CBSE EXAMINATION PAPER-2024

CHEMISTRY

(Solved)

Time allowed : 3 hours | Maximum Marks : 74

General Instructions :

Read the following instructions carefully and follow them :

i. This question paper contains **49 questions.** All questions are **compulsory.**

ii. This question paper is divided into **5 sections.**

iii. **Section A** – questions number **1 to 15** are case based questions

iv. **Section B** – questions number **16 to 31** are multiple choice questions

v. **Section C** – questions number **32 to 37** are very short answer

vi. **Section D** – questions number **38 to 44** are short answer

vii. **Section E** – questions number **45 to 49** are long answer

viii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.

ix. Use of calculator is NOT allowed.

Section A

Question 1. Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries: primary batteries and secondary batteries. In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion

of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

Question 2.

Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries secondary batteries. primary batteries and In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

Answer the following questions :

Question 3.

Question 4.

Question 5.

Question 6.

Question 7.

Question 8.

Question 9.

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Question 10.

Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries secondary batteries. primary batteries and In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme. Answer the following questions :

Question 11.

Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries secondary batteries. primary batteries and In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme. Answer the following questions :

Question 12.

Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries secondary batteries. primary batteries and In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme. Answer the following questions :

Question 13. Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries secondary batteries. primary batteries and In the primary batteries, the reaction occurs only once and after use over a period of time the battery

becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable. Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

Question 14.

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

Batteries and fuel cells are very useful forms of galvanic cell. Any battery or cell that we use as a source of electrical energy is basically a galvanic cell. However, for a battery to be of practical use it should be reasonably light, compact and its voltage should not vary appreciably during its use. There are mainly two types of batteries primary batteries and secondary batteries.

In the primary batteries, the reaction occurs only once and after use over a period of time the battery becomes dead and cannot be reused again, whereas the secondary batteries are rechargeable.

Production of electricity by thermal plants is not a very efficient method and is a major source of pollution. To solve this problem, galvanic cells are designed in such a way that energy of combustion of fuels is directly converted into electrical energy, and these are known as fuel cells. One such fuel cell was used in the Apollo space programme.

(1)

How do primary batteries differ from secondary batteries ?

[1 Marks]

Answer: Primary batteries undergo a chemical reaction only once and cannot be recharged after they are dead, whereas **secondary batteries** can be recharged and used multiple times. This is because secondary batteries allow the chemical reactions to be reversed by applying electrical energy. As mentioned in the case, primary batteries become dead after use and secondary batteries are rechargeable.

Key Points: Primary batteries have one-time reaction - Secondary batteries are rechargeable - Primary batteries cannot be reused after discharge

(2)

The cell potential of Mercury cell is 1·35 V, and remains constant during its life. Give reason.

[1 Marks]

Answer: Answer: The mercury cell has a constant cell potential of 1.35 V because the concentration of the electrolyte and the reactants remains nearly constant during its use as explained in the case. This occurs since the reactants are used up slowly and the products do not affect the electrolyte concentration, keeping voltage stable.

Key Points: Constant cell potential - Electrolyte concentration remains constant - Reactants and products do not change voltage appreciably

(3)

Write the reactions involved in the recharging of the lead storage battery.

[2 Marks]

Answer: Reactions involved in recharging a lead storage battery: During recharging, electrical energy is applied, reversing the discharge reactions. At the positive electrode, lead sulfate and water convert back to lead dioxide and sulfuric acid: $PbSO_4 + 2H_2O \rightarrow PbO_2 + 4H^+ + SO_4^{2-} + 2e^-$. At the negative electrode, lead sulfate converts back to lead and sulfate ions: $PbSO_4 + 2e^- \rightarrow Pb + SO_4^{2-}$. This restores the original lead, lead dioxide, and sulfuric acid, enabling the battery to be reused. This process shows the battery is a secondary battery as mentioned in the case passage.

Key Points: Recharging reverses discharge reaction - Lead sulfate converts to lead and lead dioxide - Sulfuric acid concentration is restored - Secondary battery is rechargeable - Electrical energy drives the reverse reactions

(4)

Write two advantages of fuel cells over other galvanic cells.

[2 Marks]

Answer: Advantages of fuel cells over other galvanic cells are:
Fuel cells produce electricity by converting energy of fuel combustion directly into electrical energy, so they are more efficient. They are pollution free as stated in the case, unlike batteries or thermal plants which may cause pollution. Also, fuel cells can continuously operate by feeding reactants, making them suitable for long-term use as used in Apollo space programme.

Key Points: Fuel cells convert fuel energy directly to electrical energy - Fuel cells are pollution free - Fuel cells can operate continuously by supplying reactants

Question 15.

The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometrical shapes of coordination compounds whereas" The Crystal Field Theory" for coordination compounds is based on the effect of different crystal fields (provided by ligands taken as point charges), on the degeneracy of d-orbital energies of the central metal atom/ion. The splitting of the d-orbitals provides different electronic arrangements in strong and weak crystal fields. The crystal field theory attributes the colour of the coordination compounds to d-d transition of the electron. Coordination compounds find extensive applications in metallurgical processes, analytical and medicinal chemistry

(1)

What is crystal field splitting energy ?

