Maharastra Board | Class 12 Chemistry

Previous 3-Year Questions with Detailed Solutions (2022-2024)

93 Questions

of Chemistry with Detailed Solution

CAREERS360

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About This Book

Welcome to the comprehensive collection of Maharashtra Board Class 12 Chemistry Previous 3-Year Questions with Detailed Solutions (2022-2024). This ebook is designed to be your go-to resource for mastering the Class 12 Chemistry syllabus and excelling in your exams.

Inside This Ebook:

- **Thorough Syllabus Coverage:** Dive into a curated compilation of questions from the past three years (2022, 2023, and 2024), covering all essential topics and ensuring no concept is left unaddressed.
- **Elaborate Solutions:** Benefit from precise, step-by-step solutions to each question, crafted to simplify complex concepts and enhance your problem-solving skills.
- **Strategic Exam Preparation:** Utilize this ebook as a strategic tool for revision and practice, gaining familiarity with the exam pattern and the variety of questions typically encountered.
- **Expertly Crafted Content:** All solutions are prepared by seasoned educators, ensuring they are accurate, comprehensive, and easy to follow.

This ebook is more than just a collection of questions and answers; it's a complete study guide designed to support you through your academic journey. Whether you're aiming to reinforce your understanding, practice rigorously, or get a clear grasp of intricate concepts, this resource is tailored to meet your needs and help you achieve excellence in your Class 12 Chemistry exams.

Happy learning!

Warm regards,
Team Careers360

Maharashtra Board Class 12 Chemistry
Solutions - 2024

SECTION-A

Q. 1. Select and write the correct answer for the following multiple-choice type of questions :
(i) The spin only magnetic moment of Cr^{3+} cation is .
(a) 3.742 BM
(b) 3.755 BM
(c) 3.873 BM
(d) 3.633 BM

Solution:

To determine the spin-only magnetic moment of Cr^{3+}, we consider the number of unpaired electrons in the ion. Chromium (Cr) has an atomic number of 24, with the electron configuration $[Ar]3d^5 4s^1$. When Cr loses three electrons to form Cr^{3+}, the configuration becomes $[Ar]3d^3$, meaning there are 3 unpaired electrons. The spin-only magnetic moment (μ) is given by:

$$\mu = \sqrt{n(n+2)}\,\text{BM}$$

where n is the number of unpaired electrons. For Cr^{3+}, $n = 3$:

$$\mu = \sqrt{3(3+2)}\,\text{BM} = \sqrt{15}\,\text{BM} \approx 3.873\,\text{BM}$$

Thus, the spin-only magnetic moment of Cr^{3+} is approximately 3.873 BM, which corresponds to option (c).

(ii) The linkage present in Lactose is
(a) $\alpha, \beta - 1, 2-$ glycosidic linkage
(b) $\alpha - 1, 4$-glycosidic linkage
(c) $\beta - 1, 4-$ glycosidic linkage
(d) $\alpha - 1, 4-$ glycosidic linkage

Solution:

The linkage present in lactose is a β-1,4-glycosidic linkage. Therefore, the correct answer is:

(c) β-1,4-glycosidic linkage

(iii) The product of the following reaction is

$$C_2H_5\text{-}C(=O)\text{-}CH_3 \xrightarrow{H_2/Ni,\Delta} ?$$

(a) CH_3-CH_2-CH_2-CH_2-OH

(b) CH_3-CH_2-CH(OH)-CH_3

(c) CH_3-CH_2-CH_2-CH_3

(d) CH_3-CH_2-CH_2-COOH

Solution: Correct option is (b)

$$C_2H_5 - \overset{\overset{O}{\|}}{C} - CH_3 \xrightarrow[\Delta]{H_2/Ni} CH_3 - \underset{\underset{OH}{|}}{CH} - CH_2 - CH_3$$

(iv) The pH of 0.001 M HCl solution is

(a) 10

(b) 3

(c) 2

(d) 11

Solution:

To calculate the pH of a 0.001 M HCl solution:

HCl is a strong acid and dissociates completely in water:

$$HCl \rightarrow H^+ + Cl^-$$

Therefore, the concentration of H+\text{H}^+H+ ions will be equal to the concentration of HCl, which is 0.001 M.

The pH is calculated using the formula:

$$pH = -\log[H^+]$$

Substituting the concentration of H+:

$pH = -\log[0.001] = -\log[10^{-3}] = 3$

Therefore, the pH of the 0.001 M HCl solution is: (b) 3

(v) The correct structure of complex having IUPAC name sodium hexanitrocobaltate (III) is

(a) $Na_3\,[Co(NO_2)_5]$

(b) $Na_4\,[Co(NO_2)_6]$

(c) $Na_3\,[Co(NO_2)_6]$

(d) $Na_4\,[Co(NO_2)_5]$

Solution: The IUPAC name sodium hexanitrocobaltate(III) indicates the complex contains six nitrito ligands (NO_2^-) and cobalt in the +3 oxidation state. The complex ion is $[Co(NO_2)_6]^{3-}$, which requires three Na^+ ions to neutralize the charge.

Thus, the correct structure is:

$$Na_3[Co(NO_2)_6]$$

The correct answer is:(c)

(vi) The number of particles present in Face Centred Cubic Unit Cell is/are

(a) 1

(b) 2

(c) 3

(d) 4

Solution: The number of particles present in the centered Cubic Unit Cell is 4.

Hence the correct option is (d) 4.

(vii) The monomer used in preparation of teflon is .

(a) E caprolactam

(b) vinyl chloride

(c) styrene

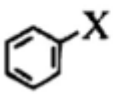
(d) tetrafluoroethylene

Solution: The monomer used in preparation of teflon is tetrafluoroethlene.

Hence the correct option is (d) tetrafluoroethlene.

(viii) Among the following vinylic halide is _____.

(a) $R-\underset{\displaystyle X}{\underset{|}{CH}}-R$ (b) $CH_2=CH-X$

(c)  (d) $CH_2=CH-CH_2-X$

Solution: Among the following vinylic halide.

$$\underline{\mathrm{CH_2 = CH - X.}}$$

Hence the correct option is (b).

(ix) The product of hydrolysis of propyne in the presence of $1\%\mathrm{H_gSO_4}$ and $40\%\mathrm{H_2SO_4}$ is
(a) methanal
(b) ethanal
(c) propanal
(d) propanane

Solution: Hence the correct option is (d) propanone.

(x) If unit of rate constant is $\mathrm{moldm^{-3}\ s^{-1}}$, the order of reaction would be
(a) zero
(b) 1
(c) 2
(d) 3

Solution:

If the unit of the rate constant is $\mathrm{mol\ dm^{-3}s^{-1}}$, the order of the reaction can be determined using the general formula for the units of the rate constant:

$$\text{Unit of rate constant} = [\text{concentration}]^{1-n}[\text{time}]^{-1}$$

Given that the unit of the rate constant is $\mathrm{mol\ dm^{-3}s^{-1}}$:

$$\mathrm{mol\ dm^{-3}s^{-1}} = \left[\mathrm{mol\ dm^{-3}}\right]^{1-n}[\mathrm{s}]^{-1}$$

We can see that:

$$\left[\mathrm{mol\ dm^{-3}}\right]^{1-n} = \mathrm{mol\ dm^{-3}}$$

which implies:

$$1 - n = 1 \Rightarrow n = 0$$

So, the order of the reaction is zero.

Thus, the correct answer is:

SECTION-B

Attempt any EIGHT of the following questions :

Q. 2. Answer the following questions :

(i) Write the name of the metal nanoparticle used to remove E.coli bacteria from water.

(ii) Write the name of the reduction product formed when ethyl

(v) The compounds of Ti^{4+} ions are colourless due to cyanide is treated with sodium and alcohol.

(vi) Write the SI unit of molar conductivity.

(vii) Write the sign convention of work done during the expansion of gas.

(iii) Complete the reaction: $CH_3CH_2Cl \xrightarrow[\text{alc. } \Delta]{Ag_gCN}$?

(iv) Calculate effective atomic number of $[Co(NH_3)_6]^{3+}$ ion.

(viii) Write the condition of reverse osmosis.

Solution:

(i) Silver nanoparticles

(ii) Mendius Reduction

(iii) Ethyl chloride

$$CH_3CH_2Cl \xrightarrow{AgCN alc \cdot \Delta} CH_3{-}CH_2{-}NC$$

(iv) To calculate the effective atomic number (EAN) of $[Co(NH_3)_6]^{3+}$ ion, we use the formula:

$$EAN = Z - x + n \times y$$

For $[Co(NH_3)_6]^{3+}$, where $Z = 27$ (atomic number of Co), $x = 3$ (oxidation state), $n = 6$ (number of ligands), and $y = 2$ (electrons donated by each ligand):

$$EAN = 27 - 3 + 6 \times 2 = 36$$

Thus, the effective atomic number of $[Co(NH_3)_6]^{3+}$ is 36.

(v) The compounds of Ti4+ ions are colorless due to the absence of d-d electron transitions.

(vi) the SI unit of molar conductivity is $S \cdot m^2 \cdot mol^{-1}$.

(vii) The sign convention for work done during the expansion of gas follows these principles:

- When a gas expands, it does work on the surroundings.

- According to the sign convention in thermodynamics, work done by the system (the gas) on the surroundings is considered negative.

Therefore, during the expansion of a gas, the work done by the gas is negative.

(viii) Reverse osmosis occurs when pressure is applied to a solution to overcome the natural osmotic pressure, forcing the solvent to move through a semi-permeable membrane from a region of higher solute concentration to a region of lower solute concentration.

The conditions for reverse osmosis to occur are:

The applied pressure must be greater than the osmotic pressure of the solution.**

This external pressure forces the solvent (usually water) to flow in the opposite direction of natural osmosis, allowing for the separation of solute and solvent.

Q. 3. Derive an expression for maximum work obtainable during isothermal reversible expansion of an ideal gas from initial volume (V_1) to final volume (V_2).

Solution: The maximum work obtainable during an isothermal reversible expansion of an ideal gas from initial volume V_1 to final volume V_2 is given by:

$$W_{\max} = -nRT \ln\left(\frac{V_2}{V_1}\right)$$

where n is the number of moles, R is the gas constant, and T is the temperature.

Q. 4. What are interhalogen compounds? Write the chemical reacuon, when chlorine reacts with dry slaked lime.

Solution Interhalogen Compounds

Interhalogen compounds are molecules formed between two different halogen atoms (elements from Group 17 of the periodic table). These compounds can involve any combination of halogens such as fluorine, chlorine, bromine, iodine, and astatine. Interhalogen compounds typically have the general formula XYn where X and Y are halogens and n can be 1, 3, 5, or 7.

Chemical Reaction of Chlorine with Dry Slaked Lime

When chlorine reacts with dry slaked lime (calcium hydroxide, Ca(OH)2, it forms bleaching powder, which is a mixture of calcium hypochlorite, calcium chloride, and water. The chemical reaction can be written as follows:

$$2Cl2+2Ca(OH)2 \rightarrow Ca(OCl)2+CaCl2+2H2O$$

Q. 5. What is nano material? Write the reaction involved in sol-gei process during hydrolysis.

Solution: A nanomaterial is a material with structural components smaller than 100 nanometers in at least one dimension. The reaction involved in the sol-gel process during hydrolysis is:

$$\mathrm{M(OR)}_n + n\mathrm{H_2O} \rightarrow \mathrm{M(OH)}_n + n\mathrm{ROH}$$

where M is a metal and OR is an alkoxide group.

Q. 6. Write classification of proteins with an example.

Solution: Proteins can be classified into two main categories: fibrous proteins and globular proteins.

Collagen, is found in connective tissues such as tendons and ligaments.

Hemoglobin, is responsible for the transport of oxygen in the blood.

Q. 7. Calculate the time required to deposit 2.4 g or Cu , wnen $\angle.\,\mathrm{U}\Omega$ of current passed through $\mathrm{CuSO_4}$ solution.
(At. mass of $\mathrm{Cu} = 63.5\ \mathrm{g \cdot mol^{-1}}$)

Solution: To calculate the time required to deposit 2.4 g of Cu using 2.03 A of current, use Faraday's laws:

$$\text{Moles of Cu} = \frac{2.4\,\mathrm{g}}{63.5\,\mathrm{g/mol}} = 0.0378\,\mathrm{mol}$$

$$\text{Charge (Q)} = 0.0378\,\mathrm{mol} \times 2 \times 96485\,\mathrm{C/mol} = 7294.596\,\mathrm{C}$$

$$\text{Time (t)} = \frac{Q}{I} = \frac{7294.596\,\mathrm{C}}{2.03\,\mathrm{A}} \approx 3594\,\mathrm{s} \approx 59.9\,\mathrm{minutes}$$

Q. 8. Why amines are basic in nature? Among dimethylamine $(\mathrm{pK_b} = 3.27)$ and diethylamine $(\mathrm{pK\ b} = 3.0)$, which one is more basic?

Solution: Amines are basic in nature because they have a lone pair of electrons on the nitrogen atom that can accept a proton ($\mathrm{H^+}$). Among dimethylamine ($\mathrm{p}K_b = 3.27$) and diethylamine ($\mathrm{p}K_b = 3.0$), diethylamine is more basic because a lower $\mathrm{p}K_b$ value indicates a stronger base.

Thus, diethylamine is more basic than dimethylamine.

Q. 9. Explain buffer action of sodium acetate-acetic acid buffer.

Solution: The sodium acetate-acetic acid buffer works by maintaining the pH when small amounts of acid or base are added. When an acid ($\mathrm{H^+}$) is added, acetate ions ($\mathrm{CH_3COO^-}$) react with the $\mathrm{H^+}$ to form acetic acid ($\mathrm{CH_3COOH}$):

$$\mathrm{CH_3COO^- + H^+ \rightarrow CH_3COOH}$$

When a base ($\mathrm{OH^-}$) is added, acetic acid reacts with $\mathrm{OH^-}$ to form water and acetate ions:

$$CH_3COOH + OH^- \rightarrow CH_3COO^- + H_2O$$

This equilibrium reaction helps to resist changes in pH.

Q. 10. Write preparation of (a) diethyl ether (b) ethyl cyanide from ethyl bromide.

Solution:

(a) Preparation of diethyl ether from ethyl bromide:

$$2\,C_2H_5Br + Na_2O \rightarrow C_2H_5OC_2H_5 + 2\,NaBr$$

(b) Preparation of ethyl cyanide from ethyl bromide:

$$C_2H_5Br + KCN \rightarrow C_2H_5CN + KBr$$

Q. 11. Henry's constant for $CH_3Br_{(g)}$ is $0.159\ moldm^{-3}$. bar $^{-1}$ at $25^\circ C$. Calculate its solubility in water at $25^\circ C$, if its partial pressure is 0.164 bar.

