} - \overset{2}{\text{CH}} - \overset{1}{\text{CH}_2} - \text{OH}$

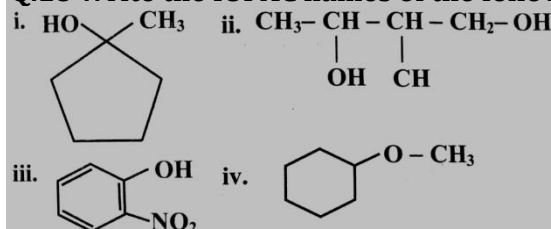
iii) 2-Methoxypropane:



iv) Phenylmethanol:

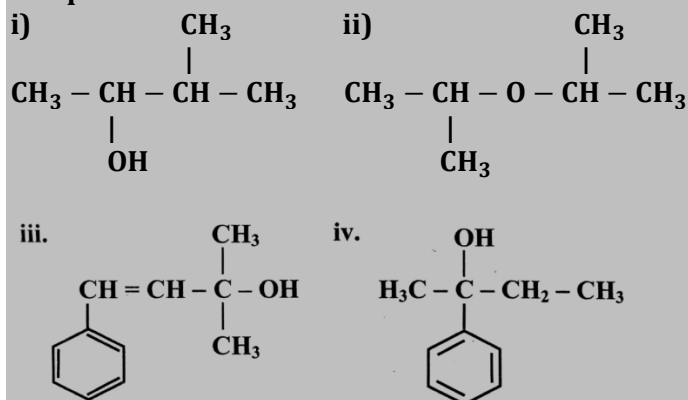


Q.18 Write the IUPAC names of the following.



Ans: i) 1-Methylcyclopentanol
ii) 2-Methylbutane-1,3-diol
iii) 2-Nitrophenol
iv) Methoxycyclohexane

Q.19 Write the IUPAC name of following compounds.



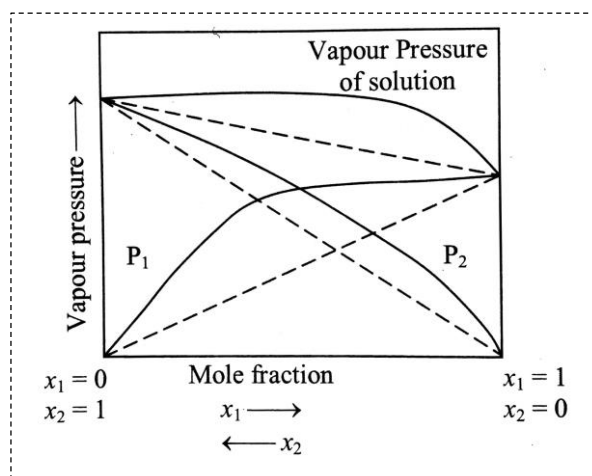
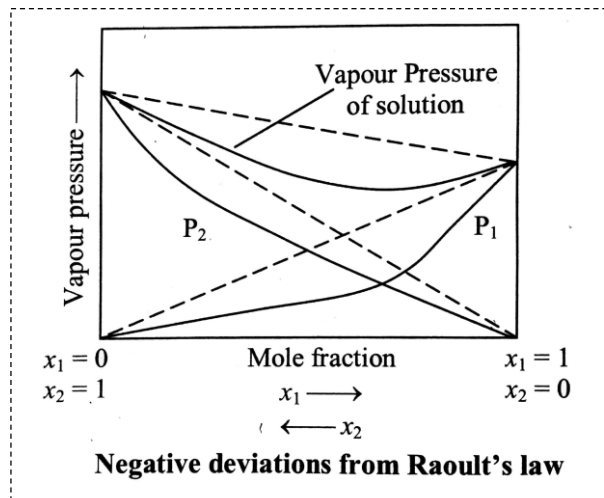
Q.20 Write a note on:**a) Positive deviation from Raoult's law.****b) Negative deviations from Raoult's law.****Ans: a) Positive deviations from Raoult's law:**

i) The above diagram represents a plot of vapour pressure vs mole fraction for a nonideal solution showing positive deviation from Raoult's law.

ii) The solutions in which solute-solvent intermolecular attractions are weaker than those between solute-solute molecules and solvent-solvent molecules, exhibit positive deviations.

iii) The vapour pressures of such solutions are higher than those of pure components as shown in Figure.

iv) e.g. The solutions of ethanol and acetone, carbon disulphide and acetone show positive deviations from the Raoult's law.