[1 Marks]

Answer: Crystal field splitting energy is the energy difference created between the d orbitals of a central metal ion when ligands approach and produce a crystal field. It is the measure of splitting of d orbital energies due to the effect of ligands treated as point charges according to Crystal Field Theory, as explained in the case passage.

Key Points: Energy difference between split d orbitals - Caused by ligand crystal field - Explained by Crystal Field Theory

(2)

Give reason for the violet colour of the complex $[Ti(H_2O)_6]^{3+}$ on the basis of crystal field theory.

[1 Marks]

Answer: According to crystal field theory, the violet colour of $[Ti(H_2O)_6]^{3+}$ is due to d-d electron transitions between split d-orbitals caused by the ligand field. The energy difference corresponds to violet light, which is absorbed causing the complex to appear violet.

Key Points: Crystal Field Theory explains colour in coordination compounds - Splitting of d-orbitals by ligands causes electronic transitions - Violet colour is due to absorption of light matching d-d transition energy in $[Ti(H_2O)_6]^{3+}$

(3)

Explain why $[Fe(CN)_6]^{3-}$ is an inner orbital complex, whereas $[Fe(H_2O)_6]^{3+}$ is an outer orbital complex. [Atomic No. : Fe = 26]

[2 Marks]

Answer: The complex [Fe(CN)6]3- is an inner orbital complex because CN- is a strong field ligand causing pairing of electrons in the 3d orbital, allowing the use of 3d orbitals for bonding (inner orbital). In contrast, [Fe(H2O)6]3+ is an outer orbital complex since H2O is a weak field ligand and does not pair electrons in 3d orbitals, so bonding involves 4s and 4p orbitals (outer orbital). This is explained by Valence Bond Theory and Crystal Field Theory from the case passage.

Key Points: [Fe(CN)6]3- has strong field ligand - causes electron pairing in 3d orbitals - forms inner orbital complex - [Fe(H2O)6]3+ has weak field ligand - no pairing in 3d orbitals - uses 4s and 4p orbitals - forms outer orbital complex

(4)

$[Cr(NH_3)_6]^{3+}$ is paramagnetic while $[Ni(CN)_4]^{2-}$ is diamagnetic. Explain why. [Atomic No. : Cr = 24, Ni = 28]

[2 Marks]

Answer: Explanation: The complex $[Cr(NH_3)_6]^{3+}$ has Cr^{3+} with electronic configuration $3d^3$. NH_3 is a weak field ligand, so it does not pair the electrons, leaving three unpaired electrons making it paramagnetic.

The complex $[Ni(CN)_4]^{2-}$ has Ni^{2+} with electronic configuration $3d^8$. CN^- is a strong field ligand causing pairing of electrons in dsp^2 hybrid orbitals in square planar geometry, resulting in all electrons paired and making it diamagnetic.

This explanation uses Valence Bond Theory as stated in the passage to justify the magnetic behaviour based on ligand field strength and orbital hybridisation.

Key Points: [Cr(NH3)6]3+ has unpaired electrons due to weak field NH3 ligand - [Ni(CN)4]2- has paired electrons due to strong field CN- ligand - Magnetic behaviour explained by Valence Bond Theory and ligand field strength

Section B

Question 16.

Which one of the following first row transition elements is expected to have the highest third ionization enthalpy ?

[1 Marks]

(A) Manganese (Z = 25)

(B) Vanadium (Z = 23)

(C) Chromium (Z = 24)

(D) Iron (Z = 26)

Explanation: Manganese (Z = 25) is expected to have the highest third ionization enthalpy among the given options. This is because Mn2+ has a d5 configuration, which is particularly stable due to its half-filled d subshell. The removal of an electron from this stable configuration requires significantly more energy, resulting in a higher third ionization enthalpy compared to the other elements provided.

Question 17.

Two among the three components of DNA are β-D-2-deoxyribose and a heterocyclic base. The third component is :

[1 Marks]

(A) Phosphoric acid

(B) Adenine

(C) Sulphuric acid

(D) Uracil

Explanation: The correct answer is Phosphoric acid. DNA consists of three main components: a sugar (β-D-2-deoxyribose), a nitrogenous base (which can be adenine, guanine, cytosine, or thymine), and a phosphate group (phosphoric acid). The context provided confirms that DNA's structure includes these components.

Question 18.

For an electrolyte undergoing association in a solvent, the vant factor :

[1 Marks]

(A) has negative value

(B) has zero value

(C) is always greater than one

(D) is always less than one

Explanation:

The correct answer is 'is always less than one'. This is because when an electrolyte associates, the number of particles in solution decreases compared to the number expected based on the formula units, leading to a lower van 't Hoff factor (v) which is a measure of the degree of dissociation or association in the solution.

Question 19.

For the reaction $X + 2Y \rightarrow P$, the differential form equation of the rate law is :

[1 Marks]

(A) $-d[P]/dt = -d[X]/dt$

(B) -2d[Y]/dt = +d[P]/dt

(C) 2d[P]/dt = -d[Y]/dt

(D) +d[X]/dt =-d[P]/dt

Explanation: The correct answer is 2d[P]/dt = -d[Y]/dt because in differential rate laws, the rate of change of reactants and products is related to their stoichiometric coefficients. For the reaction X + 2Y → P, the rate law can be expressed as -1/dX = -1/2dY = 1/dP, which leads to the differential form where changing concentration of Y affects P's formation at twice the rate.