Solution: Henry's law states that the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid:

$$S = k_H \cdot P$$

Given Henry's constant (k_H) for CH_3Br is $0.159\,mol\,dm^{-3}\,bar^{-1}$ and the partial pressure (P) is $0.164\,bar$:

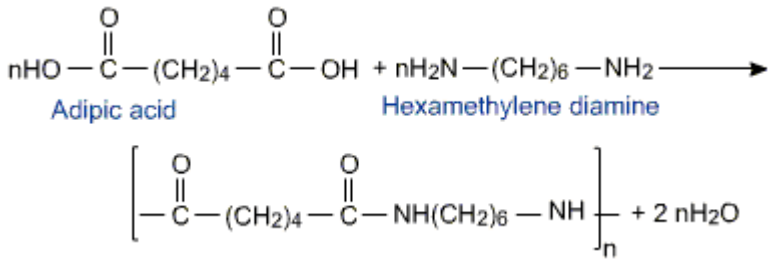
$$S = 0.159\,mol\,dm^{-3}\,bar^{-1} \times 0.164\,bar = 0.0261\,mol\,dm^{-3}$$

Thus, the solubility of CH_3Br in water at 25°C is $0.0261\,mol\,dm^{-3}$.

Q. 12. Write the structure and name of the monomer of
(a) Nylon-6
(b) Natural rubber

Solution:

Nylon- 6,6
- Monomers involved are adipic acid $(HOOC-(CH_2)_4-COOH)$ and hexamethylenediamine $(H_2N-(CH_2)_6-NH_2)$.
- Nylon-6,6 is a polyamide.



(b) Natural rubber is a natural homopolymer having isoprene as the monomer. IUPAC name of isoprene is 2-methylbuta-1,3-diene.. The structure of the same is shown below.

	Structure	Monomer
Natural rubber	$\underset{\text{(isoprene)}}{\overset{\overset{\overset{\mathrm{CH_3}}{\vert}}{\mathrm{CH_2=C-CH=CH_2}}}{}}$	isoprene

Q. 13. Define Lanthanide contraction. Write the balanced chemical equations when acidified $\mathrm{K_2Cr_2O_7}$ reacts with $\mathrm{H_2\ S}$.

Solution: Lanthanide contraction refers to the gradual decrease in the atomic and ionic radii of the lanthanide series elements from La (Lanthanum) to Lu (Lutetium) due to the poor shielding effect of the 4f electrons.

The balanced chemical equation for the reaction of acidified $\mathrm{K_2Cr_2O_7}$ with $\mathrm{H_2S}$ is:

$$\mathrm{K_2Cr_2O_7 + H_2SO_4 + 3H_2S \rightarrow Cr_2(SO_4)_3 + 3S + 4H_2O + K_2SO_4}$$

Q. 14. Derive the relationship between molar mass, density of the substance and unit cell edge length.

Solution: The relationship between molar mass (M), density (ρ), and unit cell edge length (a) for a cubic crystal system is given by:

$$\rho = \frac{Z \cdot M}{N_A \cdot a^3}$$

SECTION-C

Attempt any EIGHT of the following questions :

Q. 15. What is osmotic pressure? How will you determine the molar mass of solute from osmotic pressure?

Solution: Osmotic pressure (Π) is the pressure required to stop the flow of solvent molecules through a semipermeable membrane from a dilute solution to a concentrated solution. It is given by the equation:

$$\Pi = CRT$$

To determine the molar mass (M) of a solute from osmotic pressure, use the relationship:

$$M = \frac{mRT}{\Pi V}$$

Q. 16. Write chemical reactions involved in :
(a) Rosenmund reduction.
(b) Gatterman Koch formylation.
(c) Cannizzaro reaction of methanal.

Solution:

(a)

In this reaction, the acyl chlorides are converted to the aldehyde in the presence of hydrogen gas over palladium metal which is poisoned by barium sulfate. Now let us see an example for this reaction,

$$C_6H_5COCl \xrightarrow[Pd-BaSO_4]{H_{2(g)}} C_6H_5 - CHO + HCl$$

(b)

In this reaction, the formation of reactive species is done by the reaction of the acid with carbon monoxide which will yield an aldehydic group. The lewis acid $AlCl_3$ activates the benzene ring and the formation of aldehyde happens. Now let us see an example for the reaction,

$$C_6H_6 + CO + HCl \xrightarrow[CuCl]{Anhyd.AlCl_3} C_6H_5 - CHO$$

(c)

$$\underset{\text{(Formaldehyde)}}{2\,H-\overset{O}{\overset{||}{C}}-H} + \underset{\substack{\text{(sodium hydroxide)}\\ (50\,\%)}}{NaOH} \xrightarrow{\Delta} \underset{\text{(Sodium formate)}}{H-\overset{O}{\overset{||}{C}}-O^{\ominus}Na^{\oplus}} + \underset{\text{(Methanol)}}{H-\overset{H}{\overset{|}{C}}-OH}$$

Q. 17. Calculate the standard enthalpy of combustion of methane, if the standard enthalpy of formation of methane, carbon dioxide and water are $-74\cdot 8, -393\cdot 5$ and $-285\cdot 8 kJmol^{-1}$ respectively.

Solution: To calculate the standard enthalpy of combustion of methane, use the given enthalpies of formation:

$$\Delta H_f^\circ(\mathrm{CH_4}) = -74.8\,\mathrm{kJ/mol}$$
$$\Delta H_f^\circ(\mathrm{CO_2}) = -393.5\,\mathrm{kJ/mol}$$
$$\Delta H_f^\circ(\mathrm{H_2O}) = -285.8\,\mathrm{kJ/mol}$$

The balanced combustion reaction of methane is:

$$\mathrm{CH_4}(g) + 2\mathrm{O_2}(g) \rightarrow \mathrm{CO_2}(g) + 2\mathrm{H_2O}(l)$$

The standard enthalpy of combustion is calculated as:

$$\Delta H_{\text{comb}}^\circ = \sum \Delta H_f^\circ(\text{products}) - \sum \Delta H_f^\circ(\text{reactants})$$
$$\Delta H_{\text{comb}}^\circ = [\Delta H_f^\circ(\mathrm{CO_2}) + 2 \cdot \Delta H_f^\circ(\mathrm{H_2O})] - [\Delta H_f^\circ(\mathrm{CH_4}) + 0]$$
$$\Delta H_{\text{comb}}^\circ = [-393.5 + 2 \cdot (-285.8)] - [-74.8] = -890.3\,\mathrm{kJ/mol}$$

Thus, the standard enthalpy of combustion of methane is $-890.3\,\mathrm{kJ/mol}$.

Q. 18. What is the action of following on ethyl bromide ?
(a) silver nitrite
(b) Mg in dry ether
(c) alcoholic sodium hydroxide

Solution: The action of the following reagents on ethyl bromide ($\mathrm{C_2H_5Br}$):

(a) Silver nitrite ($\mathrm{AgNO_2}$):

$$\mathrm{C_2H_5Br + AgNO_2 \rightarrow C_2H_5NO_2 + AgBr}$$

Ethyl nitrite is formed.

(b) Mg in dry ether:

$$\mathrm{C_2H_5Br + Mg \rightarrow C_2H_5MgBr}$$

Ethyl magnesium bromide (Grignard reagent) is formed.

(c) Alcoholic sodium hydroxide (NaOH):

$$\mathrm{C_2H_5Br + NaOH(alc.) \rightarrow C_2H_4 + NaBr + H_2O}$$

Ethene is formed via dehydrohalogenation.

Q. 19. For the reaction $A + B \rightarrow P$. If [B] is doubled at constant [A], the rate of reaction doubled. If $[A]$ is triple and $[B]$ is doubled, the rate of reaction increases by a factor of 6. Calculate the rate law equation.

Solution: For the reaction $\mathrm{A} + \mathrm{B} \rightarrow \mathrm{P}$, the rate law can be written as:

$$\text{Rate} = k[\mathrm{A}]^m[\mathrm{B}]^n$$

Given that doubling $[\mathrm{B}]$ at constant $[\mathrm{A}]$ doubles the rate:

$$2^n = 2 \Rightarrow n = 1$$

When $[\mathrm{A}]$ is tripled and $[\mathrm{B}]$ is doubled, the rate increases by a factor of 6:

$$3^m \cdot 2^1 = 6 \Rightarrow 3^m = 3 \Rightarrow m = 1$$

Therefore, the rate law equation is:

$$\text{Rate} = k[\mathrm{A}][\mathrm{B}]$$

Q. 20. Arrange the following in the increasing order of the property mentioned:
(i) $\mathrm{HOCl}, \mathrm{HClO_2}, \mathrm{HClO_3}, \mathrm{HClO_4}$ **(acidic strength)**
(ii) $\mathrm{MF}, \mathrm{MCl}, \mathrm{MBr}, \mathrm{MI}$ **(ionic character)**
(iii) $\mathrm{HF}, \mathrm{HCl}, \mathrm{HBr}, \mathrm{HI}$ **(thermal stability)**

Solution:

(i) Arrange the following in increasing order of acidic strength:

$$\mathrm{HOCl} < \mathrm{HClO_2} < \mathrm{HClO_3} < \mathrm{HClO_4}$$

(ii) Arrange the following in increasing order of ionic character:

$$\mathrm{MI} < \mathrm{MBr} < \mathrm{MCl} < \mathrm{MF}$$

(iii) Arrange the following in increasing order of thermal stability:

$$\mathrm{HI} < \mathrm{HBr} < \mathrm{HCl} < \mathrm{HF}$$

Q. 21. Explain Wolf-Kishner reduction reaction. Write preparation of propanone by using ethanoyl chloride and dimethyl cadmium.

Solution: The Wolff-Kishner reduction reaction is a method used to convert carbonyl compounds (aldehydes and ketones) to alkanes. It involves heating the hydrazone derivative of the carbonyl compound with a strong base such as potassium hydroxide (KOH) in a high-boiling-point solvent like ethylene glycol.

$$\mathrm{R_2C{=}O + NH_2NH_2} \xrightarrow{\mathrm{KOH,\ heat}} \mathrm{R_2CH_2 + N_2 + H_2O}$$

Preparation of propanone (acetone) from ethanoyl chloride and dimethyl cadmium:

$$2\,CH_3COCl + (CH_3)_2Cd \rightarrow 2\,CH_3COCH_3 + CdCl_2$$

Q. 22. Write postulates of Werner theory of coordination complexes. Write the name of a hexadentate ligand.

Solution: The postulates of Werner's theory of coordination complexes are:
primary (ionizable) and secondary (non-ionizable).
Primary valencies correspond to oxidation states and are satisfied by negative ions.
Secondary valencies correspond to coordination numbers and are satisfied by ligands, which can be neutral or negative.

An example of a hexadentate ligand is ethylenediaminetetraacetate (EDTA).

Q. 23. Define the electrochemical series and write its two applications.

Solution: The electrochemical series is a list of elements arranged in order of their standard electrode potentials. Elements at the top of the series are strong reducing agents, while those at the bottom are strong oxidizing agents.

Two applications of the electrochemical series are:
A reaction is feasible if the species being reduced has a higher reduction potential than the species being oxidized.
Electrons flow from the element with lower reduction potential to the element with higher reduction potential.

Q. 24. Identify ' A ', ' B ' and ' C ' in following chain reaction and rewrite the chemical reactions:

$$CH_3CH_2OH \xrightarrow[Br2]{redP'} A \xrightarrow[alc]{KCN} B \xrightarrow[Ether]{LiAlH_4} C$$

Solution:

$$CH_3CH_2OH \xrightarrow[Br_2]{red'P'} CH_3-CH_2-Br \xrightarrow[alc]{KCN} CH_3-CH_2-CN \xrightarrow[Ether]{LiAlH_4} CH_3-CH_2-CH_2-NH_2$$

Q. 25. Define acids and bases according to Bronsted-Lowry theory. Derive the relationship between pH and pOH .

Solution: According to the Brønsted-Lowry theory, an acid is a substance that donates a proton (H^+), and a base is a substance that accepts a proton.

The relationship between pH and pOH is derived from the ionization of water:

$$H_2O \leftrightarrow H^+ + OH^-$$

The ion product of water (K_w) is:

$$K_w = [H^+][OH^-] = 1.0 \times 10^{-14} \text{ at } 25^\circ C$$

Taking the negative logarithm of both sides:

$$pK_w = pH + pOH = 14$$

Therefore, the relationship between pH and pOH is:

$$pH + pOH = 14$$

Q. 26. Write the preparation of potassium dichromate from chromut ore.

Solution:

The preparation of potassium dichromate ($K_2Cr_2O_7$) from chromite ore ($FeCr_2O_4$) involves the following steps:

1. Roasting:

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$$

2. Leaching:

$$Na_2CrO_4 + H_2SO_4 \rightarrow Na_2SO_4 + Na_2Cr_2O_7 + H_2O$$

3. Crystallization:

$$Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$$

Thus, potassium dichromate is obtained from chromite ore.

SECTION-D

Attempt any THREE of the following questions :

Q. 27. Convert the following :

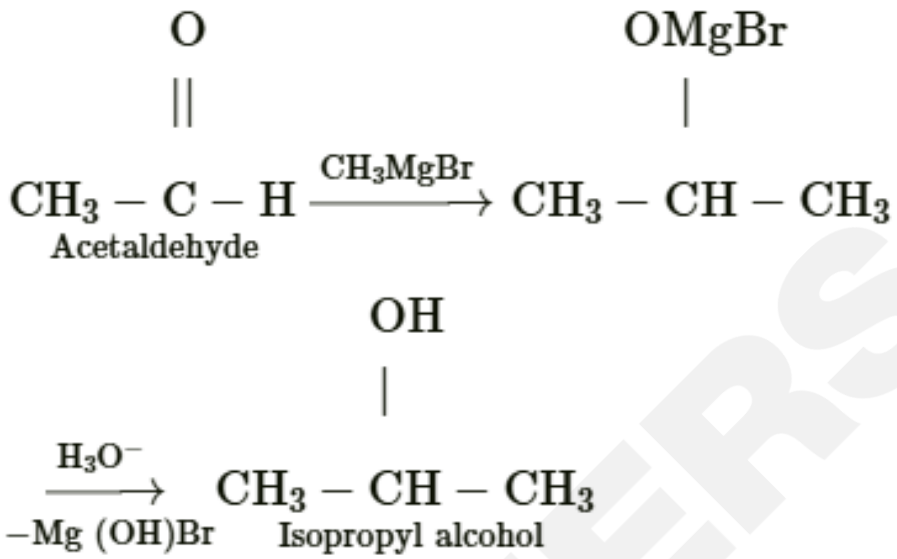
(i) acetaldehyde to isopropyl alcohol.