**b) Negative deviations from Raoult's law:**

i) The solutions in which the interactions between solvents and solute molecules are stronger than solute-

solute or solvent-solvent interactions, exhibit negative deviations.

ii) The vapour pressures of such solutions are lower than those of pure components as shown in figure.

iii) e.g. The solutions of phenol and aniline, chloroform and acetone exhibit negative deviations from the Raoult's law.

Q.21 Differentiate between ideal and nonideal solutions.**OR****Q.21 Give four examples of nonideal solutions.****Ans: Ideal and Nonideal solutions:**

No	Ideal solutions	Nonideal solutions
i	Ideal solutions obey Raoult's law over entire range of concentrations.	Nonideal solutions do not obey Raoult's law over the entire range of concentration.
ii	The vapour pressure of ideal solution always lies between vapour pressures of pure components.	The vapour pressures of these solutions can be higher or lower than those of pure components.
iii	Solvent-solute, solute-solute and solvent-solvent molecular interactions are comparable.	Solute-solvent intermolecular attractions may be weaker or stronger than those between solute-solute molecules and solvent-solvent molecules.
iv	e.g. Benzene + toluene	e.g. Ethanol + acetone carbon disulphide + acetone Phenol + aniline Chloroform + acetone

प्रस्तावना- विद्युत रसायनशास्त्र हि भौतिक रसायनशास्त्राची शाखा आहे. यामध्ये रासायनिक बदल आणि विद्युत यांच्या परस्परसंबंधाचा विद्युत अपघटनी द्रावणांच्या रोधाचा प्रवहनासारख्या भौतिक गुणधर्माचाही विचार केला जातो. या शास्त्रात विद्युत अपघटनींच्या वेगवेगळ्या संहतीच्या जलीय द्रावणाची वाहकता नक्की केली जाते. या माहितीचा उपयोग विद्युत अपघटनींच्या पाण्यामधील आयनीभवनाची मर्यादा कळण्यासाठी होतो. आयनाची पाण्यामधील हालचालीची पद्धत यामुळे समजते. रासायनिक अभिक्रियांमुळे निर्माण होणारी विद्युत शक्ती व विद्युत शक्तीने निर्माण होणारी रासायनिक अभिक्रिया याचा आधार क्षणॉक्स अभिक्रिया आहे. विद्युत रासायनिक घटांमध्ये विद्युत उर्जा आणि रासायनिक उर्जा यांचे एकमेकांत रूपांतर होत असते.

Electrochemistry (विद्युत रसायन शास्त्र)- Physical chemistry ची अशी branch कि, ज्या मध्ये chemical changes (रासायनिक बदल) आणि electricity (विद्युत) यांच्यातील interrelation (परस्परसंबंधाचा) अभ्यास केला जातो.

i) Oxidation (ऑक्सिडीकरण)- ज्या प्रक्रियेमध्ये electron loss (इलेक्ट्रॉनची घट) होते त्याला oxidation म्हणतात, किंवा ज्या process मध्ये पदार्थाचा किंवा मुलद्रव्याचा oxidation number वाढतो, त्या process ला oxidation असे म्हणतात.

ii) Reduction (क्षपण)- ज्या प्रक्रियेमध्ये electrons घेतला जातो, त्याला reduction म्हणतात, किंवा ज्या process मध्ये मुलद्रव्याचा oxidation number कमी होतो. त्याला reduction म्हणतात.

Redox reaction (क्षणॉक्स अभिक्रिया)- ज्या chemical reactions मध्ये oxidation आणि reduction ह्या क्रिया एकाच वेळी घडतात. त्या reaction ला redox reaction असे म्हणतात.

i) Redox reaction मध्ये एक species (पदार्थ) electron सोडतो आणि oxidise होतो, तर दुसरी species, electron घेतो आणि reduce होतो.

ii) ह्या reaction मध्ये एका species पासून दुसऱ्या species कडे electrons transfer (प्रसार) होतो, त्यामुळे reaction ला electron transfer reaction असेही म्हणतात.

iii) ह्या reaction मध्ये एका element चा oxidation number वाढतो, तर दुसऱ्या element चा oxidation number कमी होतो.

iv) अशाप्रकारे oxidation number मधील एकुण वाढ किंवा घट हि सारखीच राहते आणि redox reaction मध्ये balance (समतोल) राहतो.