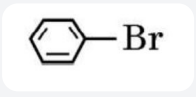
Question 20.

The compound which undergoes SN_1 reaction most rapidly is

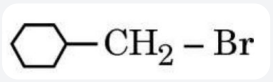
;

[1 Marks]

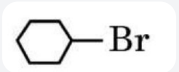
(A)



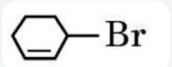
(B)



(C)



(D)



Explanation:

The SN1 reaction proceeds via the formation of a carbocation intermediate. Tertiary carbocations are the most stable due to greater alkyl group electron donation and steric hindrance that stabilizes the positive charge. Hence, tertiary alkyl halides like (CH3)3CBr undergo SN1 reactions most rapidly compared to primary or secondary alkyl halides.

Question 21.

Acetic acid reacts with PCl_5 to give :

[1 Marks]

(A) CCl_3 -COOH

(B) Cl -CH_2 -COOH

(C) Cl -CH_2 -COCl

(D) CH_3- COCl

Explanation: The correct answer is CH_3-COCl. Acetic acid (CH_3COOH) reacts with PCl_5 to form acetyl chloride (CH_3COCl) by replacing the hydroxyl (-OH) group with a chlorine atom, as the hydroxyl group behaves like that of alcohol and can be substituted when treated with PCl_5.

Question 22.

The formation of cyanohydrin from an aldehyde is an example of :

[1 Marks]

(A) nucleophilic addition

(B) electrophilic addition

(C) electrophilic substitution

(D) nucleophilic substitution

Explanation:

The correct answer is 'nucleophilic addition' because the reaction involves a nucleophile (cyanide ion) attacking the electrophilic carbonyl carbon of the aldehyde, leading to the formation of cyanohydrin.

Question 23.

In the Arrhenius equation, when log k is plotted against 1/T, a straight line is obtained whose :

[1 Marks]

(A) slope is A and intercept is -Ea/R.

(B) slope is A/R and intercept is E_a.

(C) slope is -Ea/RT and intercept is log A.

(D) slope is -Ea /2.303 R and intercept is log A.

Explanation:

The Arrhenius equation is k = A * exp(-Ea/(RT)). Taking the logarithm base 10 on both sides, we get log k = log A - Ea/(2.303 R) * 1/T. This equation is in the form of a straight line y = mx + c, where y =

log k, x = 1/T, slope m = -Ea/(2.303 R), and intercept c = log A. Hence, the plot of log k versus 1/T gives a straight line with slope -Ea/(2.303 R) and intercept log A.

Question 24.

The reaction of an alkyl halide with sodium alkoxide forming ether is known as :

[1 Marks]

(A) Reimer-Tiemann reaction

(B) Williamson synthesis

(C) Kolbe reaction

(D) Wurtz reaction

Explanation:

The correct answer is Williamson synthesis. In Williamson synthesis, an alkyl halide reacts with a sodium alkoxide to produce an ether. This reaction is a common method for synthesizing ethers from alcohols and alkyl halides.

Question 25.

The correct order of the ease of dehydration of the following alcohols by the action of conc. H_2SO_4 is :

[1 Marks]

(A) $(CH_3)_2CH$- OH > $(CH_3)_3C$- OH > CH_3CH_2- OH

(B) $(CH_3)_2CH$- OH > CH_3CH_2- OH > $(CH_3)_3C$- OH

(C) CH_3CH_2 -OH > $(CH_3)_2CH$- OH > $(CH_3)_3C$ -OH

(D) $(CH_3)_3C$- OH > $(CH_3)_2CH$- OH > CH_3CH_2- OH

Explanation: The correct order is $(CH_3)_3C$- OH > $(CH_3)_2CH$- OH > CH_3CH_2- OH. This is because tertiary alcohols dehydrate more easily than secondary, which in turn dehydrate more easily than primary alcohols. According to the provided context, the relative ease of dehydration follows the order: Tertiary > Secondary > Primary, which aligns with the structure of the given alcohols.

Question 26.

Which functional groups of glucose interact to form cyclic hemiacetal leading to pyranose structure ?

[1 Marks]

(A) Ketone group and hydroxyl group at C- 4

(B) Aldehyde group and hydroxyl group at C- 4

(C) Ketone group and hydroxyl group at C- 5

(D) Aldehyde group and hydroxyl group at C- 5

Explanation: The correct option is 'Aldehyde group and hydroxyl group at C- 5.' In glucose, the aldehyde group at C-1 reacts with the hydroxyl group at C-5 to form a cyclic hemiacetal, resulting in the pyranose structure, which is a six-membered ring.

Question 27.

Assertion (A) : When NaCl is added to water a depression in freezing point is observed.

Reason (R) : NaCl undergoes dissociation in water.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is false, but Reason (R) is true.

(D) Assertion (A) is true, but Reason (R) is false.

Explanation: Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). The addition of NaCl to water causes dissociation into Na+ and Cl- ions, which disrupts the formation of ice, leading to a depression in the freezing point.