(ii) cumene to phenol.

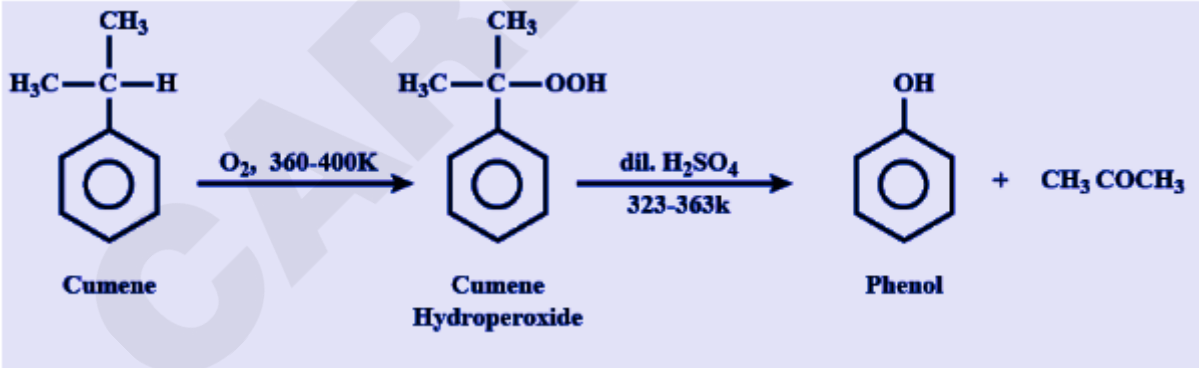
(iii) anisole to phenol. Write two uses of neon.

Solution:

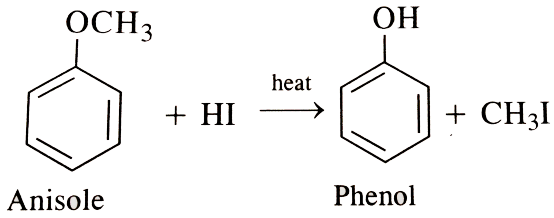
(i)



(ii)



(iii)



Two uses of neon are:

1. Neon is widely used in advertising signs due to its ability to emit bright light when an electric current passes through it.
2. Neon is used in high-voltage indicators, vacuum tubes, lightning arresters, and wave meter tubes because of its electrical properties and bright glow.

1. 28.A. Define: (i) Extensive and Intensive properties
(ii) Isobaric and Adiabatic processes
B. What are enzymes?
C. Write the atomic numbers of transuranium elements.

Solution:

(i) (a) Extensive properties are properties that depend on the amount of matter present. Examples include mass, volume, and total charge.

(b) Intensive properties are properties that do not depend on the amount of matter present. Examples include temperature, density, and refractive index.

(ii) (a) The isobaric process is a thermodynamic process that occurs at constant pressure.

(b) The adiabatic process is a thermodynamic process in which no heat is exchanged with the surroundings.

B. Enzymes are biological catalysts that speed up biochemical reactions in living organisms by lowering the activation energy required for the reaction.

C. Transuranium elements are those with atomic numbers greater than uranium (92).

.Neptunium (Np): 93

Plutonium (Pu): 94

Americium (Am): 95

Curium (Cm): 96

Q. 29. Predict the type of cubic lattice of a solid element having edge length of 400 pm and density is $6.25\ \mathrm{g/ml}$
(Atomic mass of element $= 60$)
Define: Nanoscience
Write a chemical reaction for the preparation of polyacrylonitrile.

Solution:

Given:

Edge length (a) = 400 pm = 400×10^{-10} cm

Density (ρ) = 6.25 g/cm^3

Atomic mass (M) = 60 g/mol

The formula for density in a cubic lattice is:

$$\rho = \frac{Z \cdot M}{N_A \cdot a^3}$$

Rearranging for Z:

$$Z = \frac{\rho \cdot N_A \cdot a^3}{M}$$

Substituting values:

$$Z = \frac{6.25 \times 6.022 \times 10^{23} \times (400 \times 10^{-10})^3}{60}$$

Calculating Z:

$$Z \approx 4$$

Therefore, the element forms a face-centered cubic (FCC) lattice.

Nanoscience is the study of structures and materials on the scale of nanometers (one billionth of a meter). It focuses on understanding and manipulating properties of materials at the atomic and molecular scale.

Q. 30. Derive the relation between the half-life period and rate constant for first-order reaction. Write the net cell reaction during the discharging of the lead accumulator. Draw the structure of peroxymonosulphuric acid.

Solution:

Derive the relation between half-life period and rate constant for first-order reactio:

For a first-order reaction, the half-life ($t_{1/2}$) is related to the rate constant (k) by the formula:

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

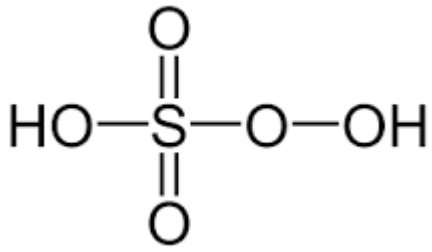
\item \textbf{Net cell reaction during discharging of lead accumulator}:

The net cell reaction during the discharging of a lead accumulator is:

$$\mathrm{Pb} + \mathrm{PbO_2} + 2\mathrm{H_2SO_4} \rightarrow 2\mathrm{PbSO_4} + 2\mathrm{H_2O}$$

\item \textbf{Structure of peroxymonosulfuric acid}:

The structure of peroxymonosulfuric acid (H_2SO_5) is shown below:



Q. 31. Mention the number of unpaired electrons and geometry of the following complexes :

(i) $[Ni(Cl)_4]^{2-}$

(ii) $[Ni(CN)_4]^{2-}$

Convert the following :

(a) Ethanenitrile into ethanal.

(b) Cyclohexane into adipic acid.

Solution:

Number of unpaired electrons and geometry of the following complexes:

(i) Number of unpaired electrons: 2

Geometry: Tetrahedral

(ii) Number of unpaired electrons: 0

Geometry: Square planar

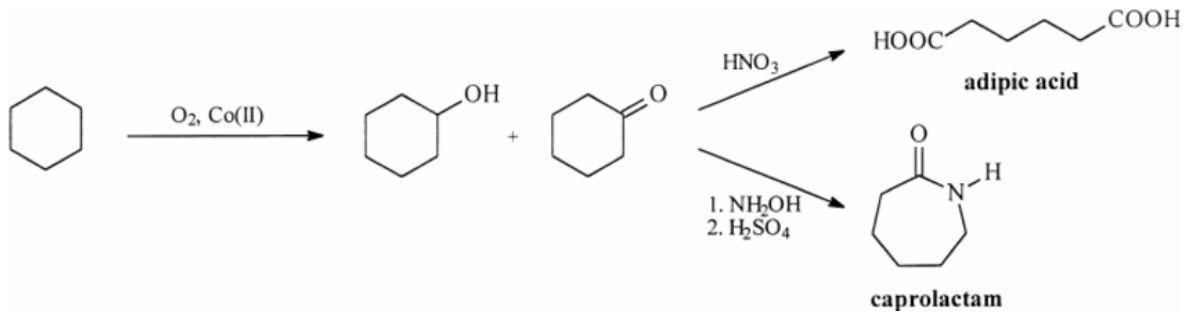
Convert the following:

(a) Ethanenitrile into ethanal:

$$\underset{\text{ethanenitrile}}{CH_3-CN} + 2H_2O + HCl \xrightarrow{\Delta} \underset{\text{Ethanoic acid}}{CH_3-\overset{\overset{O}{\|}}{C}-OH} + NH_4Cl$$

$$\underset{\text{Ethanoic acid}}{CH_3-COOH} \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } LiAlH_4,\ \text{ether}} \underset{\text{ethanol}}{CH_3-CH_2-OH}$$

(b) Cyclohexane into adipic acid:



Maharashtra Board Class 12 Chemistry

Solutions - 2023

SECTION-A

Q.1. Select and write the correct answer for the following multiple choice type of questions:
i. The relation between radius of sphere and edge length in body centered cubic lattice is given by formula:
(A) $\sqrt{3}\mathrm{r} = 4\mathrm{a}$
(B) $r = \frac{\sqrt{3}}{a} \times 4$
(C) $r = \frac{\sqrt{3}}{4}a$
(D) $r = \frac{\sqrt{2}}{4} \times \mathrm{a}$

Solution:

The given problem is to find the correct relation between the radius r of a sphere and the edge length a in a body-centered cubic lattice.

In a body-centered cubic (BCC) lattice, the relation between the radius r of the sphere and the edge length a is given by:

$$\sqrt{3} \cdot a = 4r \implies r = \frac{\sqrt{3}}{4}a$$

So, the correct option is (C).

ii. The pH of weak monoacidic base is 11.2 , its OH^- ion concentration is:
(A) $1.585 \times 10^{-3}\ \mathrm{moldm}^{-3}$
(B) $3.010 \times 10^{-11}\ \mathrm{moldm}^{-3}$
(C) $3.010 \times 10^{-3}\ \mathrm{moldm}^{-3}$
(D) $1.585 \times 10^{-11}\ \mathrm{moldm}^{-3}$

Solution:

To find the OH^- ion concentration given the pH of a weak monoacidic base, we need to use the following relations:

$$\mathrm{pH} + \mathrm{pOH} = 14$$

Given that the pH is 11.2:

$$\mathrm{pOH} = 14 - 11.2 = 2.8$$

Now, the concentration of OH^- ions is given by:

$$[\mathrm{OH}^-] = 10^{-\mathrm{pOH}} = 10^{-2.8}$$

Calculating $10^{-2.8}$:

$$10^{-2.8} \approx 1.585 \times 10^{-3}\,\mathrm{mol\ dm}^{-3}$$

Thus, the correct option is (A).

iii. Which of the following correctly represents integrated rate law equation gas phase:
(A) $k = \frac{2.303}{t} \times \log_{10} \frac{P_i}{P_i - P}$
(B) $\mathrm{k} = \frac{2.303}{\mathrm{t}} \times 10$
(C) $\mathrm{k} = \frac{2.303}{\mathrm{t}} \times \log_{10} \frac{2P_i}{P_i - P}$
(D) $\mathrm{k} = \frac{2.303}{\mathrm{t}} \times 1\mathrm{lo}$

Solution:

For a first-order reaction in the gas phase, the integrated rate law equation is:

$$k = \frac{2.303}{t} \log_{10} \left(\frac{P_i}{P_i - P} \right)$$

Therefore, the correct option is (A).

iv. The spin only magnetic moment of Mn^{2+} ion is
(A) 4.901 BM (B) 5.916 BM
(C) 3.873 BM (D) 2.914 BM

Solution:

The spin-only magnetic moment μ of an ion can be calculated using the formula:

$$\mu = \sqrt{n(n+2)}\,\mathrm{BM}$$

where n is the number of unpaired electrons. For Mn^{2+}, which has 5 unpaired electrons:

$$\mu = \sqrt{5(5+2)} = \sqrt{35} \approx 5.916\,\mathrm{BM}$$

Thus, the correct option is (B).

v. The correct formula of a complex having IUPAC name Tetraamm is
(A) $[\mathrm{PtBr}(\mathrm{NH}_3)_4]\mathrm{Br}_2$
(B) $[\mathrm{PtBr}]_2$
(C) $[\mathrm{PtBr}_2(\mathrm{NH}_3)_4]\mathrm{Br}_2$
(D) $[\mathrm{PtBr}]$

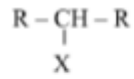
Solution:

The IUPAC name Tetraamminedibromoplatinum(IV) bromide indicates that the complex contains:

The correct formula of the complex is $[\mathrm{PtBr_2(NH_3)_4}]\mathrm{Br_2}$.

Thus, the correct option is (C).

VI. The allylic halide, among the following is_____.

(A) 

(B) $CH_2 = CH - X$

(C) 

(D) $CH_2 = CH - CH_2 - X$

Solution:

An allylic halide is a compound where the halogen atom (X) is attached to a carbon atom that is adjacent to a carbon-carbon double bond (the allylic position).

Option (D) represents the allylic halide as the halogen (X) is attached to the carbon adjacent to the double bond.

Thus, the correct option is (D).

VII. The product of the following reaction is:

$\mathrm{CH_3 - CH = CH - CH_2 - CHO} \xrightarrow[\text{ii) } \mathrm{H_3O^+}]{\text{i) LiMH}_4} \Rightarrow$

(A) $\mathrm{CH_3 - CH_2 - CH_2 - CH_2 - CH_2 - OH}$
(B) $\mathrm{CH_3 - CH = CH - CH_2 - CH_2 - OH}$
(C) $\mathrm{CH_3 - CH_2 - CH_2 - CH_2 - COOH}$
(D) $\mathrm{CH_3 - CH = CH - CH_2 - COOH}$

Solution:

The given reaction involves the reduction of an aldehyde (CHO) group using lithium aluminum hydride ($\mathrm{LiAlH_4}$) followed by hydrolysis ($\mathrm{H_2O}$).

The reactant is:

$$\mathrm{CH_3 - CH = CH - CH_2 - CHO}$$

Lithium aluminum hydride ($\mathrm{LiAlH_4}$) reduces the aldehyde group (CHO) to a primary alcohol ($\mathrm{CH_2OH}$) without affecting the double bond.

Thus, the product of the reaction is:

$$CH_3 - CH = CH - CH_2 - CH_2OH$$

Therefore, the correct option is (B).

viii. Ozonolysis of 2,3 dimethyl but-2-ene, followed by decomposition by Zn dust and water gives

(A) acetaldehyde
(B) propionaldehyde and acetone
(C) acetone
(D) acetaldehyde and butyraldehyde

Solution:

Ozonolysis of 2,3-dimethylbut-2-ene involves the cleavage of the double bond and subsequent formation of carbonyl compounds. The structure of 2,3-dimethylbut-2-ene is:

$$CH_3 - C(CH_3) = C(CH_3) - CH_3$$

Upon ozonolysis followed by decomposition with zinc dust and water, the double bond is cleaved, yielding two molecules of acetone ($CH_3 - CO - CH_3$).