i) Oxidising agent (ऑक्सिडीकारक)- जे पदार्थ electrons, gains (स्वीकारतात) त्या पदार्थांना oxidising agent किंवा oxidant म्हणतात. जेव्हा एखादी species, oxidising agent असते, तेव्हा त्यातील कमीत-कमी एका atom चा तरी oxidation number कमी

होतो. Oxidising agent हा पदार्थ दुसऱ्या पदार्थाचे oxidation करतो, मात्र त्याचवेळेस स्वतः reduce होतो.

ii) Reducing agent (क्षपणक)- जे पदार्थ electrons, donates (देतात) त्या पदार्थांना reducing agent किंवा reductant म्हणतात. जेव्हा एखादी species, reducing agent असते, तेव्हा त्यातील कमीत-कमी एका atom चा तरी oxidation number वाढतो. Reducing agent हा पदार्थ दुसऱ्या पदार्थाचे reduction करतो, मात्र त्याचवेळेस स्वतः oxidise होतो.

Conductors (वाहक)- ज्या पदार्थातून electricity (विद्युतशक्ती) पाठवता येते, किंवा त्यातून electricity चे वहन होते, त्या पदार्थांना conductors म्हणतात.

Conductors चे वर्गीकरण दोन प्रकारामध्ये केले जाते.

i) Electronic conductors (विद्युत वाहक)- दिलेल्या potential (विद्युत भारामुळे), ज्या conductors मधून electricity चे वहन हे थेट electrons च्या वहनातून होते, त्या conductors ला electronic conductors म्हणतात.

ii) Electrolytic conductors (विद्युत अपघटनी वाहक)- ज्या conductors मध्ये conductors (वहन) हे positive (धन) आणि negative (ऋण) ions च्या migration (स्थानांतरणामुळे) होते, त्या conductors ला electrolytic conductors म्हणतात.

i) Electrolytes (विद्युत अपघटनी)- ज्या पदार्थाच्या aqueous solution (जलीय द्रावणाची) conductivity हि पाण्याच्या conductivity पेक्षा खूप जास्त असते, त्या पदार्थांना electrolytes म्हणतात.

ii) Non-electrolytes (विद्युत अनपघटनी)- ज्या पदार्थाच्या aqueous solution ची conductivity हि पाण्याच्या conductivity एवढी असते, अशा पदार्थांना non-electrolytes असे म्हणतात.

Dissociation (विचरणावरून) electrolytes चे विभाजन दोन प्रकारे होते.

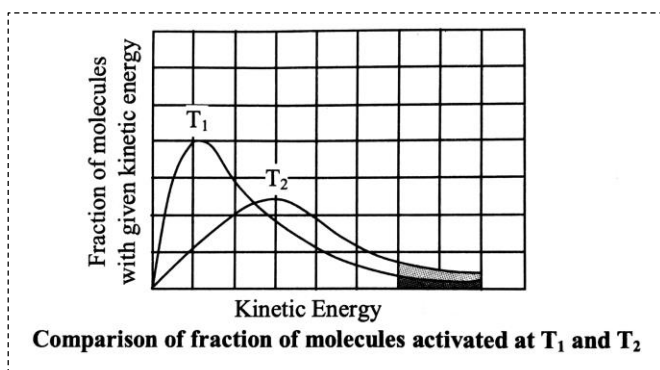
a) Strong electrolytes (प्रबल विद्युत अपघटनी)- जे पदार्थ aqueous solution मध्ये पूर्णपणे ionize (आयनीभवन) होतात, त्या पदार्थांना strong electrolyte म्हणतात.

b) Weak electrolyte (दुर्बल विद्युत अपघटनी)- जे पदार्थ aqueous solution मध्ये अगदी थोड्या प्रमाणात ionize होतात, त्या पदार्थांना weak electrolyte असे म्हणतात.

i) Resistance (रोध)- solution मध्ये current च्या वहनाला होणारा hindrance (अडथळा) म्हणजेच resistance होय. तो R ह्या अक्षराने दर्शवितात.

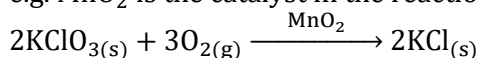
Q.42 Explain graphically the effect of temperature on the rate of reaction.**Ans: Effect of temperature on the rate of reaction:**

- The average kinetic energy of molecules is proportional to temperature.
- At a given temperature, the fraction of molecules with their kinetic energy equal to or greater than E_a may lead to the product.
- With an increase of temperature, the fraction of molecules having their energies (E_a) would increase. The rate of the reaction thus would increase.
- This is depicted by plotting a fraction of molecules with given kinetic energy versus kinetic energy for two different temperature T_1 and T_2 ($T_2 > T_1$). The area is the same at T_1 and T_2 .
- The entire shaded area which represented a fraction of molecules with kinetic energy exceeding E_a is larger at T_2 than at T_1 ($T_2 > T_1$).
- This indicates that a fraction of molecules possessing energies larger than E_a increase with temperature. The rate of reaction increases accordingly.