Question 28.

Assertion (A) : Separation of Zr and Hf is difficult.

Reason (R) : Zr and Hf have similar radii due to lanthanoid contraction.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Assertion (A) is true, but Reason (R) is false.

(C) Assertion (A) is false, but Reason (R) is true.

(D) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

Explanation:

Both Assertion (A) and Reason (R) are true, and Reason (R) is the correct explanation of Assertion (A). The similar ionic radii of Zr and Hf, resulting from the lanthanoid contraction, indeed make their separation challenging.

Question 29.

Assertion (A) : The pK_a of ethanoic acid is lower than that of Cl -CH_2- COOH.

Reason (R) : Chlorine shows electron withdrawing (I) effect which increases the acidic character of Cl -CH 2- COOH.

[1 Marks]

(A) Assertion (A) is false, but Reason (R) is true.

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(D) Assertion (A) is true, but Reason (R) is false.

Explanation:

Assertion (A) is false, but Reason (R) is true. The pK_a of Cl-CH_2-COOH is actually lower than that of ethanoic acid due to the electron-withdrawing effect of chlorine, which does increase the acidic character of Cl-CH_2-COOH. Therefore, while Reason (R) correctly describes the influence of chlorine on acidity, Assertion (A) is incorrect.

Question 30.

Assertion (A) : Aniline is a stronger base than ammonia.

Reason (R) : The unshared electron pair on nitrogen atom in aniline becomes less available for protonation due to resonance.

[1 Marks]

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

Explanation: Assertion (A) is false, but Reason (R) is true. Aniline is actually a weaker base than ammonia because the lone pair of electrons on the nitrogen atom in aniline is involved in resonance with the aromatic ring, which decreases its availability for protonation. Therefore, while the reason correctly describes the effect of resonance on aniline's basicity, the assertion that aniline is a stronger base than ammonia is incorrect.

Question 31.

Which of the following compounds will give a ketone on oxidation with chromic anhydride (CrO_3) ?

[1 Marks]

(A) CH_3 -CH_2 -CH (OH)-CH_3

(B) $(CH_3)_3C$- OH

(C) CH3CH2CH2OH

(D) (CH3)2CH -CH2OH

Explanation: The correct option is $(CH_3)_3C$-OH, which is a tertiary alcohol that does not undergo oxidation to form a ketone, but secondary alcohols like CH_3-CH_2-CH(OH)-CH_3 can be oxidized to ketones. Tertiary alcohols do not give ketones upon oxidation, whereas secondary alcohols do. Therefore, the ketone formed will be from the oxidation of a suitable secondary alcohol, and the only option that fits this is CH_3-CH_2-CH(OH)-CH_3, which can form a ketone upon oxidation with CrO_3.

Section C

Question 32.

Calculate the potential of Iron electrode in which the concentration of

Fe2+ ion is 0·01 M.

(E°Fe2+/Fe = 0·45 V at 298 K)

[Given : log 10 = 1]

[2 Marks]

Answer: The potential of the iron electrode is calculated using the Nernst equation:

$E = E° - (0.0592 / n) * \log [Fe^{2+}]$

Here, $E° = 0.45$ V, $n = 2$, and $[Fe^{2+}] = 0.01$ M

So, $E = 0.45 - (0.0592 / 2) * \log 0.01$

$= 0.45 - 0.0296 * (-2)$ since $\log 0.01 = -2$

$= 0.45 + 0.0592$

$= 0.5092$ V

Therefore, the potential of the iron electrode is approximately 0.51 V.

Key Points: Use of Nernst equation - Substitution of given values - Calculation of log and final potential

Question 33.

Define molecularity of the reaction. State any one condition in which a bimolecular reaction may be kinetically of first order

[2 Marks]

Answer: (a) Molecularity of a reaction is defined as the number of reacting species (atoms, ions, or molecules) that must collide simultaneously in an elementary reaction to bring about the chemical change. It is always a whole number like 1, 2, 3 and cannot be zero or a fraction.

(b) Condition when a bimolecular reaction is kinetically first order: If one reactant is in large excess so that its concentration remains nearly constant during the reaction, the rate depends effectively only on the concentration of the other reactant. Thus, the reaction appears to follow first order kinetics even though it is bimolecular in molecularity.

Key Points: Molecularity is number of species colliding - Molecularity is always whole number - Bimolecular reaction appears first order if one reactant concentration is constant

Question 34.

What happens when D-glucose is treated with the following reagents?