Thus, the product of the reaction is acetone.

Therefore, the correct option is (C).

ix. The glycosidic linkage present in maltose is
(A) $\alpha, \beta - 1, 2$-glycosidic linkage
(C) β-1, 4-glycosidic linkage
(B) α-1, 4-glycosidic linkage
(D) α-1,6-glycosidic linkage

Solution:

Maltose is a disaccharide composed of two glucose units. The glycosidic linkage in maltose is an α-1,4-glycosidic linkage, which means that the linkage is formed between the alpha position (carbon 1) of the first glucose and the carbon 4 of the second glucose.

Therefore, the correct option is (B).

x. The monomer of natural rubber is
(A) Isoprene
(B) Acrylonitrile
(C) ε-Caprolactam
(D) Tetrafluoroethylene

Solution:

The monomer of natural rubber is isoprene.

Natural rubber is a polymer of isoprene (2-methyl-$1,3$-butadiene).

Therefore, the correct option is (A).

Q.2. Answer the following questions:
i. Write the name of the technique used to know the geometry of nanoparticles.
ii. Write the name of the product formed by the action of $\mathrm{LiAlH_4}/$ ether on acetamide.
iii. Write the structure of the product formed when chlorobenzene is treated with sodium metal in the presence of dry ether.
iv. Write the chemical composition of cryolite.
v. Write the name of the platinum complex used in the treatment of cancer.
vi. Write the SI unit of the cryoscopic constant.
vii. Write the correct condition for spontaneity in terms of Gibbs energy.
viii. Calculate molar conductivity for $0.5\mathrm{MBaCl_2}$ if its conductivity at 298 K is $0.01\Omega^{-1}\ \mathrm{cm}^{-1}$

Solution (i):

The technique used to determine the geometry of nanoparticles is {Transmission Electron Microscopy (TEM)}. TEM allows for the visualization of the detailed internal structure of nanoparticles at the atomic or molecular level.

Solution (ii):

The action of lithium aluminum hydride in ether on acetamide reduces the acetamide to ethylamine.

Solution (iii):

When chlorobenzene is treated with sodium metal in the presence of dry ether, the reaction that occurs is known as the Wurtz-Fittig reaction. This reaction results in the formation of biphenyl (diphenyl).

The reaction is as follows:

$$2\,\mathrm{C_6H_5Cl} + 2\,\mathrm{Na} \rightarrow \mathrm{C_6H_5} - \mathrm{C_6H_5} + 2\,\mathrm{NaCl}$$

Solution(iv):

Cryolite is a mineral with the chemical composition of sodium hexafluoroaluminate, which is represented by the formula:

$$\mathrm{Na_3AlF_6}$$

Solution(v):

The platinum complex used in the treatment of cancer is {cisplatin}. Its chemical name is cis-diamminedichloroplatinum(II).

Solution(vi):

The SI unit of the cryoscopic constant (also known as the molal freezing point depression constant) is:

$$\mathrm{K \cdot kg \cdot mol^{-1}}$$

Solution(vii):

The correct condition for spontaneity in terms of Gibbs energy is that the change in Gibbs free energy (ΔG) must be negative. This is mathematically represented as:

$$\Delta G < 0$$

Solution(viii):

To calculate the molar conductivity (Λ_m) for a 0.5 M $\mathrm{BaCl_2}$ solution, given its conductivity (κ) at 298 K is $0.01\,\Omega^{-1}\mathrm{cm}^{-1}$, we use the formula:

$$\Lambda_m = \frac{\kappa \times 1000}{c}$$

Substituting the values, we get:

$$\Lambda_m = \frac{0.01 \times 1000}{0.5} = 20\,\Omega^{-1}\mathrm{cm}^2\mathrm{mol}^{-1}$$

SECTION-B

Attempt any EIGHT of the following questions:

Q.3. Distinguish between lanthanides and actinides.

Solution :

Lanthanoids and actinoids are two series of elements found in the f-block of the periodic table. They can be distinguished based on several characteristics:

(i) Electronic Configuration:
Lanthanoids: 4f orbital is progressively filled.
Actinoids: 5f orbital is progressively filled.
(ii) Oxidation States:
Lanthanoids: Typically exhibit a +3 oxidation state.
Actinoids: Exhibit a range of oxidation states, typically from +3 to +6.
(iii) Magnetic Properties:
Lanthanoids: Generally show weak paramagnetic properties.
Actinoids: Typically show strong paramagnetic and sometimes even ferromagnetic properties.
(iv) Occurrence:
Lanthanoids: More commonly found in nature and are less radioactive.
Actinoids: Most are synthetic and highly radioactive.

Q.4. Calculate the mole fraction of solute, if the vapor pressure of pure benzene at a certain temperature is 640 mmHg and the vapor pressure of a solution of a solute in benzene is 600 mmHg.

Solution:

To calculate the mole fraction of the solute, we can use Raoult's law. According to Raoult's law:

$$P_{\text{solution}} = P_{\text{pure solvent}} \cdot (1 - x_{\text{solute}})$$

Rearranging the formula to solve for x_{solute}:

$$x_{\text{solute}} = 1 - \frac{P_{\text{solution}}}{P_{\text{pure solvent}}}$$

Substituting the given values:

$$x_{\text{solute}} = 1 - \frac{600}{640} = 1 - 0.9375 = 0.0625$$

So, the mole fraction of the solute is 0.0625.

Q.5. Define Green chemistry. Write two advantages of nanoparticle and nanotechnology.

Solution:

Green chemistry is the design of chemical products and processes that reduce or eliminate the use and generation of hazardous substances. It aims to improve the efficiency of chemical processes and minimize the impact on the environment and human health.

Two advantages of nanoparticles and nanotechnology are:
Improved Catalysis: Nanoparticles provide a high surface area to volume ratio, which enhances the catalytic activity and efficiency of chemical reactions, leading to reduced energy consumption and waste generation.
Enhanced Drug Delivery: Nanotechnology enables targeted drug delivery systems, which improve the efficacy of treatments and reduce side effects by delivering drugs directly to specific cells or tissues.

Q.6. Explain the following terms:
i. Substitutional impurity defect
ii. Interstitial impurity defect

Solution:

(i) Substitutional Impurity Defect:

This type of defect occurs when an atom of a different element replaces a host atom in the crystal lattice. The impurity atom must have a similar atomic radius to the host atom to fit into the lattice position without significantly distorting the structure. For example, when zinc atoms replace copper atoms in a copper crystal.

(ii) Interstitial Impurity Defect:

This defect occurs when smaller impurity atoms occupy interstitial spaces in the crystal lattice, which are normally empty. These impurity atoms must be significantly smaller than the host atoms to fit into these spaces without causing major distortions. An example is the presence of carbon atoms in the interstitial spaces of an iron lattice in steel.

Q.7. Write the chemical reactions for the following:

i. Chlorobenzene is heated with fuming H_2SO_4

ii. Ethyl bromide is heated with silver acetate

Solution:

(i) Chlorobenzene is heated with fuming H_2SO_4:

$$C_6H_5Cl + H_2SO_4 \rightarrow C_6H_4(SO_3H)Cl + H_2O$$

(ii) Ethyl bromide is heated with silver acetate:

$$C_2H_5Br + CH_3COOAg \rightarrow C_2H_5OOCCH_3 + AgBr$$

Q.8. Define : Acidic buffer solution. Write the relationship between solubility and solubility product for PbI_2.

Solution:

An acidic buffer solution is a solution that resists changes in pH upon the addition of small amounts of acid or base. It typically consists of a weak acid and its conjugate base. For example, a mixture of acetic acid (CH_3COOH) and sodium acetate (CH_3COONa).

The relationship between solubility and the solubility product (K_{sp}) for PbI_2 is given by the equation:

$$PbI_2(s) \rightleftharpoons Pb^{2+}(aq) + 2I^-(aq)$$

Let s be the solubility of PbI_2 in moles per liter. The solubility product is:

$$K_{sp} = [Pb^{2+}][I^-]^2$$

Since $[Pb^{2+}] = s$ and $[I^-] = 2s$, we have:

$$K_{sp} = s \cdot (2s)^2 = 4s^3$$

Q.9. What is the action of the following reagents on ethyl amine

i. Chloroform and caustic potash

ii. Nitrous acid

Solution:

The action of Chloroform and Caustic Potash on Ethylamine:

This reaction is known as the Carbylamine reaction. When ethylamine reacts with chloroform and caustic potash (potassium hydroxide), it forms ethyl isocyanide (an offensive-smelling compound) and potassium

chloride.

$$C_2H_5NH_2 + CHCl_3 + 3KOH \rightarrow C_2H_5NC + 3KCl + 3H_2O$$

Action of Nitrous Acid on Ethylamine:

When ethylamine reacts with nitrous acid, it forms ethyl alcohol, nitrogen gas, and water. This reaction is typical of primary amines with nitrous acid.

$$C_2H_5NH_2 + HNO_2 \rightarrow C_2H_5OH + N_2 + H_2O$$

Q.10. Calculate standard Gibbs energy change at $25^{\circ}C$ for the cell reaction

$$Cd_{(s)} + Sn^{2+}_{(aq)} \longrightarrow Cd^{2+}_{(sq)} + Sn_{(s)}$$
$$E^{0}_{-.} = -0.403\ V . E^{\circ}_{c.} = -0.136\ V$$

Solution:

To calculate the standard Gibbs energy change (ΔG°) for the cell reaction, we use the formula:

$$\Delta G^{\circ} = -nFE^{\circ}_{cell}$$

The cell reaction is:

$$Cd(s) + Sn^{2+} \rightarrow Cd^{2+} + Sn(s)$$

The standard cell potential (E°_{cell}) is calculated as:

$$E^{\circ}_{cell} = E^{\circ}_{cathode} - E^{\circ}_{anode} = -0.136\,V - (-0.403\,V) = 0.267\,V$$

Since 2 electrons are transferred ($n = 2$):

$$\Delta G^{\circ} = -2 \times 96500\,C/mol \times 0.267\,V = -51501\,J/mol$$

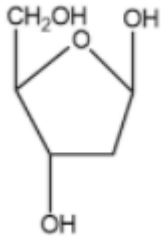
Q.11. Write chemical reaction for the preparation of glucose from sucrose. Write structure of D-ribose.

Solution:

The chemical reaction for the preparation of glucose from sucrose involves the hydrolysis of sucrose. This reaction is catalyzed by the enzyme invertase or by dilute acid. The reaction is as follows:

$$C_{12}H_{22}O_{11} + H_2O \rightarrow C_6H_{12}O_6(\text{glucose}) + C_6H_{12}O_6(\text{fructose})$$

The structure of D-ribose (a five-carbon sugar) is:



Q.12. Define Extensive property. Calculate the work done during the expansion of 2 moles of an ideal gas from $10\mathrm{dm}^3$ to $20\mathrm{dm}^3$ at 298 K in vacuum.

Solution:

extensive property is a property of a system that depends on the amount of matter present. Examples of extensive properties include mass, volume, and total energy.

To calculate the work done during the expansion of 2 moles of an ideal gas from 10 dm^3 to 20 dm^3 at 298 K in a vacuum, we use the fact that the work done (W) in a vacuum (free expansion) is zero because there is no external pressure resisting the expansion.

Thus, the work done is:

$$W = 0$$

Q.13. Write the reactions for the formation of nylon 6,6 polymer.

Solution:

Nylon 6,6 is a type of polyamide formed by the condensation polymerization of hexamethylenediamine and adipic acid. The reaction involves the formation of amide bonds and the release of water molecules. The reactions can be represented as follows:

The reaction between hexamethylenediamine ($\mathrm{H_2N-(CH_2)_6-NH_2}$) and adipic acid ($\mathrm{HOOC-(CH_2)_4-COOH}$):

$$\mathrm{H_2N-(CH_2)_6-NH_2 + HOOC-(CH_2)_4-COOH \rightarrow H_2N-(CH_2)_6-NHCO-(CH_2)_4-COOH + H_2O}$$

The polymerization step, where the intermediate formed above reacts further:

$$\mathrm{H_2N-(CH_2)_6-NHCO-(CH_2)_4-COOH + H_2N-(CH_2)_6-NH_2 \rightarrow [-NH-(CH_2)_6-NHCO-(CH_2)_4-CO-]_n + (n-1)H_2O}$$

SECTION-C

Attempt any EIGHT of the following questions:

Q.15. Define Osmosis. How will you determine the molar mass of nonvolatile solute by elevation of boiling point?

Solution:

Osmosis is the process by which solvent molecules pass through a semipermeable membrane from a region of lower solute concentration to a region of higher solute concentration until equilibrium is reached.

To determine the molar mass of a non-volatile solute by the elevation of boiling point, follow these steps:

Measure the boiling point of the pure solvent (T_0).
Dissolve a known mass of the non-volatile solute (w_2) in a known mass of the solvent (w_1).
Measure the boiling point of the solution (T_b).
Calculate the elevation in boiling point ($\Delta T_b = T_b - T_0$).
Use the formula for elevation of boiling point:

$$\Delta T_b = K_b \cdot m$$

where K_b is the ebullioscopic constant of the solvent and m is the molality of the solution.
\item Calculate the molality (m):

$$m = \frac{n_2}{w_1} = \frac{w_2}{M_2 \cdot w_1}$$

where n_2 is the number of moles of solute, w_2 is the mass of solute, M_2 is the molar mass of the solute, and w_1 is the mass of solvent in kg.
Rearrange to solve for the molar mass of the solute (M_2):

$$M_2 = \frac{K_b \cdot w_2}{\Delta T_b \cdot w_1}$$

Q.16. Convert the following:
i. Ethyl alcohol into ethyl acetate
ii. Phenol into benzene
iii. Diethyl ether into ethyl chloride

Solution:

Here are the conversions:
(i) Ethyl alcohol to ethyl acetate:

$$CH_3CH_2OH + CH_3COOH \xrightarrow{H_2SO_4} CH_3COOCH_2CH_3 + H_2O$$

(Esterification reaction)

(ii) Phenol to benzene:

$$C_6H_5OH \xrightarrow{Zn,\Delta} C_6H_6 + ZnO$$

(Reduction using zinc dust)

(iii) Diethyl ether to ethyl chloride:

$$C_2H_5OC_2H_5 + HCl \rightarrow C_2H_5Cl + C_2H_5OH$$

(Acidic cleavage of ether)

Q.17. A weak monobasic acid is 10% dissociated in 0.05 M solution. What is percent dissociation in 0.15 M solution?