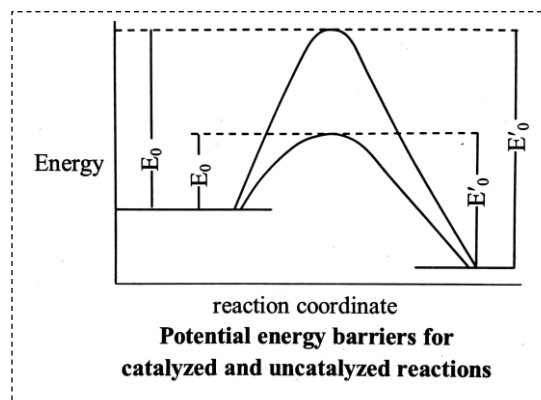
**6.8 Effect of catalyst on the rate of reaction****Q.43 What is a catalyst? Give an example.**

Ans: Catalyst: A catalyst is a substance added to the reactant that increases the rate of the reaction without itself being consumed in the reaction.

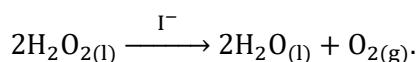
e.g. MnO_2 is the catalyst in the reaction;

**Q.44 How catalyst increases the rate of reaction? Explain with the help of potential energy diagram for catalyzed and uncatalyzed reactions.**

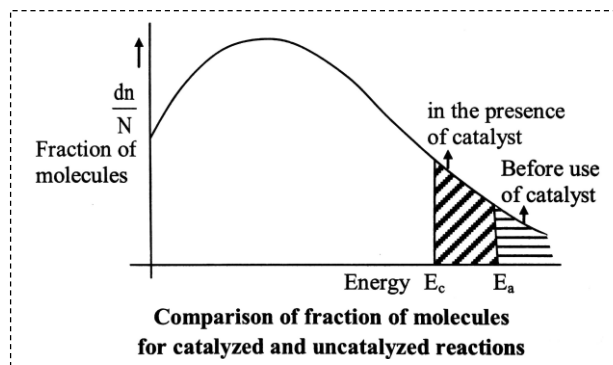
- Ans:** i) A catalyst provides alternative pathway associated with lower activation energy.
 ii) The potential energy diagram compares the potential energy barriers for the catalyzed and uncatalyzed reactions. The barrier for uncatalyzed reaction (E_a) is larger than that for the same reaction in the presence of a catalyst (E_c).



- iii) Consider the decomposition of H_2O_2 in aqueous solution catalysed by I^- ions



- iv) At room temperature the rate of reaction is slower in the absence of catalyst with its activation energy being 76 kJ mol^{-1} . In the presence of catalyst, iodide ion (I^-), the reaction is faster since the activation energy decreases to 57 kJ mol^{-1} .

Q.45 Explain graphically the effect of catalyst on the rate of reaction.**Ans: Effect of catalyst on the rate of reaction:**

- A catalyst lowers the threshold energy.
- Consequently, more molecules acquire the minimum amount of energy and tend to cross the energy barrier.

Q.45 Explain: Oxoacids of sulfur.**Q.45 Draw structures of the following compounds****peroxy disulphuric acid (Feb/March-2023)-1M****(Feb/March-2024)-1M****Ans: Oxoacids of sulfur:**

Sulfur forms a number of oxoacids. Some of them are unstable and cannot be isolated. They are known to exist in aqueous solutions or in the form of their salts. Some important oxoacids of sulfur and their structures are given below:

i	Sulfurous acid, H_2SO_3	
ii	Sulfuric acid, H_2SO_4	
iii	Disulfuric acid or pyrosulfuric acid, $\text{H}_2\text{S}_2\text{O}_7$	
iv	Peroxymonosulfuric acid, H_2SO_5	
v	Peroxydisulfuric acid, $\text{H}_2\text{S}_2\text{O}_8$	
vi	Thiosulfuric acid, $\text{H}_2\text{S}_2\text{O}_3$	

Q.46 What is the oxidation state of 'S' in H_2SO_4 ?