(a) HI (b) Conc. HNO_3

[2 Marks]

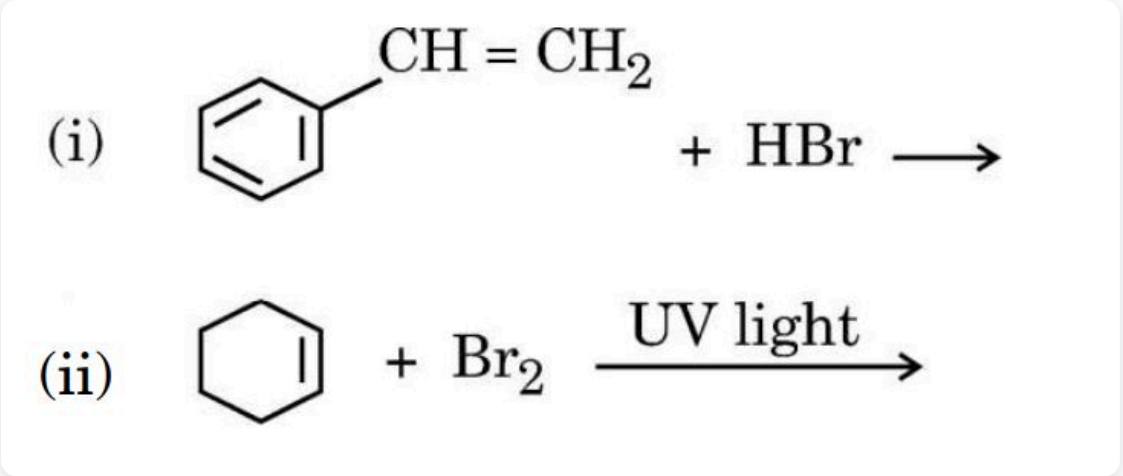
Answer: (a) When D-glucose is treated with HI, it gets converted into n-hexane as HI reduces both the aldehyde group and hydroxyl groups, resulting in cleavage of oxygen and formation of an alkane.
(b) When D-glucose is treated with concentrated HNO_3, it undergoes oxidation to form saccharic acid (a dicarboxylic acid) by oxidizing both the aldehyde group and the primary alcoholic group. This shows the presence of a primary alcoholic group in glucose.

Key Points: D-glucose reduces to n-hexane with HI - HI acts as a strong reducing agent - Concentrated HNO3 oxidizes glucose to saccharic acid - Both aldehyde and primary alcohol groups get oxidized with HNO3

Question 35.

Draw the structures of major monohalo products in each of the following reactions:

[2 Marks]



Answer:

(i) Styrene + HBr

The reaction of styrene (vinyl benzene) with Hydrogen Bromide (H Br) follows **Markovnikov's Rule**.

- **Major Product: 1-bromo-1-phenylethane** * **Mechanism:** The proton (H^+) adds to the terminal carbon to form the more stable carbocation. In this case, it forms a **benzylic carbocation**, which is highly stabilized by resonance with the benzene ring. The bromide ion (Br^-) then attacks this stable carbocation.
- **Structure:** A benzene ring attached to a -CH(Br)CH_3 group.

(ii) Cyclohexene + Br_2 (in UV light)

The presence of **UV light** (or heat) changes the reaction pathway from electrophilic addition to **Free Radical Substitution**.

- **Major Product: 3-bromocyclohexene**
- **Mechanism:** Instead of adding across the double bond, the bromine undergoes homolytic fission to form radicals. These radicals prefer to abstract a hydrogen from the **allylic position** (the carbon atom adjacent to the double bond). The resulting allylic radical is resonance-stabilized, making this the favored path.

- **Structure:** A cyclohexene ring with a Bromine atom attached to one of the carbons adjacent to the double bond.

Key Points: SOCl2 replaces -OH with -Cl- substitution reaction - PCl3 and PCl5 also convert alcohols to alkyl chlorides - Primary, secondary, tertiary alcohols all form corresponding chloro compounds - Structure depends on the original alcohol molecule

Question 36.

Give reasons for the following:

(i) Grignard reagent should be prepared under anhydrous conditions.

(ii) Alkyl halides give alcohol with aqueous KOH whereas in the presence of alcoholic KOH, alkenes are formed.

[2 Marks]

Answer: (i) Grignard reagents are highly reactive with water, as they react with moisture to form alkanes and lose their reactivity. Therefore, they must be prepared under anhydrous (dry) conditions to prevent reaction with water and to ensure they remain active for further chemical reactions.
(ii) When alkyl halides are treated with aqueous KOH, nucleophilic substitution occurs where OH- replaces the halogen atom, forming an alcohol. However, with alcoholic KOH, elimination reaction takes place where a proton is removed along with the halogen, leading to the formation of alkenes due to the absence of sufficient water to promote substitution.

Key Points: Grignard reagents react with water - Must be prepared in dry conditions - Aqueous KOH causes substitution to alcohols - Alcoholic KOH causes elimination to alkenes

Question 37.

Write the chemical equation when :

(i) Butan-2-one is treated with Zn(Hg) and conc. HCl.

(ii) Two molecules of benzaldehyde are treated with conc. NaOH.

[2 Marks]

Answer: (i) When Butan-2-one (CH_3-CO-CH_2-CH_3) is treated with Zn(Hg) and conc. HCl, it undergoes Clemmensen reduction to form Butane (CH_3-CH_2-CH_2-CH_3).
Equation: CH_3-CO-CH_2-CH_3 + Zn(Hg), HCl → CH_3-CH_2-CH_2-CH_3

(ii) When two molecules of benzaldehyde (C_6H_5CHO) are treated with conc. NaOH, benzaldehyde

undergoes Cannizzaro reaction to give benzyl alcohol ($C_6H_5CH_2OH$) and benzoic acid (C_6H_5COOH).