Solution:

For a weak monobasic acid (HA), the degree of dissociation (α) and concentration (C) are related by the expression for the dissociation constant (K_a):

$$K_a = C\alpha^2$$

Given that the acid is 10\% dissociated in a 0.05 M solution, we have:

$$\alpha_1 = 0.10 \quad \text{and} \quad C_1 = 0.05\,\text{M}$$

$$K_a = 0.05 \times (0.10)^2 = 5 \times 10^{-4}$$

We need to find the percent dissociation in a 0.15 M solution:

$$C_2 = 0.15\,\text{M}$$

Let the degree of dissociation in 0.15 M solution be α_2. Using the same K_a:

$$K_a = 0.15\alpha_2^2$$

Since K_a is constant:

$$5 \times 10^{-4} = 0.15\alpha_2^2$$

Solving for α_2:

$$\alpha_2^2 = \frac{5 \times 10^{-4}}{0.15} = \frac{5}{1500} = \frac{1}{300} \approx 0.00333$$

$$\alpha_2 = \sqrt{0.00333} \approx 0.0577$$

Therefore, the percent dissociation in a 0.15 M solution is:

$$\alpha_2 \times 100 \approx 5.77\%$$

Q.18. Explain the dehydrohalogenation reaction of 2-chlorobutane. Write the use and environmental effect of CFC.

Solution:

The dehydrohalogenation reaction of 2-chlorobutane involves the elimination of a hydrogen atom and a chlorine atom, resulting in the formation of an alkene. The reaction is typically carried out using a strong base, such as potassium hydroxide (KOH), in an alcoholic solution.

The reaction can be represented as follows:

$$\mathrm{CH_3CHClCH_2CH_3} \xrightarrow{\mathrm{KOH\ (alc.)}} \mathrm{CH_3CH{=}CHCH_3} + \mathrm{HCl}$$

This reaction produces 2-butene as the major product.

Chlorofluorocarbons (CFCs) have been used as refrigerants, propellants in aerosol sprays, and solvents. However, they have significant environmental impacts, including:

Ozone Depletion}: CFCs release chlorine atoms in the stratosphere, which catalytically destroy ozone molecules. This leads to the thinning of the ozone layer, which protects the Earth from harmful ultraviolet (UV) radiation.

Q.19. 2000 mmol of an ideal gas expanded isothermally and reversibly from 20 L to 30 L at 300 K , calculate the work done in the process $\left(\mathrm{R} = 8.314 \mathrm{JK}^{-1}\ \mathrm{mol}^{-1}\right)$.

Solution:

To calculate the work done during the isothermal and reversible expansion of an ideal gas, we use the following formula:

$$W = -nRT \ln\left(\frac{V_f}{V_i}\right)$$

Substituting the values into the formula:

$$W = -2 \times 8.314 \times 300 \ln\left(\frac{30}{20}\right)$$

$$W = -2 \times 8.314 \times 300 \ln\left(1.5\right)$$

$$W = -2 \times 8.314 \times 300 \times 0.4055$$

$$W = -2 \times 8.314 \times 300 \times 0.4055 = -2021.61\,\text{J}$$

Therefore, the work done in the process is approximately $-2021.61\,\text{J}$.

Q.20. What are interstitial compounds? Give the classification of alloys with examples.

Solution:

Interstitial compounds are chemical compounds formed when small atoms such as hydrogen, carbon, or nitrogen occupy the interstitial spaces (voids) between the larger atoms in a crystal lattice of a metal. These compounds are typically hard and have high melting points. An example is titanium carbide (TiC).

Alloys are classified based on their composition and structure into the following categories:

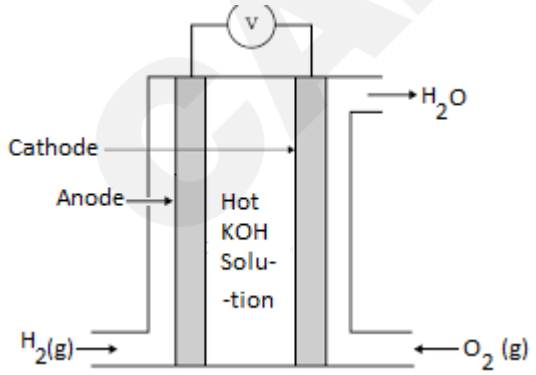
Substitutional Alloys:
One metal atom substitutes for another metal atom in the crystal lattice.
Example: Brass (copper and zinc)

Interstitial Alloys:
Small atoms occupy the interstitial spaces in the metal lattice.
Example: Steel (carbon in iron)

Intermetallic Compounds:
Alloys with a definite stoichiometric ratio and ordered structure.
Example: Alnico (aluminum, nickel, and cobalt)

Q.21. Draw labelled diagram of $\text{H}_2 - \text{O}_2$ fuel cell. Write two applications of fuel cell.
Solution:

Labelled diagram of H_2 - O_2 fuel cell:



Applications of fuel cells:

Power Generation: Fuel cells are used in power plants to generate electricity with higher efficiency and lower emissions compared to traditional combustion methods.

Transportation: Fuel cells are used in vehicles, including cars, buses, and submarines, providing a cleaner alternative to internal combustion engines.

Q.22. Explain formation of $[CoF_6]^{3-}$ complex with respect to
i. Hybridization
ii. Magnetic properties
iii. Inner/outer complex
iv. Geometry

Solution:

Formation of $[CoF_6]^{3-}$ complex:
(i) Hybridisation:
The central metal ion, Co^{3+}, in the $[CoF_6]^{3-}$ complex undergoes sp^3d^2 hybridisation. This is because F^- is a weak field ligand and does not cause pairing of electrons in the 3d orbitals.

(ii) Magnetic properties:
The $[CoF_6]^{3-}$ complex has unpaired electrons. Since F^- is a weak field ligand, it does not pair up the electrons in the d-orbitals of Co^{3+}. Therefore, the complex is paramagnetic.

(iii) Inner/outer complex:
The $[CoF_6]^{3-}$ complex is an outer orbital complex because the hybridization involves the use of outer d-orbitals ($4d$) rather than inner d-orbitals ($3d$).

(iv) Geometry:
The geometry of the $[CoF_6]^{3-}$ complex is octahedral, resulting from the sp^3d^2 hybridisation.

Q.23. What is a Pseudo first-order reaction? Derive integrated rate law equation for zero order reaction?

Solution:

Pseudo-first-order reaction:

A pseudo-first-order reaction is a reaction that is not truly first-order but can be approximated as first-order under certain conditions. This typically occurs when the concentration of one reactant is much higher than the other(s) and remains nearly constant throughout the reaction. An example is the hydrolysis of esters in the presence of a large excess of water.

The integrated rate law for zero order reaction:

For a zero-order reaction, the rate of reaction is independent of the concentration of the reactant. The rate law can be written as:

$$\text{Rate} = k$$

where k is the rate constant. Integrating this rate law with respect to time, we get:

$$\frac{d[A]}{dt} = -k$$

Integrating both sides with the initial condition $[A] = [A]_0$ at $t = 0$:

$$\int_{[A]_0}^{[A]} d[A] = -k \int_0^t dt$$

$$[A] - [A]_0 = -kt$$

Rearranging this, we get the integrated rate law for a zero-order reaction:

$$[A] = [A]_0 - kt$$

Q.24. Explain Aldol condensation of ethanal.

Soltion:

Aldol condensation of ethanol:

Aldol condensation is a reaction in which two molecules of an aldehyde or ketone react in the presence of a base to form a β-hydroxy aldehyde (aldol) or β-hydroxy ketone. In the case of ethanol, the reaction proceeds as follows:

1. Formation of the enolate ion:

$$\mathrm{CH_3CHO + OH^- \rightarrow CH_2CHO^- + H_2O}$$

2. Nucleophilic addition of the enolate ion to another molecule of ethanal:

$$\mathrm{CH_2CHO^- + CH_3CHO \rightarrow CH_3CH(OH)CH_2CHO}$$

3. Formation of the aldol (3-hydroxy butanal):

$$CH_3 - CH(OH) - CH_2 - CHO$$

4. Dehydration to form the α,β-unsaturated aldehyde (crotonaldehyde):

$$\mathrm{CH_3CH(OH)CH_2CHO \xrightarrow{OH^-} CH_3CH{=}CHCHO + H_2O}$$

The overall reaction is:

$$\mathrm{2CH_3CHO \xrightarrow{OH^-} CH_3CH{=}CHCHO + H_2O}$$

Q.25. Explain the anomalous behavior of oxygen in group 16 with respect to:
i. Atomicity
ii. Magnetic property
iii. Oxidation state

Solution:

Anomalous behavior of oxygen in group 16 with respect to:

(i) Atomicity:

Oxygen exists as a diatomic molecule (O_2), whereas other elements in group 16 (such as sulfur, selenium, and tellurium) typically exist in polyatomic forms (S_8, Se_8, etc.). This is due to the small size and high electronegativity of oxygen, which favors the formation of strong $O-O$ double bonds

(ii) Magnetic property:

Molecular oxygen (O_2) is paramagnetic due to the presence of two unpaired electrons in its antibonding π^* orbitals. This is in contrast to other group 16 elements, which are typically diamagnetic in their most stable forms.

(iii) Oxidation state:

Oxygen predominantly exhibits an oxidation state of -2 in its compounds, while other group 16 elements can exhibit a variety of oxidation states, including -2, $+4$, and $+6$. This is due to the high electronegativity and small size of oxygen, which makes it less likely to share or lose electrons compared to its heavier congeners.

Q.26. Write chemical reactions for the following conversions:
i. Acetic acid into acetic anhydride
ii. Acetic acid into ethyl alcohol Write IUPAC name and structure of methylphenylamine.

Solution:

Chemical reactions for the following conversions:

enumerate

(i) Acetic acid into acetic anhydride:

$$2\,CH_3COOH \xrightarrow{P_2O_5} CH_3COOCOCH_3 + H_2O$$

(ii) Acetic acid into ethyl alcohol:

$$CH_3COOH + 2\,H_2 \xrightarrow{LiAlH_4} CH_3CH_2OH + H_2O$$

IUPAC name and structure of methyl phenylamine:
The IUPAC name of methylphenylamine is N-methylaniline.

SECTION-D

Attempt any THREE of the following questions:

Q.27. Show that, the time required for 99.9% completion of a first-order reaction is three times the time required for 90% completion.

Give electronic configuration of $\mathrm{Gd(Z=64)}$.

Write the name of nano-structured material used in car tires to increase the life of tires.

Solution:

For a first-order reaction, the integrated rate law is:

$$\ln\left(\frac{[A]_0}{[A]}\right) = kt$$

Where $[A]_0$ is the initial concentration, $[A]$ is the concentration at time t, k is the rate constant, and t is the time.

For 90\% completion:

$$[A] = 0.1[A]_0$$

$$\ln\left(\frac{[A]_0}{0.1[A]_0}\right) = kt_{90}$$

$$\ln(10) = kt_{90}$$

$$t_{90} = \frac{\ln(10)}{k}$$

For 99.9\% completion:

$$[A] = 0.001[A]_0$$

$$\ln\left(\frac{[A]_0}{0.001[A]_0}\right) = kt_{99.9}$$

$$\ln(1000) = kt_{99.9}$$

$$t_{99.9} = \frac{\ln(1000)}{k}$$

Since $\ln(1000) = 3\ln(10)$:

$$t_{99.9} = \frac{3\ln(10)}{k} = 3t_{90}$$

Thus, the time required for 99.9\% completion is three times the time required for 90% completion.

Electronic configuration of Gd (Z = 64):

The electronic configuration of Gadolinium (Gd) is:

$$[\text{Xe}]4f^7 5d^1 6s^2$$

Nano-structured material used in car tyres:

The name of the nano-structured material used in car tires to increase their life is Carbon Black.

Q.28. Derive the relationship between ΔH and ΔU for gaseous reaction.
Define: Vulcanization
What is a peptide bond?

Solution:

For a gaseous reaction, the relationship between enthalpy change (ΔH) and internal energy change (ΔU) is given by:

$$\Delta H = \Delta U + \Delta n_g RT$$

where:
- ΔH is the change in enthalpy,
- ΔU is the change in internal energy,
- Δn_g is the change in the number of moles of gas,
- R is the universal gas constant,
- T is the temperature in Kelvin.

Derivation:

The change in enthalpy is defined as:

$$\Delta H = \Delta U + \Delta(PV)$$

For an ideal gas, $PV = nRT$. Therefore, the change in PV is:

$$\Delta(PV) = \Delta(nRT) = \Delta n_g RT$$

Substituting this into the enthalpy equation, we get:

$$\Delta H = \Delta U + \Delta n_g RT$$

Vulcanization:

Vulcanization is the process of heating natural rubber with sulfur (or other cross-linking agents) to improve its elasticity, strength, and durability. This process introduces cross-links between polymer chains, making the rubber harder and more resistant to deformation.

peptide bond:

A peptide bond is a covalent bond that forms between the carboxyl group ($-COOH$) of one amino acid and the amino group ($-NH_2$) of another amino acid. This bond is formed through a dehydration synthesis reaction, where a molecule of water is released:

$$\text{R-COOH} + \text{H-NH-R'} \rightarrow \text{R-CONH-R'} + \text{H}_2\text{O}$$

Q.29. Silver crystallizes in fcc structure. If edge length of unit cell is 400 pm , calculate density of silver (Atomic mass of $\text{Ag} = 108$).
Write a note on Haloform reaction.

Solution:

Calculation of density of silver:

For a face-centered cubic (fcc) structure, there are 4 atoms per unit cell. The density (ρ) can be calculated using the formula:

$$\rho = \frac{Z \times M}{N_A \times a^3}$$

where:
- $Z = 4$ (number of atoms per unit cell in fcc)
- $M = 108\,\text{g/mol}$ (atomic mass of Ag)
- $N_A = 6.022 \times 10^{23}\,\text{atoms/mol}$ (Avogadro's number)
- $a = 400\,\text{pm} = 400 \times 10^{-10}\,\text{cm}$ (edge length of unit cell)

Substituting the values, we get:

$$\rho = \frac{4 \times 108}{6.022 \times 10^{23} \times (400 \times 10^{-10})^3}$$

$$\rho = \frac{432}{6.022 \times 10^{23} \times 64 \times 10^{-30}}$$

$$\rho = \frac{432}{3.85408 \times 10^{-5}}$$

$$\rho \approx 11.21\,\mathrm{g/cm^3}$$

Q.30. Define: Distereoisomers.
Give cis and trans isomers of $[\mathrm{Co(NH_3)_4Cl_2}]^+$.
What is a reference electrode?
Give reason: The bleaching action of ozone is also called dry bleach.