Ans: (Oxidation number of H) + (Oxidation number of S) + (Oxidation number of O) = 0

$$2 \times (+1) + (\text{Oxidation number of S}) + 4 \times (-2) = 0$$

$$\text{Oxidation number of S} + 2 - 8 = 0$$

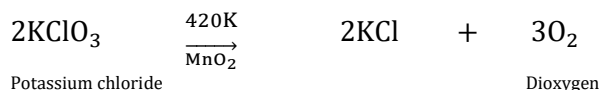
$$\text{Hence, oxidation number of 'S' in } \text{H}_2\text{SO}_4 = +6$$

Q.47 Write the names and structural formulae of oxoacids of chlorine.**Q.47 Draw structures of the following compounds****chloric acid (Feb/March-2023)-1M****Ans:**

i	Hypochlorous acid, HOCl	
ii	Chlorous acid, HOClO or HClO_2	
iii	Chloric acid, HClO_3	
iv	Perchloric acid, HClO_4	

7.9 Oxygen and compounds of oxygen**Q.48 How is dioxygen prepared in laboratory from KClO_3 ?****OR****Q.48 How is oxygen prepared by Laboratory method.**

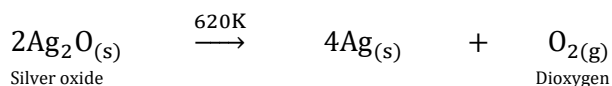
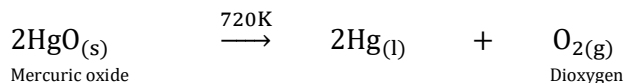
Ans: Laboratory method: In the laboratory dioxygen can be prepared very conveniently by heating a mixture of KClO_3 (4 parts) in a hard tube to about 420K. The gas thus produced may be collected by the downward displacement of water.



MnO_2 acts as catalysts. In the absence of manganese dioxide, the thermal decomposition of KClO_3 requires temperature of 670K - 720K. MnO_2 lowers it to about 420K.

Q.49 How is dioxygen prepared in laboratory from following compounds?

i) Ag_2O ii) HgO iii) PbO_2 iv) H_2O_2

Ans: i) Thermal decomposition of Ag_2O :**ii) Thermal decomposition of HgO :**

Q.37 Write note on: Optical isomer (or enantiomers).

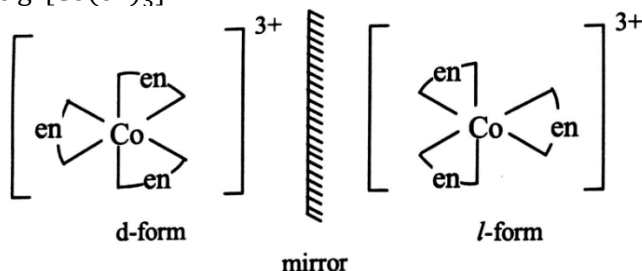
Ans: Optical isomer: Optical isomers are also called as enantiomers.

i) The complex molecules or ions that are nonsuperimposable mirror images of each other are enantiomers.

ii) The nonsuperimposable mirror images are chiral.

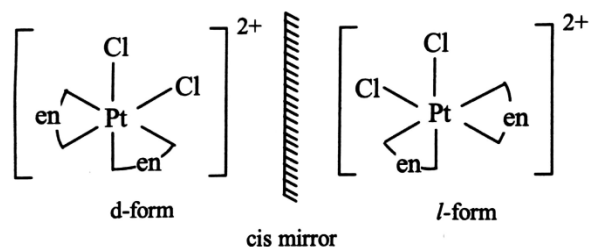
v) Optical isomers in octahedral complexes:

e.g. $[\text{Co}(\text{en})_3]^{3+}$

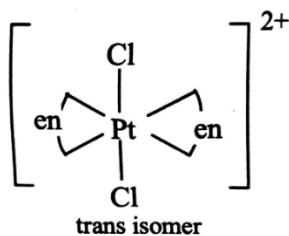


vi) Octahedral complexes existing as both geometric and optical isomers. e.g. $[\text{PtCl}_2(\text{en})_2]^{2+}$

1) Cis isomer of the complex show optical isomerism.



2) Trans isomer of $[\text{PtCl}_2(\text{en})_2]^{2+}$ does not show optical isomerism as it has a plane of symmetry.



vii) Square planar complexes do not show enantiomers since they have mirror plane and axis of symmetry.