Equation: $2\ C_6H_5CHO + NaOH \rightarrow C_6H_5CH_2OH + C_6H_5COONa$

Here, one molecule of benzaldehyde is reduced and the other is oxidized in presence of alkali.

Key Points: Butan-2-one undergoes Clemmensen reduction to form Butane - Clemmensen reagent is Zn(Hg) with conc. HCl - Benzaldehyde undergoes Cannizzaro reaction with conc. NaOH - One benzaldehyde molecule is reduced to benzyl alcohol - Another benzaldehyde molecule is oxidized to benzoic acid

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Section D

Question 38.

When a certain conductivity cell was filled with 0·05 M KCl solution, it has a resistance of 100 ohm at 25ºC. When the same cell was filled with 0·02 M $AgNO_3$ solution, the resistance was 90 ohm. Calculate the conductivity and molar conductivity of AgNO3 solution.

(Given : Conductivity of 0·05 M KCl solution = 1·35 * 10 $^{-2}$ ohm-1cm^{-1})

[3 Marks]

Answer: (a) First, calculate the cell constant (G*) using the KCl solution data. Given: Conductivity, k = $1.35 * 10^{-2}$ ohm^{-1} cm^{-1}, Resistance, R = 100 ohm

Cell constant, $G^* = k * R = 1.35 * 10^{-2} * 100 = 1.35\ cm^{-1}$

(b) Now, calculate the conductivity of 0.02 M $AgNO_3$ solution using G* and its resistance (R = 90 ohm).

Conductivity, $k = G^* / R = 1.35 / 90 = 0.015\ ohm^{-1}\ cm^{-1}$

(c) Calculate molar conductivity, Λ_m = k / concentration

Concentration of $AgNO_3$ = 0.02 M, so

$\Lambda_m = 0.015 / 0.02 = 0.75\ ohm^{-1}\ cm^2\ mol^{-1}$

Final answers:

Conductivity of $AgNO_3$ solution = $0.015\ ohm^{-1}\ cm^{-1}$

Molar conductivity of $AgNO_3$ solution = $0.75\ ohm^{-1}\ cm^2\ mol^{-1}$

Key Points: Calculate cell constant using KCl data - Use cell constant to find conductivity of AgNO3 solution - Compute molar conductivity using conductivity and concentration

Question 39.

The following initial rate data were obtained for the reaction : $2NO\ (g) + Br_2\ (g) \rightarrow 2NOBr\ (g)$

(a) What is the order with respect to NO and Br_2 in the reaction ?

(b) Calculate the rate constant (k).

(iii) Determine the rate of reaction when concentration of NO and Br_2 are 0·4 M and 0·2 M, respectively.

[3 Marks]

Expt. No.	$[NO]/mol\ L^{-1}$	$[Br_2]/mol\ L^{-1}$	Initial Rate $(mol\ L^{-1}\ s^{-1})$
1	0·05	0·05	$1·0 \times 10^{-3}$
2	0·05	0·15	$3·0 \times 10^{-3}$
3	0·15	0·05	$9·0 \times 10^{-3}$

Answer: (a) The order with respect to NO is found by observing how the rate changes when the concentration of NO is varied while Br_2 concentration is constant. If doubling [NO] quadruples the rate, the order with respect to NO is 2. Similarly, if doubling $[Br_2]$ doubles the rate, then the order with respect to Br_2 is 1.

(b) The rate law is Rate = k $[NO]^2$ $[Br_2]^1$. Using initial rate data, say Rate = R, [NO] = a, $[Br_2]$ = b, then k = R / (a^2 * b). Substitute values from any experiment to calculate k.

(iii) Substitute [NO] = 0.4 M and $[Br_2]$ = 0.2 M into the rate law with the calculated k to find the new rate: Rate = k * $(0.4)^2$ * (0.2). This gives the rate of reaction under the given concentrations.

Key Points: Order with respect to NO is 2 - Order with respect to Br_2 is 1 - Use rate law Rate = k $[NO]^2$ $[Br_2]^1$ to calculate k and rate

Question 40.

(a) Write the formula for the following coordination compound : Potassium tetrahydroxidozincate (II)

(b) Arrange the following complexes in the increasing order of conductivity of their solution : $[Cr(NH_3)_5Cl]Cl_2$, $[Cr(NH_3)_3Cl_3]$, $[Cr(NH_3)_6]C_3$

(c) Identify the type of isomerism exhibited by the following complexes :

(i) $[Co(NH_3)_5NO_2]^{2+}$

(ii) $[Co(en)_3]Cl_3$

[3 Marks]