Solution:

(i) Diastereoisomers:

Diastereoisomers are stereoisomers that are not mirror images of each other. They have different physical properties and different configurations at one or more (but not all) of the equivalent stereocenters.

(ii) Cis and trans isomers of $[\mathrm{Co(NH_3)_4Cl_2}]^+$:

The cis and trans isomers of $[\mathrm{Co(NH_3)_4Cl_2}]^+$ can be represented as follows:

$$\text{Cis isomer:Cl-[-1]Co}(-[-1]NH_3)(-[-3]NH_3)(-[:30]NH_3)(-[:-30]NH_3)\text{-Cl}$$

$$\text{Trans:Cl-[-1]Co}(-[:30]NH_3)(-[:-30]NH_3)(-[:150]NH_3)(-[:-150]NH_3)\text{-Cl}$$

(iii) What is a reference electrode?

()A reference electrode is an electrode that has a stable and well-known electrode potential. It is used as a reference point in measuring the electrode potentials of other electrodes. Examples include the standard hydrogen electrode (SHE) and the silver/silver chloride electrode (Ag/AgCl).

(iv) Reason: Bleaching action of ozone is also called dry bleach.

The bleaching action of ozone is called dry bleach because it does not require the presence of water for the bleaching process. Ozone (O_3) is a powerful oxidizing agent that can directly oxidize and break down the chromophores (color-producing groups) in organic compounds, leading to decolorization.

Q.31. Write Dow process for the preparation of Phenol. What is the action of bromine water on phenol?
Give reason: Group 16^{th} elements have lower ionisation enthalpy compared to group 15^{th} elements.
Write two uses of dioxygen.

Solution:

process for the preparation of Phenol are:

The Dow process involves the hydrolysis of chlorobenzene to produce phenol. The reaction is carried out at high temperature and pressure in the presence of a base (NaOH).

$$C_6H_5Cl + 2\,NaOH \xrightarrow{\Delta} C_6H_5OH + NaCl + H_2O$$

What is the action of bromine water on phenol?

Phenol reacts with bromine water to form 2,4,6-tribromophenol, which precipitates out as a white solid.

$$*6(= -(-Br) - (-Br) - = -(-Br)-)$$

Group 16 elements have a lower ionization enthalpy compared to Group 15 elements because Group 16 elements have one more electron than Group 15 elements, which results in increased electron-electron repulsion within the same shell. This makes it easier to remove an electron from Group 16 elements, leading to lower ionization enthalpy.

Write two uses of dioxygen.

Respiration:

Dioxygen (O_2) is essential for the respiration of aerobic organisms, where it is used to produce energy from food.

Combustion:

Dioxygen is necessary for combustion processes, such as in burning fuels for energy and in industrial processes like metal smelting.

Maharashtra Board Class 12 Chemistry

Solutions - 2022

SECTION-A

Q. 1. Select and write the correct answer for the following multiple choice type of questions :

(i) The co-ordination number of atoms in body centred cubic structure (bcc) is

(a) 4

(b) 6

(c) 8

(d) 12

Solution: The coordination number of atoms in a body-centered cubic (bcc) structure is 8.

Thus, the correct answer is: (c) 8.

(ii) In calculating osmotic pressure, the concentration of solute is expressed in .

(a) molarity

(b) molality

(c) mole fraction

(d) percentage mass

Solution:

The correct answer is (a) molarity. Osmotic pressure is calculated using the formula

$$\Pi = MRT$$

, where Π is the osmotic pressure, M is the molarity of the solute, R is the gas constant, and T is the temperature in Kelvin.

(iii) The enthalpy change for the chemical reaction $\mathrm{H_2O(s)} \rightarrow \mathrm{H_2O_{(l)}}$ is called enthalpy of .

(a) vapourisation

(b) fusion

(c) combustion

(d) sublimation

Solution: The enthalpy change for the chemical reaction:

$$\mathrm{H_2O_{(s)} \rightarrow H_2O_{(l)}}$$

is called enthalpy of fusion.

Thus, the correct answer is: (b) Fusion.

(iv) Which of the following transition element shows maximum oxidation state?
(a) Sc
(b) Fe
(c) Mn
(d) V

Solution:

Among the given transition elements, manganese (Mn) shows the maximum oxidation state of +7.

Thus, the correct answer is: (c) Mn.

(v) The correct formula for the complex compound, sodium hexacyanoferrate (III) is
(a) $\mathrm{Na}\left[\mathrm{Fe(CN)_6}\right]$
(b) $\mathrm{Na_2}\left[\mathrm{Fc(CN)_6}\right]$
(c) $\mathrm{Na_3}\left[\mathrm{Fe(CN)_6}\right]$
(d) $\mathrm{Na_4}\left[\mathrm{Fe(CN)_6}\right]$

Solution:

The correct formula for the complex compound sodium hexacyanoferrate (III) is $\mathrm{Na_3[Fe(CN)_6]}$.

Thus, the correct answer is:(c)

(vi) Isopropylbenzene on air oxidation followed by decomposition by dilute acid gives
(a) $\mathrm{C_6H_5OH}$
(b) $\mathrm{C_6II_5COOCH_3}$
(c) $\mathrm{C_6H_5COOH}$
(d) $\mathrm{C_6H_5CHO}$

Solution:

Isopropylbenzene (cumene) on air oxidation followed by decomposition with dilute acid gives phenol ($\mathrm{C_6H_5OH}$).

Thus, the correct answer is: (a)

(vii) The name of metal nanoparticle which acts as highly effective bacterial disinfectant in water purification process is
(a) carbon black .
(c) gold
(b) silver
(d) copper

Solution:

The name of the metal nanoparticle which acts as a highly effective bacterial disinfectant in the water purification process is silver.

Thus, the correct answer is: (b) Silver.

(viii) Acid anhydride on reaction with primary amine gives compound having a functional group
(a) amide
(b) nitrile
(c) secondary amine
(d) imine

Solution:

Acid anhydride on reaction with a primary amine gives a compound having an amide functional group.

Thus, the correct answer is (a) Amide.

(ix) The standard potential of the cell in the following reaction is

$$\mathrm{Cd}_{(s)} + \mathrm{Cu}^{2+}_{(\mathrm{IM})} \longrightarrow \mathrm{Cd}^{2+}_{(\mathrm{IM})} + \mathrm{Cu}_{(s)}$$
$$\left(\mathrm{E}^{\circ}_{\mathrm{Cd}} = -0.403\ \mathrm{V}, \mathrm{E}^{0}_{\mathrm{Cu}} = 0.334\ \mathrm{V}\right)$$
(a) -0.737 V$
(b) 0.737 V
(c) -0.069 V$
(d) 0.069 V

Solution:

The standard potential of the cell for the reaction:
$\mathrm{Cd}_{(s)} + \mathrm{Cu}^{2+}_{(1M)} \rightarrow \mathrm{Cd}^{2+}_{(1M)} + \mathrm{Cu}_{(s)}$

is calculated using the standard electrode potentials:
$E^{\circ}_{\text{cell}} = E^{\circ}_{\mathrm{Cu}} - E^{\circ}_{\mathrm{Cd}} = 0.334\,\mathrm{V} - (-0.403\,\mathrm{V}) = 0.737\,\mathrm{V}$

Thus, the correct answer is: (b) 0.737V.

(x) **The value of** $[\mathrm{H_3O^+}]$**in** mollit^{-1} **of 0.001 M acetic acid solution** $\left(\mathrm{Ka} = 1.8 \times 10^{-5}\right)$ **is**
(a) 1.34×10^{-1}
(b) 1.34×10^{-2}
(c) 1.34×10^{-3}
(d) 1.34×10^{-4}

Solution:

Given the concentration of acetic acid ($\mathrm{CH_3COOH}$) is $0.001\ \mathrm{M}$ and the ionization constant (K_a) is 1.8×10^{-5}, we can find the hydronium ion concentration ($[\mathrm{H_3O^+}]$) using the formula:

$$[\mathrm{H_3O^+}] = \sqrt{K_a \cdot \mathrm{C}} = \sqrt{1.8 \times 10^{-5} \cdot 0.001} = 1.34 \times 10^{-4}\ \mathrm{M}$$

Thus, the correct answer is: (d).

Q. 2. Answer the following questions :

∴ (i) Write the product formed when alkyl halide reacts with silver nitrite.

(ii) Write the name of product formed, when acetone is treated with 2, 4-dinitrophenyl hydrazine.

(iii) Write the name of biodegradable polyamide copolymer.

(iv) Identify the molecularity of following elementary reaction:

$\mathrm{NO_{(g)} + O_{3(g)} \longrightarrow NO_{3(g)} + O_{(g)}}$

(v) What is the action of selenium on magnesium metal?

(vi) Write the name of isomerism in the following complexes :

$[\mathrm{Cu(NH_3)_4}]\,[\mathrm{PtCl_4}]$ and $[\mathrm{Pt(NH_3)_4}]\,[\mathrm{CuCl_4}]$

(vii) Write the name of the alloy used in Fischer Tropsch process in the synthesis of gasoline.

(vii) Henry's law constant for $\mathrm{CH_3Br}$ (g) $0.159\ \mathrm{moldm^{-3}bar^{-1}}$ at $25^{\circ}\mathrm{C}$. What is solubility of $\mathrm{CH_3Br_{(g)}}$ in water at same temperature and partial pressure of 0.164 bar?

Solution (i):

When an alkyl halide reacts with silver nitrite ($\mathrm{AgNO_2}$), the product formed is an alkyl nitrite ($\mathrm{R\text{-}ONO}$).

The general reaction is:

$\mathrm{R\text{-}X + AgNO_2 \rightarrow R\text{-}ONO + AgX}$

where R is the alkyl group and X is the halide.

Solution (ii):

When acetone is treated with 2,4-dinitrophenylhydrazine, the product formed is 2,4-dinitrophenylhydrazone of acetone.

The reaction is:

$$\mathrm{CH_3COCH_3 + 2{,}4\text{-}DNP \rightarrow CH_3C{=}N\text{-}NH\text{-}C_6H_3(NO_2)_2 + H_2O}$$

Solution (iii):

The name of a biodegradable polyamide copolymer is {Nylon-2-Nylon-6}.

Solution (iv):

The molecularity of the following elementary reaction:

$$NO_{(g)} + O_{3(g)} \rightarrow NO_{3(g)} + O_{(g)}$$

is 2, since it involves two reactant molecules.

Solution (v):

When selenium reacts with magnesium metal, it forms magnesium selenide ($MgSe$).

The reaction is:

$$Mg + Se \rightarrow MgSe$$

Solution (vi):

The type of isomerism shown by the complexes $[Cu(NH_3)_4][PtCl_4]$ and $[Pt(NH_3)_4][CuCl_4]$ is called \textbf{coordination isomerism}.

(vii) Solution:

The name of the alloy used in the Fischer-Tropsch process in the synthesis of gasoline is {cobalt-molybdenum}.

(viii) Solution:

Given Henry's law constant (K_H) for $CH_3Br_{(g)}$ is $0.159\,mol\,dm^{-3}\,bar^{-1}$ at 25°C, and the partial pressure (P) is $0.164\,bar$, the solubility (S) is calculated as:

$$S = K_H \cdot P = 0.159\,mol\,dm^{-3}\,bar^{-1} \times 0.164\,bar = 0.0261\,mol\,dm^{-3}$$

SECTION-B

Attempt any EIGHT of the following questions :
Q. 3. Explain pseudo-first order reaction with suitable example.

Solution:

A pseudo-first-order reaction is a reaction that is not truly first-order but appears to be so because one of the reactants is present in a large excess. This causes the concentration of that reactant to remain almost constant during the reaction, simplifying the rate law.

For example, the hydrolysis of an ester in the presence of a large excess of water:

$$CH_3COOCH_3 + H_2O \rightarrow CH_3COOH + CH_3OH$$

The rate law can be written as:

$$\text{Rate} = k[\text{CH}_3\text{COOCH}_3][\text{H}_2\text{O}]$$

Since water is in large excess, its concentration remains nearly constant, and the rate law simplifies to:

$$\text{Rate} = k'[\text{CH}_3\text{COOCH}_3]$$

where $k' = k[\text{H}_2\text{O}]$, making it appear as a first-order reaction

Q. 4. Write the consequences of Schottky defect with reasons.

Solution:

The consequences of the Schottky defect are:

Decrease in density: The defect involves the removal of equal numbers of cations and anions from the lattice, reducing the overall mass without changing the volume.

Increased electrical conductivity: The presence of vacancies allows ions to move more freely, enhancing ionic conductivity.

Stabilization of crystal structure: The defect can help to stabilize the crystal structure by relieving internal stresses.

Q. 5. What is the action of following on ethyl bromide :
(i) Na in dry ether
(ii) Mg in dry ether

Solution:

(i) The action of Na in dry ether on ethyl bromide ($\text{C}_2\text{H}_5\text{Br}$) results in the formation of butane:

$$2\text{C}_2\text{H}_5\text{Br} + 2\text{Na} \rightarrow \text{C}_4\text{H}_{10} + 2\text{NaBr}$$

(ii) The action of Mg in dry ether on ethyl bromide results in the formation of ethylmagnesium bromide (Grignard reagent):

$$\text{C}_2\text{H}_5\text{Br} + \text{Mg} \rightarrow \text{C}_2\text{H}_5\text{MgBr}$$

Q. 6. Explain formation of peptide linkage in protein with an example.

Solution:

The formation of a peptide linkage in proteins involves a condensation reaction between the carboxyl group of one amino acid and the amino group of another, releasing a molecule of water. The resulting bond is called a peptide bond.

For example:

$$\text{H}_2\text{N-CH(R)-COOH} + \text{H}_2\text{N-CH(R')-COOH} \rightarrow \text{H}_2\text{N-CH(R)-CO-NH-CH(R')-COOH} + \text{H}_2\text{O}$$

Q. 7. Derive an expression to calculate molar mass of non volatile solute by osmotic pressure measurement.

Solution:

The osmotic pressure (Π) of a solution is given by the equation:

$$\Pi = iCRT$$

where i is the van 't Hoff factor, C is the molarity, R is the gas constant, and T is the temperature in Kelvin.