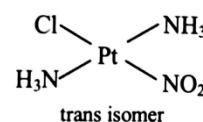
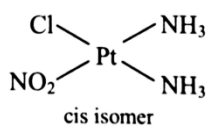
Q.38 Draw isomers in each of the following

i) $\text{Pt}(\text{NH}_3)_2\text{ClNO}_2$

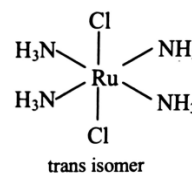
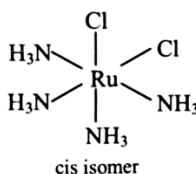
ii) $\text{Ru}(\text{NH}_3)_4\text{Cl}_2$

iii) $[\text{Cr}(\text{en})_2\text{Br}_2]^+$

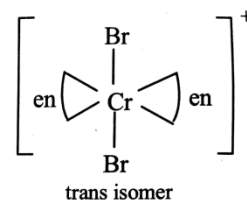
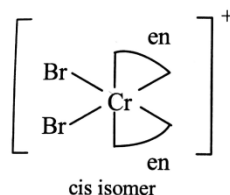
Ans: i) Cis and trans isomers of $\text{Pt}(\text{NH}_3)_2\text{ClNO}_2$

**ii) $\text{Ru}(\text{NH}_3)_4\text{Cl}_2$**

Cis and trans isomers of $\text{Ru}(\text{NH}_3)_4\text{Cl}_2$

**iii) $[\text{Cr}(\text{en})_2\text{Br}_2]^+$**

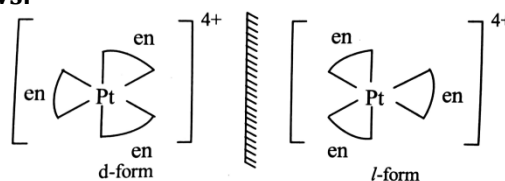
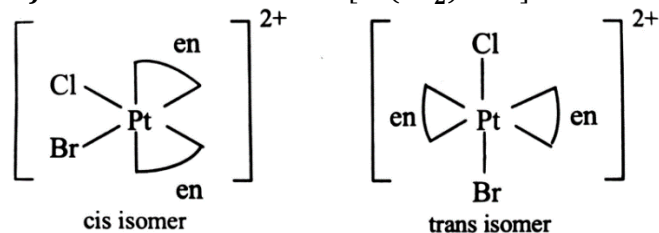
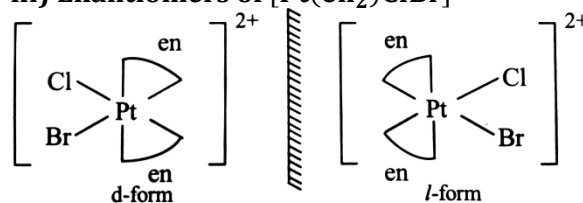
a) Cis and trans isomer of $[\text{Cr}(\text{en})_2\text{Br}_2]^+$

**Q.39 Draw geometric isomers and enantiomers of the following complexes.**

i) $[\text{Pt}(\text{en})_3]^{4+}$

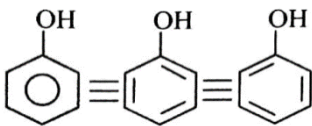
ii) $[\text{Pt}(\text{en})_2\text{ClBr}]^{2+}$

Ans: i) $[\text{Pt}(\text{en})_3]^{4+}$ shows only enantiomers as follows:

**ii) Geometric isomers of $[\text{Pt}(\text{en})_2\text{ClBr}]^{2+}$** **iii) Enantiomers of $[\text{Pt}(\text{en})_2\text{ClBr}]^{2+}$** 

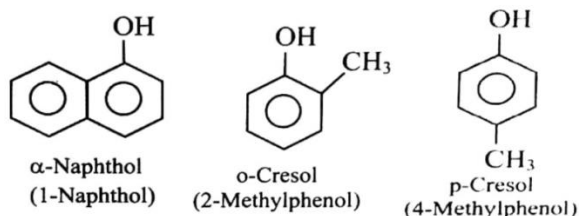
Q.8 What are phenols? How are they classified?

Ans: Phenols: Phenols are organic aromatic, hydroxyl compounds, in which one or more hydroxyl ($-OH$) groups are directly attached to the aromatic nucleus (i.e., benzene like ring). It is represented as $Ar - OH$.