Answer: (a) The given compound is Potassium tetrahydroxidozincate (II). "Tetrahydroxido" means 4 hydroxide (OH^-) ligands, "zincate (II)" means zinc ion with +2 charge complex ion. The complex ion is $[Zn(OH)_4]^{2-}$. To balance the charge, 2 K^+ ions are required. Therefore, the formula is $K_2[Zn(OH)_4]$.
(b) Conductivity depends on number of ions produced in solution. For the given complexes:
1. $[Cr(NH_3)_5Cl]Cl_2$: One complex cation $[Cr(NH_3)_5Cl]^{2+}$ and 2 Cl^- ions outside, total 3 ions.
2. $[Cr(NH_3)_3Cl_3]$: Neutral complex, no ions outside.
3. $[Cr(NH_3)_6]Cl_3$: One complex cation $[Cr(NH_3)_6]^{3+}$ and 3 Cl^- ions outside, total 4 ions.
Thus, increasing order of conductivity is: $[Cr(NH_3)_3Cl_3] < [Cr(NH_3)_5Cl]Cl_2 < [Cr(NH_3)_6]Cl_3$.
(c) Type of isomerism:
(i) $[Co(NH_3)_5NO_2]^{2+}$: This complex shows linkage isomerism because NO_2 ligand can bind through N or O.
(ii) $[Co(en)_3]Cl_3$: This complex shows optical isomerism due to chiral nature of tris(ethane-1,2-diamine)cobalt(III) complex.

Key Points: Formula writing for coordination compounds - Conductivity relates to number of ions in solution - Identification of linkage and optical isomerism

Question 41.

(a) Which of the following is an allylic halide ?

(i) CH_3 -CH=CH-Br

(ii) CH_2=CH-CH (Br)-CH_3

(b) Out of chlorobenzene and 2,4,6-trinitrochlorobenzene, which is more reactive towards nucleophilic substitution and why ?

(c) Which isomer of C_4H_9Cl has the lowest boiling point ?

[3 Marks]

Answer: (a) An allylic halide has the halogen attached to the carbon adjacent to a double bond (allylic position). In (i) CH_3-CH=CH-Br, the bromine is attached to the carbon next to the double bond, so it is an allylic halide. In (ii) CH_2=CH-CH(Br)-CH_3, bromine is attached to a carbon which is not adjacent to the double bond, so it is not allylic. Therefore, (i) is the allylic halide.
(b) 2,4,6-Trinitrochlorobenzene is more reactive towards nucleophilic substitution than chlorobenzene because the nitro groups are strong electron withdrawing groups which make the benzene ring electron deficient, stabilizing the negative charge in the intermediate Meisenheimer complex, thus facilitating nucleophilic substitution. Chlorobenzene has no such electron withdrawing groups and is less reactive.
(c) Among isomers of C_4H_9Cl, the one with the lowest boiling point is the most branched isomer. The isomer is 2-chloro-2-methylpropane (tert-butyl chloride) because branching reduces surface area and intermolecular forces, thus lowering boiling point.

Key Points: Allylic halide has halogen next to a double bond - Electron withdrawing groups increase reactivity in nucleophilic substitution - More branched isomer has lower boiling point

Question 42.

(a) Write the mechanism of the following reaction

(b) Write the main product in each of the following reactions :

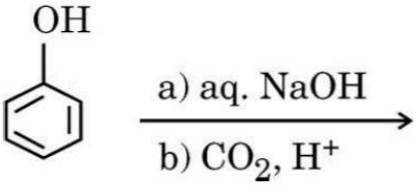
[3 Marks]

(a) Write the mechanism of the following reaction :

$$CH_3CH_2OH \xrightarrow[443\ K]{H^+} CH_2 = CH_2$$

(b) Write the main product in each of the following reactions :

(i) $$CH_3 - CH_2 - CH = CH_2 \xrightarrow[b)\ 3H_2O_2/OH^-]{a)\ B_2H_6}$$

(ii) 

Answer:

(a) (i) Styrene + HBr: Yields **1-bromo-1-phenylethane** via Markovnikov addition, forming a stable benzylic carbocation.

- **(ii) Cyclohexene + Br_2 (UV):** Yields **3-bromocyclohexene** via allylic radical substitution (UV light prevents addition across the double bond).

  (b) (i) Hydroboration-Oxidation: Yields **Butan-1-ol**. It follows Anti-Markovnikov addition of water across the double bond.

- **(ii) Kolbe's Reaction:** Phenol reacts with NaOH and CO_2 followed by acidification to yield **2-hydroxybenzoic acid (Salicylic acid)**.

Key Points:

All these reactions are governed by the stability of intermediates (carbocations or radicals) and specific regioselectivity rules like Markovnikov or Anti-Markovnikov addition.

Question 43.

Answer the following: (any three)

(a) What is peptide linkage ?

(b) What type of bonds hold a DNA double helix together ?

(c) Which one of the following is a polysaccharide ? Sucrose, Glucose, Starch, Fructose

(d) Give one example each for water-soluble vitamins and fat-soluble vitamins.

[3 Marks]

Answer: (a) **Peptide linkage** is the bond formed between the carbon atom of the carboxyl group of one amino acid and the nitrogen atom of the amino group of another. It is also called a peptide bond and is responsible for linking amino acids together to form proteins.
(b) **Hydrogen bonds** hold the two strands of the DNA double helix together. These bonds form between complementary nitrogenous bases: adenine pairs with thymine by two hydrogen bonds and cytosine pairs with guanine by three hydrogen bonds.
(c) Out of sucrose, glucose, starch, and fructose, **starch** is a polysaccharide. It is made of many glucose units linked together and serves as an energy storage molecule in plants.
(d) An example of a **water-soluble vitamin** is vitamin C, and an example of a **fat-soluble vitamin** is vitamin A.