For a non-volatile solute, the molarity C can be expressed as $\frac{n}{V}$, where n is the number of moles of solute and V is the volume of solution in liters. Thus:

$$\Pi = \frac{n}{V}RT$$

The number of moles n can be written as $\frac{m}{M}$, where m is the mass of solute and M is the molar mass of solute:

$$\Pi = \frac{m}{M} \cdot \frac{1}{V}RT \Rightarrow M = \frac{mRT}{\Pi V}$$

Q. 8. Explain monodentate and ambidentate ligands with examples.

Solution:

Monodentate ligand-Only one donor site is present. Examples include ammonia and chloride ions. Ambidentate ligand Ligands can coordinate to a central metal through two different sites.

Examples include

(1) nitro group (N as donor atom) and nitrito group (O as donor atom)

(2) Thiocyanate (S atom as donor atom) and isothiocyanate (N atom as donor atom).

Q. 9. Explain the trends in the following atomic propert1es of group 10 elements :
(i) Atomic radii
(ii) Ionisation enthalpy
(iii) Electronegativity
(iv) Electron gain enthalpy

Solution:

(i) Atomic and ionic radii :

In group 16, the atomic and ionic radii increase down the group, due to an increase in the number of quantum shells. Across a period atomic or ionic radii decrease due to an increase in effective nuclear charge.

(ii) Ionisation enthalpy :

In group 16, the ionization enthalpy decreases down the group, due to an increase in atomic size.

(iii) Electronegativity :

In group 16, the electronegativity decreases down the group.

(iv) Electron gain enthalpy :

In group 16 the electron gain enthalpy becomes less negative down the group.

Q. 10. Write preparation of phenol from aniline.

Solution:

The preparation of phenol from aniline involves the following steps:

1. Diazotization: Aniline ($C_6H_5NH_2$) is treated with nitrous acid (HNO_2) to form benzene diazonium chloride ($C_6H_5N_2Cl$).

$$C_6H_5NH_2 + HNO_2 + HCl \rightarrow C_6H_5N_2Cl + 2H_2O$$

2. Hydrolysis: Benzene diazonium chloride is then hydrolyzed to form phenol (C_6H_5OH).

$$C_6H_5N_2Cl + H_2O \rightarrow C_6H_5OH + N_2 + HCl$$

Q. 11. Write chemical reactions to prepare ethanamine from :
(i) acetonitrile
(ii) nitrocthane

Solution: Ethanamine from acetonitrile :

$$CH_3 - C \equiv N + 4[H] \xrightarrow{Na/C_2H_5OH} CH_3 - CH_2 - NH_2$$

b.

$$CH_3 - CH_2 - NO_2 + 6[H]$$

Nitroethane

$$\xrightarrow[\Delta]{\text{Sn/ conc. HCl}} \underset{\text{Ethanamine}}{CH_3 - CH_2 - NH_2} + 2H_2O$$

Q. 12. Identify A and B from the following reaction :

$$2CH_3 - \overset{CH_3}{\underset{}{C}} = O \xrightarrow{Ba(OH)_2} A \xrightarrow{\Delta} B + H_2O$$

Solution:

Identify A and B from the following reaction:}

$$2\ CH_3COCH_3 + Ba(OH)_2 \rightarrow A \rightarrow \Delta \rightarrow B + H_2O$$

{Step 1: Formation of the Aldol product (A)}

$$2CH_3COCH_3 + Ba(OH)_2 \rightarrow CH_3C(OH)(CH_3)CH_2COCH_3$$

The product (A) is a β-hydroxy ketone, specifically, 4-hydroxy-4-methyl-2-pentanone.

{Step 2: Dehydration to form the α,β-unsaturated ketone (B)}

$$CH_3C(OH)(CH_3)CH_2COCH_3 \xrightarrow{\Delta} CH_3C(CH_3)=CHCOCH_3 + H_2O$$

The product (B) is 4-methyl-3-penten-2-one.

Thus, compound A is 4-hydroxy-4-methyl-2-pentanone, and compound B is 4-methyl-3-penten-2-one.

Q. 13. One mole of an ideal gas is expanded isothermally and reversibly from 10 L to 15 L at 300 K . Calculate the work done in the process.

Solution:

Given:

- Number of moles of gas (n) = 1 mol
- Gasconstant (R) = 8.314 J/mol·K
- Temperature (T) = 300 K
- Initial volume (Vi) = 10 L
- Final volume (Vf) = 15 L

Work done in an isothermal process can be calculated using the formula:

W=-nRTln(Vf/Vi)

where:

- Wisthework done (J)
- The number of moles of gas
- Risthe gas constant (J/mol·K)
- Tisthe temperature (K)
- Vi is the initial volume (L)
- Vf is the final volume (L)

Substituting the given values into the formula, we get:

W=-18.314 300 ln(15/10) =-1011.31 J

Therefore, the work done in the process is- 1011.31 J. Since the work is negative, we know that the gas is doing work on the surroundings.

Q. 14. How many moles of electrons are required for reduction of 2 moles of Zn^{2+} to Zn ? How many Faradays of electricity will be required?

Solution:

The balanced equation for the reduction of

Zn^{2+} to Zn is Zn^{2+} + 2e----------> Zn

The equation shows that 1 mole of Zn^{2+} is reduced to Zn by 2 moles of

electrons for

reduction of 2 mole of Zn^{2+}, 4 mole of electron will be required.

SECTION-C

Attempt any EIGHT of the following questions :
Q. 15. Write chemical composition of haematite. Write the names and electronic configurations of first two elements of group 17.

Solution: Fe_2O_3

group 17 elements

9F– $1s^2\ 2s^2\ 2p^5$

17Cl– $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

Q. 16. Write the classification of polymers on the basis of structure.

Solution:

Polymers can be classified based on their structure into the following categories:

1. **Linear Polymers**: These consist of long and straight chains. Examples include polyethylene and PVC.
2. **Branched Polymers**: These have side chains branching off from the main chain. Examples include low-density polyethylene.
3. **Cross-linked Polymers**: These have chains connected by links or bonds, forming a network. Examples include vulcanized rubber and Bakelite.
4. **Network Polymers**: These form a three-dimensional network throughout the material. Examples include epoxies and phenol-formaldehyde resins.

Q. 17. Define green chemistry. Write two disadvantages or nanotechnology.

Solution:

Green chemistry is the use of chemistry for pollution prevention and it designs the use of chemical products and processes that reduce or eliminate the use or generation of hazardous www.collegedunia.com substances.

Disadvantages of nanotechnology

1. Nanoparticles can cause lung damage

2. Nanopollution is very dangerous for living organisms.

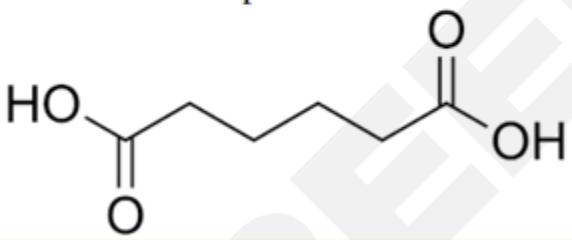
Q. 18. Write a commercial method for the preparation of glucose. Write the structure of adipic acid.

Solution: Commercially, on a large scale, glucose is prepared by hydrolysis of starch with dilute sulphuric acid. Starchy material is mixed with water and dilute sulphuric acid and heated at 393 K under 2 to 3-atm pressure. Starch is hydrolyzed to give glucose.

$$(C_6H_{10}O_5)_n + n\ H_2O \xrightarrow[393\ K\ \text{pressure 2-3 atm}]{H^+\ (\text{dilute}\ H_2SO_4)\ 398\ K} n\ C_6H_{12}O_6$$

Starch glucose — glucose

Structure of adipic acid



Q. 19. Write chemical reactions of following reagents on methoxyethane:
(i) hot Hl
(ii) PCl_5
(ii) dilue H_2SO_4

Solution:

1. **Reaction with Hot Hydroiodic Acid (HI):**

$$CH3OCH2CH3 + HI \rightarrow heatCH3I + CH3CH2OH\mathrm{CH_3OCH_2CH_3}$$
$$+\mathrm{HI} \xrightarrow{\text{heat}} \mathrm{CH_3I} + \mathrm{CH_3CH_2OH}CH3OCH2CH3 + HIheatCH3I + CH3CH2OH$$

When methoxyethane reacts with hot hydroiodic acid, the ether bond is cleaved, producing methyl iodide and ethanol.

2. **Reaction with Phosphorus Pentachloride (PCl5):**

$$\mathrm{CH_3OCH_2CH_3 + PCl_5 \rightarrow CH_3Cl + CH_3CH_2Cl + POCl_3}$$

Phosphorus pentachloride reacts with methoxyethane to produce methyl chloride, ethyl chloride, and phosphoryl chloride.

3. **Reaction with Dilute Sulfuric Acid (H2SO4):**

$CH3OCH2CH3 + H2SO4(dil.) \rightarrow CH3OH + CH3CH2OH\mathrm{CH_3OCH_2CH_3}$
$+\mathrm{H_2SO_4(dil.)} \rightarrow \mathrm{CH_3OH+}$
$\mathrm{CH_3CH_2OH}CH3OCH2CH3 + H2SO4(dil.) \rightarrow CH3OH + CH3CH2OH$
Dilute sulfuric acid can hydrolyze methoxyethane to produce methanol and ethanol.

These reactions illustrate the different types of chemical behaviour exhibited by methoxyethane when exposed to various reagents.

Q. 20. Explain cationic, anionic and neutral sphere complexes with example.

Solution:

Cationic, Anionic, and Neutral Sphere Complexes refer to the overall charge on coordination compounds. Here's an explanation of each type with examples:

1. Cationic Complexes: These are coordination compounds where the complex ion carries a positive charge. The cationic complex is typically paired with an anion to balance the charge.
- Example: $[Co(NH_3)_6]Cl_3$
- Here, $[Co(NH_3)_6]^{3+}$ is the cationic complex ion, and Cl^- ions balance the charge.

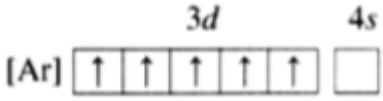
2. Anionic Complexes: These are coordination compounds where the complex ion carries a negative charge. The anionic complex is paired with a cation to balance the charge.
- Example: $K_3[Fe(CN)_6]$
- Here, $[Fe(CN)_6]^{3-}$ is the anionic complex ion, and K^+ ions balance the charge.

3. Neutral Complexes: These are coordination compounds where the overall complex does not carry any charge.
- Example: $[Ni(CO)_4]$
- Here, $[Ni(CO)_4]$ is a neutral complex because the overall charge is zero.

In summary:
- Cationic Complexes: $[Co(NH_3)_6]Cl_3$ where $[Co(NH_3)_6]^{3+}$ is the cationic part.
- Anionic Complexes: $K_3[Fe(CN)_6]$ where $[Fe(CN)_6]^{3-}$ is the anionic part.
- Neutral Complexes: $[Ni(CO)_4]$ which is electrically neutral.

Q. 21. Calculate spin only magnetic moment of divalent cation of transition metal with atomic number 25 . Salts of $\mathrm{Ti^{4+}}$ are colourless. Give reason.

Solution: For the element with atomic number 25. electronic configuration of its divalent cation will be [Ar] 3d5.



There are 5 unpaired electrons.

$$\therefore n = 5.$$
$$\therefore \mu = \sqrt{5(5+2)} = 5.92 \text{ B.M.}$$

The electronic configuration of Ti 4^+ is $[Ar]3d^0\ 4s^0$.

Since no unpaired electron is present in Ti4+

So, it is colourless

Q. 22. What is lanthanoid contraction?
Write preparation of acetic acid from
(i) dry ice
(ii) acetyl chloride.

Solution: Lanthanide contraction is the gradual decrease in the atomic and ionic size of lanthanoids with an increase in atomic number. Causes of lanthanide contraction:

With an increase in the atomic number, the positive charge on the nucleus increases by one unit, and one more electron enters the same 4f subshell.

The electrons in the 4f subshell imperfectly shield each other. Shielding in a 4f subshell is lesser than in d subshell. With the increase in nuclear charge, the valence shell is pulled slightly towards the nucleus.

This causes lanthanide contraction.

Q. 23. Write the classification of aliphatic ketones with example. What is the action of sodium hypoiodite on acetone?

Solution:

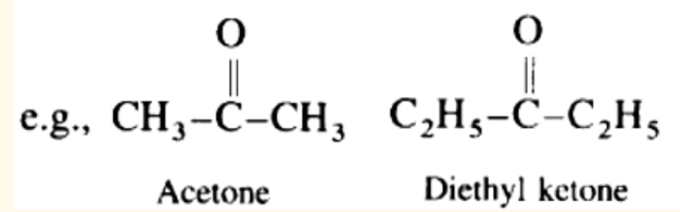
Aliphatic ketones: The compounds in which a group is attached to two alkyl groups are called aliphatic ketones.

Ketones are classified into two types :

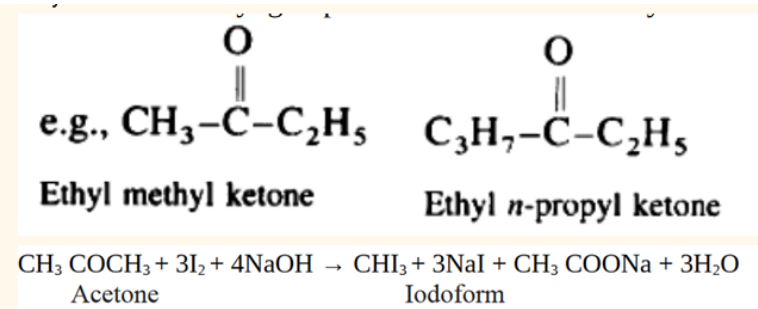
1. Simple or symmetrical ketones and

2. mixed or unsymmetrical ketones.

1. Simple or symmetrical ketone :



The ketone in which the carbonyl carbon is attached to two identical alkyl groups is called a simple or symmetrical ketone.



Q. 24. Define the half-life of a first-order reaction. Obtain the expression for half-life and rate constant of the first-order reaction.

Solution:

The half-life of a first-order reaction is the time it takes for the concentration of a reactant to decrease to half of its initial concentration. It is a characteristic property of the reaction and is independent of the initial concentration of the reactant. The half-life is denoted by the symbol $t_{1/2}$.