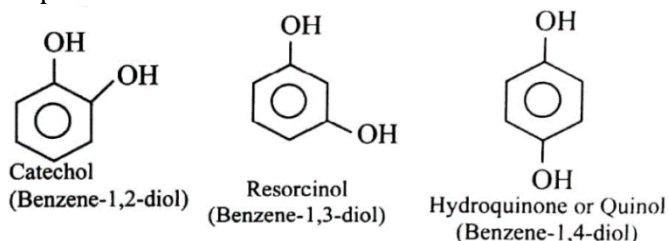
**Phenols are classified as follows:**

The classification depends upon the presence of one, two or three hydroxyl groups attached to aromatic ring.

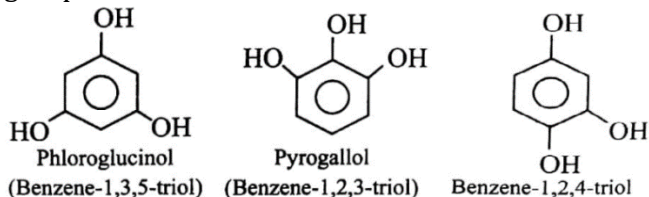
i) Monohydric phenols: They contain one hydroxyl groups.



ii) Dihydric phenols: They contain two hydroxyl groups.



iii) Trihydric phenols: They contain three hydroxyl groups.

**Q.9 How are monohydric alcohols classified?**

Ans: Classification of monohydric alcohols:

Monohydric alcohols are further classified on the basis of hybridization of the carbon atom to which hydroxyl group is attached.

i) Alcohols containing $C_{sp^3} - OH$ bond: In these alcohols, $-OH$ group is attached to sp^3 hybridised carbon atom of an alkyl, allyl or benzylic group.

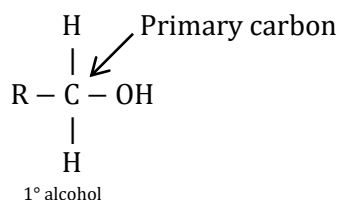
They are further classified as primary, secondary and tertiary alcohols.

a) Alkyl alcohols:

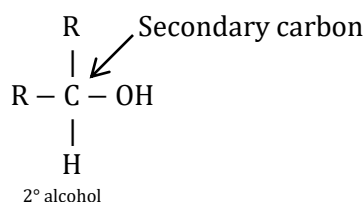
1) In this type of alcohols, $-OH$ group (hydroxyl group) is attached to sp^3 hybridised carbon atom of an alkyl group.

2) They are further classified on the basis of the nature of carbon atom ($1^\circ, 2^\circ, 3^\circ$) to which hydroxyl group is attached.

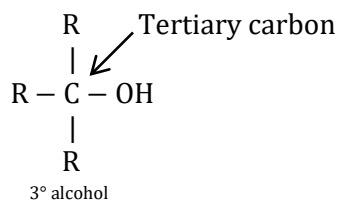
i) Primary (1°) alcohols: The hydroxyl ($-OH$) group is attached to a primary carbon atom.



ii) Secondary (2°) alcohols: The hydroxyl ($-OH$) group is attached to a secondary carbon atom.



iii) Tertiary (3°) alcohols: The hydroxyl ($-OH$) group is attached to tertiary carbon atom.



Tertiary alcohols चे oxidation सहजरित्या होत नाही, त्यासाठी strong oxidizing agent CrO_3 किंवा KMnO_4 च्या सानिध्यात त्याचे oxidation केले जाते.

प्रश्नातील reaction मध्ये tert Butyl alcohol चे oxidation होऊन २-methylpropene मिळते, पुन्हा २-methylpropene चे oxidation होऊन Acetone मिळतो. पुन्हा Acetone चे oxidation होऊन Acetic acid मिळते, यालाच tertiary alcohol चे oxidation म्हणतात. प्रश्नातील सर्व reactions चे नीट निरीक्षण करून समजावून घ्या.

i) Phenol चे Bromination म्हणजेच त्याची reaction bromine water बरोबर कमी temperature ला केल्यावर २, ४, ६ tribromophenol तयार होते. वरील प्रश्नातील reaction पहा.

ii) जेंव्हा phenol ची Br_2 (organic solvent च्या स्वरूपातील) म्हणजेच CS_2 , CCl_4 किंवा CHCl_3 च्या उपस्थितीत २७३ K temperature ला reaction घडविल्यानंतर ortho-bromophenol आणि para bromophenol यांचे मिश्रण तयार होते.