The expression for the half-life of a first-order reaction is:

$t_{1/2} = 0.693 / k$

where k is the rate constant of the reaction. The rate constant is a measure of the speed of the reaction and is defined as the proportionality constant between the rate of the reaction and the concentration of the reactant. The units of the rate constant depend on the order of the reaction. For a first-order reaction, the units of the rate constant are s^{-1}.

The expression for the rate of a first-order reaction is:

rate = k[A]

where [A] is the concentration of the reactant in mol/L. The rate of a reaction is the measure of how quickly the reaction is occurring and is defined as the change in concentration of a reactant or product per unit time. The units of the rate of a reaction are $mol/L \cdot s^{-1}$.

Q. 25. Calculate the standard enthalpy of formation of $CH_3OH_{(I)}$ from the following data
(i) $CH_3OH_{(l)} + \frac{3}{2}O_{2(g)} \rightarrow CO_{2(g)} + 2H_2O_{(l)}$
$\Delta H^\circ = -726\ kJ\ mol^{-1}$
(ii) $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)} \Delta_c H^\circ = -393\ kJ\ mol^{-1}$
(iii) $H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(1)} \Delta_f H^\circ = -286\ kJ\ mol^{-1}$**Q. 25. Calculate the standard enthalpy of formation of $CH_3OH_{(I)}$ from the following data**

Solution:

$$\text{(i)} \quad \mathrm{CH_3OH(l)} + \frac{3}{2}\mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)} + 2\mathrm{H_2O(l)} \quad \Delta H^\circ = -726\,\mathrm{kJ\ mol^{-1}}$$

$$\text{(ii)} \quad \mathrm{C(s)} + \mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)} \quad \Delta H_c^\circ = -393\,\mathrm{kJ\ mol^{-1}}$$

$$\text{(iii)} \quad \mathrm{H_2(g)} + \frac{1}{2}\mathrm{O_2(g)} \rightarrow \mathrm{H_2O(l)} \quad \Delta H_f^\circ = -286\,\mathrm{kJ\ mol^{-1}}$$

To find ΔH_f° of $\mathrm{CH_3OH(l)}$, we use Hess's Law, which states that the enthalpy change of a reaction is the sum of the enthalpy changes of the steps into which the reaction can be divided.

First, write the formation reaction of methanol from its elements in their standard states:

$$\mathrm{C(s)} + 2\mathrm{H_2(g)} + \frac{1}{2}\mathrm{O_2(g)} \rightarrow \mathrm{CH_3OH(l)}$$

We need to relate this to the given reactions. The given reactions can be combined to form this overall reaction:

1. Combustion of methanol:

$$\mathrm{CH_3OH(l)} + \frac{3}{2}\mathrm{O_2(g)} \rightarrow \mathrm{CO_2(g)} + 2\mathrm{H_2O(l)} \quad \Delta H^\circ = -726\,\mathrm{kJ\ mol^{-1}}$$

2. Reverse of the combustion of carbon:

$$\mathrm{CO_2(g)} \rightarrow \mathrm{C(s)} + \mathrm{O_2(g)} \quad \Delta H^\circ = +393\,\mathrm{kJ\ mol^{-1}}$$

3. Reverse of the formation of water (for 2 moles of $\mathrm{H_2O}$):

$$2\mathrm{H_2O(l)} \rightarrow 2\mathrm{H_2(g)} + \mathrm{O_2(g)} \quad \Delta H^\circ = 2 \times (+286\,\mathrm{kJ\ mol^{-1}}) = +572\,\mathrm{kJ\ mol^{-1}}$$

Now, add these reactions together:

$$\begin{aligned}
\mathrm{CH_3OH(l)} + \frac{3}{2}\mathrm{O_2(g)} &\rightarrow \mathrm{CO_2(g)} + 2\mathrm{H_2O(l)} \quad \Delta H^\circ = -726\,\mathrm{kJ\ mol^{-1}} \\
\mathrm{CO_2(g)} &\rightarrow \mathrm{C(s)} + \mathrm{O_2(g)} \quad \Delta H^\circ = +393\,\mathrm{kJ\ mol^{-1}} \\
2\mathrm{H_2O(l)} &\rightarrow 2\mathrm{H_2(g)} + \mathrm{O_2(g)} \quad \Delta H^\circ = +572\,\mathrm{kJ\ mol^{-1}}
\end{aligned}$$

The net reaction is:

$$\mathrm{CH_3OH(l)} \rightarrow \mathrm{C(s)} + 2\mathrm{H_2(g)} + \frac{1}{2}\mathrm{O_2(g)}$$

The total enthalpy change for this reaction is the sum of the enthalpy changes of the individual steps:

$$\Delta H^\circ = -726\,\text{kJ mol}^{-1} + 393\,\text{kJ mol}^{-1} + 572\,\text{kJ mol}^{-1}$$

$$\Delta H^\circ = 239\,\text{kJ mol}^{-1}$$

Since this is the enthalpy change for the reverse of the formation reaction, the enthalpy of formation of methanol is:

$$\Delta H_f^\circ(\text{CH}_3\text{OH(l)}) = -239\,\text{kJ mol}^{-1}$$

Q. 26. Calculate the pH of the buffer solution composed of 0.01 M weak base BOH and 0.02 M of its salt BA.
$\left\{K_b = 1.8 \times 10^{-5} \text{ for weak base }\right]$

Solution:

The Henderson-Hasselbalch equation can be used to calculate the pH of a buffer solution composed of a weak base and its conjugate acid. The equation is:

pH =pKb+log([A-]/[HA])\

were:

● The pH of the buffer solution

● pKbis the base dissociation constant of the weak base

● [A-] is the concentration of the conjugate base (salt)

● [HA] is the concentration of the weak acid (base)

In this problem, we are given that the concentration of the weak base (BOH) is 0.01 M and the concentration of its salt (BA) is 0.02 M. We are also given that the base dissociation constant (Kb) of the weak base is 1.8 10^-5. Substituting these values into the Henderson-Hasselbalch equation, we get:

pH =4.7447 + log(0.02/0.01) = 9.7781

Therefore, the pH of the buffer solution is 9.7781.

SECTION-D

Attempt any THREE of the following questions :
Q. 27. Define the following terms :
-(i) Isotonic solution
(ii) Osmosis
Gold crystallises into face-centred cubic cells. The edge length of unit cell is 4.08×10^{-8} cm. Calculate the density of gold.
[Molar mass of gold $= 197\ \text{g mol}^{-1}$]

Solution: Isotonic solution

(i) Isotonic solution: An isotonic solution refers to a solution that has the same concentration of solutes (such as salts or sugars) as another solution. When two solutions are isotonic, there is no net movement of water molecules across a semipermeable membrane between them, as water moves equally in both directions to maintain equilibrium.

(ii) Osmosis: Osmosis is the process by which solvent molecules (usually water) move across a semipermeable membrane from a region of lower solute concentration to a region of higher solute concentration. This movement of water occurs to equalize the concentration of solute on both sides of the membrane, thus balancing the osmotic pressure between the two solutions.

Calculation of the density of gold

The formula for density is:

density = mass / volume

In this problem, we are given that the molar mass of gold is 197 g/mol and the edge length of a unit cell of gold is 4.08 10^-8 cm.

volume = a^3

where a is the edge length of the unit cell.

volume = (4.08 10^-8 cm)^3 = 6.9746 10^-23 cm^3

The number of atoms in a unit cell of a face-centered cubic crystal is 4.

Therefore, the mass of a unit cell of gold is:

mass = 197 g/mol 4 atoms/unit cell = 788 g/mol

Therefore, the density of gold is:

density = 788 g/mol / 6.9746 10^-23 cm^3 = 1.12 10^21 g/cm^3

Therefore, the density of gold is 1.12 10^21 g/cm^3.

Q. 28. Write the mathematical equation for the first law of thermodynamics for
(i) isothermal process
(ii) adiabatic process

Derive the relationship between pH and pOH .

Solution:

First Law of Thermodynamics

The first law of thermodynamics is a fundamental principle of physics that states that the total energy of an isolated system remains constant. This principle can be expressed mathematically as:

$\Delta U=Q+W$

where:

- ΔU is the change in internal energy of the system
- Q is the heat transferred into or out of the system
- W is the work done on or by the system

Isothermal Process

An isothermal process is a thermodynamic process in which the temperature of the system remains constant. For an isothermal process, the first law of thermodynamics can be written as: $\Delta U=W$

This means that the change in internal energy of the system is equal to the work done on or by the system.

Adiabatic Process

An adiabatic process is a thermodynamic process in which there is no heat transfer between the system and its surroundings. For an adiabatic process, the first law of thermodynamics can be written as:

$\Delta U=-W$

This means that the change in internal energy of the system is equal to the negative of the work done on or by the system.

Relationship between pH and pOH

The pH of a solution is a measure of the acidity or alkalinity of the solution. The pH scale ranges from 0 to 14, with 7 being neutral. A solution with a pH less than 7 is acidic, while a solution with a pH greater than 7 is alkaline.

The pOH of a solution is a measure of the hydroxide ion concentration of the solution. The pOH scale ranges from 0 to 14, with 7 being neutral.

A solution with a pOH less than 7 is basic, while a solution with a pOH greater than 7 is acidic. The pH and pOH of a solution are related by the following equation: $pH + pOH = 14$ This equation is known as the water dissociation constant, or the Kw equation.

It states that the product of the pH and the pOH of a solution is always equal to 14.

Q. 29. Define reference electrode. Write functions of salt bridge. Draw neat, labelled diagram of standard hydrogen electrode (SHE).

Solution:

Reference Electrode

A reference electrode is an electrode that has a stable and well-known electrode potential. It is used as a reference point to measure the electrode potentials of other electrodes in electrochemical cells. The potential of a reference electrode is constant and does not change with the composition of the solution or the passage of current. Some common reference electrodes include the standard hydrogen electrode (SHE), the saturated calomel electrode (SCE), and the silver/silver chloride electrode (Ag/AgCl).

Functions of a Salt Bridge

1. **Maintaining Electrical Neutrality:** The primary function of a salt bridge is to maintain electrical neutrality within the internal circuit, which prevents the cell from rapidly reaching equilibrium and stopping the flow of electrons.
2. **Completing the Circuit:** It allows the flow of ions between the two half-cells, completing the electrical circuit.
3. **Preventing Liquid Junction Potential:** It minimizes the liquid junction potential by allowing ions to flow freely and maintain balance in the charge between the two solutions.

Diagram of Standard Hydrogen Electrode (SHE)

Below is a neat, labelled diagram of the standard hydrogen electrode (SHE):

Platinum wire|Platinum foil|H2(g), 1 atm|H+(aq), 1 M|Porous disk or membrane

$$\begin{array}{c}\text{Platinum wire}\\ |\\ \text{Platinum foil}\\ |\\ \text{H}_2\text{(g), 1 atm}\\ |\\ \text{H}^+\text{(aq), 1 M}\\ |\\ \text{Porous disk or membrane}\end{array}$$

Platinum wire|Platinum foil|H2(g), 1 atm|H+(aq), 1 M|Porous disk or membrane

Q. 30. Explain metal deficiency defect with example. Write chemicat equation for preparation of sulphur dioxide from sulphur. Write uses of sulphur.

Solution: Metal deficiency defect

A metal deficiency defect is a type of point defect in a crystal in which one or more metal atoms are missing from the lattice. This type of defect can occur in any type of crystal, but it is most common in ionic crystals.

Metal deficiency defects can have a significant impact on the properties of a material. For example, they can make a material more brittle and less conductive. In some cases, they can also lead to the formation of color centers.

An example of a metal deficiency defect is iron(II) oxide (FeO).

In this crystal, some of the Fe2+ ions are missing from the lattice. This creates a vacancy at the site of the missing ion. The vacancy is then filled by an electron, which creates a color center. The color center gives iron(II) oxide its black color. Chemical equation for preparation of sulfur dioxide from sulfur The chemical equation for the preparation of sulfur dioxide from sulfur is: $S + O_2 \rightarrow SO_2$ This reaction is a combustion reaction, and it is exothermic. The reaction takes place in the presence of a catalyst, such as vanadium pentoxide (V_2O_5).

Uses of sulfur Sulfur has a wide variety of uses. Some of the most common uses of sulfur include:

● Production of sulfuric acid: Sulfuric acid is one of the most important industrial chemicals. It is used in a wide variety of applications, including the production of fertilizers, detergents, and plastics.

● Vulcanization of rubber: Sulfur is used to vulcanize rubber. This process strengthens rubber and makes it more resistant to wear and tear.

● Production of pigments: Sulfur is used to produce a variety of pigments, including white, black, and yellow pigments.

● Production of pharmaceuticals: Sulfur is used to produce a variety of pharmaceuticals, including antibiotics and painkillers.

● Production of agricultural chemicals: Sulfur is used to produce a variety of agricultural chemicals, including insecticides and fungicides.

Q. 31. Write chemical reactions for the following conversions
(i) Ethyl bromide to ethyl methyl ether.
(ii) Ethyl bromide to ethene.
(iii) Bromobenzene to toluene.
(iv) Chlorobenzene to biphenyl.

Solution:

(i) Ethyl bromide to ethyl methyl ether:

$CH_3CH_2Br + NaOH \rightarrow CH_3CH_2OCH_3 + NaBr$

This reaction is known as the Williamson ether synthesis. It is an example of an S_N2 reaction, in which the bromide ion is displaced by the ethoxide ion.

(ii) Ethyl bromide to ethene: $CH_3CH_2Br + KOH\ (alc) \rightarrow CH_2=CH_2 + KBr + H_2O$

This reaction is known as the Zaitsev reaction. It is an example of an E2 elimination reaction, in which the bromide ion is eliminated along with the hydrogen atom from the β-carbon atom.

(iii) Bromobenzene to toluene:

$C_6H_5Br + Mg \rightarrow C_6H_5MgBr$

$C_6H_5MgBr + H_2O \rightarrow C_6H_5H + MgBrOH$

This reaction is known as the Grignard reaction. It is a two-step reaction in which the magnesium atom is inserted into the carbon-bromine bond, followed by hydrolysis to form toluene.

(iv) Chlorobenzene to biphenyl:

$2\ C_6H_5Cl + 2\ Na \rightarrow C_6H_5\text{-}C_6H_5 + 2NaCl$

This reaction is known as the Wurtz reaction. It is an example of a coupling reaction, in which two aryl halides are coupled to form an aryl-aryl bond.