iii) Phenol ची conc. H_2SO_4 बरोबर २९८ K ह्या temperature ला reaction होऊन ortho-phenol sulphonic acid तयार होते. तसेच phenol ची conc. H_2SO_4 बरोबर ३७३ K ह्या temperature ला para-phenol sulphonic acid तयार होते.

iv) phenol ची dilute HNO_3 बरोबर room temperature ला reaction घडविल्यावर ortho-nitrophenol आणि para-nitrophenol यांचे मिश्रण तयार होते.

v) Phenol ची hot आणि conc. HNO_3 बरोबर conc. H_2SO_4 च्या उपस्थित reaction घडवून आणल्यावर picric acid म्हणजेच २,४,६, Tri-nitrophenol तयार होते.

i) Kolbes reaction (कोल्बस अभिक्रिया): phenoxide ion आणि carbon dioxide यांच्यातील electrophilic substitution reaction कि, ज्यातून ortho-Hydroxy benzoic acid मिळते, त्या reaction ला kolbes reaction म्हणतात.

सुरुवातीला phenol ची NaOH बरोबर reaction होऊन phenoxide ion तयार होते, त्यानंतर phenoxide ion म्हणजेच sodium phenoxide चे carbon dioxide बरोबर electrophilic substitution होऊन ortho-hydroxy benzoic acid तयार होते. प्रश्नातील reaction पहा.

ii) Reimer-Tiemann reaction (रिमेर-टायमन अभिक्रिया): जेंव्हा phenol हे chloroform बरोबर sodium hydroxide च्या उपस्थितीत मिसळले असता, $-\text{CHO}$ group हा benzene ring च्या ortho position ला जातो, त्यामुळे ह्या reaction ला Reimer-Tiemann reaction असे म्हणतात. निर्माण झालेल्या Intermediate चे alkali च्या उपस्थितीत hydrolysis केल्यावर salicylaldehyde तयार होते. प्रश्नातील reaction पहा.

i) जेंव्हा phenol हे zinc dust बरोबर तापवल्यावर त्याचे रूपांतर benzene मध्ये होते.

ii) Phenol चे chromic acid ($\text{Na}_2\text{Cr}_2\text{O}_7$) बरोबर H_2SO_4 च्या उपस्थितीत oxidation केल्यावर benzaquinone तयार होते.

iii) जेंव्हा phenol ची hot आणि conc. HNO_3 बरोबर conc. H_2SO_4 च्या उपस्थितीत reaction केली असता, पिवळ्या रंगाचे picric acid म्हणजेच Trinitrophenol तयार होते.

तीन हि reactions, प्रश्नामध्ये दिल्या आहेत, त्याचे व्यवस्थित अवलोकन करून लक्षात ठेवा.

ह्या reactions मध्ये simple तसेच mixed ethers ची निर्मिती होते.

i) जेंव्हा methyl iodide हे alcoholic sodium methoxide बरोबर heating केल्यावर dimethyl ether मिळते.

ii) methyl iodide हे sodium ethoxide बरोबर heating केल्यावर ethyl methyl ether मिळते.

iii) Ethyl bromide हे sodium ethoxide बरोबर heating केल्यावर diethyl ether मिळते.

Williamsons method मध्ये alkyl halide मधील halogen atom चे nucleophile द्वारे replacement होते, त्यामुळे ह्या reaction ला Williamsons synthesis म्हणतात.

१) Anisole चे bromine आणि acetic acid बरोबर bromination, FeBr_3 ह्या catalyst च्या उपस्थितीत केल्यावर अनुक्रमे p-Bromoanisole आणि O-Bromoanisole मिळतात.

२) Anisole चे nitration हे nitrating mixture म्हणजेच conc. HNO_3 आणि conc. H_2SO_4 सोबत केल्यावर २-nitroanisole आणि ४-nitroanisole मिळते.

३) Friedel- crafts reaction म्हणजेच anisole चे alkylation होय. यामध्ये anisole ची methyl chloride (chloromethane) बरोबर anhydrous aluminium chloride (anhy. AlCl_3) च्या उपस्थितीत reaction केल्यावर २-methoxytoluene आणि ४-methoxytoluene तयार होतात.

४) Friedel- crafts acylation reaction मध्ये anisole ची acetyl chloride बरोबर anhydrous AlCl_3 ह्या catalyst च्या उपस्थितीत reaction केल्यावर २-methoxyacetophenone आणि ४-methoxyacetophenone तयार होतात.

प्रश्नातील सर्व reactions समजून घेऊन लक्षात ठेवा.



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