Key Points: Peptide linkage is a bond between carboxyl and amino groups - DNA strands are held by hydrogen bonds between bases - Starch is a polysaccharide - Vitamin C is water-soluble vitamin and vitamin A is fat-soluble vitamin

Question 44.

Compound (A) ($C_6H_{12}O_2$) on reduction with $LiAlH_4$ gives two compounds (B) and (C). The compound (B) on oxidation with PCC gives compound (D) which upon treatment with dilute NaOH and subsequent heating gives compound (E). Compound (E) on catalytic hydrogenation gives compound (C). The compound (D) is oxidized further to give compound (F) which is found to be a monobasic acid (Molecular weight = 60). Identify the compounds (A), (B), (C), (D), (E) and (F).

[3 Marks]

Answer: Compound (A) with molecular formula $C_6H_{12}O_2$ is likely an ester since reduction with $LiAlH_4$ gives two compounds (B) and (C). $LiAlH_4$ reduces esters to two alcohols. (B) and (C) are the corresponding alcohols. Compound (B), on oxidation with PCC (a mild oxidizing agent), forms an aldehyde (D). This aldehyde (D) on treatment with dilute NaOH and heating undergoes aldol condensation to give compound (E). Hydrogenation of (E) yields compound (C), the second alcohol from the initial ester reduction. Compound (D), upon further oxidation, forms a monobasic acid (F) with molecular weight 60, which is ethanal oxidizing to acetic acid (CH_3COOH). From this, we identify compounds as follows:

(A): Ethyl acetate ($CH_3COOCH_2CH_3$)

(B): Ethanol (CH_3CH_2OH)

(C): Ethanol (CH_3CH_2OH) (since both alcohols are same here)

(D): Acetaldehyde (CH_3CHO)

(E): Crotonaldehyde ($CH_3CH=CHCHO$) formed by aldol condensation

(F): Acetic acid (CH_3COOH)

This explains the sequence of reactions where reduction of ester (A) gives two alcohols (B) and (C), oxidation of primary alcohol (B) with PCC gives aldehyde (D), which on aldol condensation with base forms (E). Hydrogenation of (E) gives back alcohol (C). Further oxidation of (D) provides the acid (F).

Key Points: Compound A is an ester C6H12O2 - LiAlH4 reduces ester to two alcohols B and C - B oxidized by PCC to aldehyde D - D undergoes aldol condensation with NaOH to form E - Hydrogenation of E gives alcohol C - Further oxidation of D gives acid F with molecular weight 60

Section E

Question 45.

(i) At the same temperature, CO_2 gas is more soluble in water than O_2 gas. Which one of them will have higher value of K_h and why?

(ii) How does the size of blood cells change when placed in an aqueous solution containing more than 0.9% (mass/volume) sodium chloride?

(iii) 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionized. Calculate the boiling point of the solution.

(Given : Kb for H_2O = 0·52 K kg mol $^{-1}$)

[5 Marks]

Answer: (a) CO_2 gas has higher solubility in water than O_2 gas at the same temperature, which means CO_2 dissolves more in water. The Henry's law constant K_h is inversely proportional to solubility, so the gas with less solubility has higher K_h. Since O_2 is less soluble than CO_2, O_2 has higher K_h value. Therefore, O_2 gas has higher K_h than CO_2.
Explanation: The higher the solubility, the lower the K_h, because $K_h = P/C$ where P is pressure and *C* concentration in solution.

(b) Normal sodium chloride concentration in blood plasma is about 0.9%. When blood cells are placed in an aqueous solution containing more than 0.9% sodium chloride (hypertonic solution), water moves out from the cells by osmosis. As a result, the cells shrink or become crenated (shrunken in size). This happens because the external solution has higher osmotic pressure compared to inside the cells.

(c) Given: molality, m = 1 mol/kg; electrolyte A_2B_3 ionizes 60%.
Number of ions formed per formula unit: 2 (A) + 3 (B) = 5 ions.
Degree of ionization, α = 0.60
van 't Hoff factor, i = 1 + (n - 1) * α = 1 + (5 - 1) * 0.60 = 1 + 4 * 0.60 = 3.4
Boiling point elevation, $\Delta T_b = i * K_b * m = 3.4 * 0.52 * 1 = 1.768$ K
Boiling point of pure water = 373 K (100°C)
Therefore, boiling point of solution = 100 + 1.768 = 101.77 °C

Final answer: The boiling point of the 1 molal A_2B_3 solution ionized 60% is approximately 101.77 °C.

Key Points: O2 has higher K_h due to lower solubility - Blood cells shrink in hypertonic NaCl solution due to osmosis - Boiling point elevation calculated using van't Hoff factor and degree of ionization

Question 46.

(i) The vapour pressures of A and B at 25ºC are 75 mm Hg and 25 mm Hg, respectively. If A and B are mixed such that the mole fraction of A in the mixture is 0.4, then calculate the mole fraction of B in vapour phase.

(ii) Define colligative property. Which colligative property is preferred for the molar mass determination of macromolecules?

(iii) Why are equimolar solutions of sodium chloride and glucose not isotonic?

[5 Marks]

Answer:

(i) Given: Vapour pressure of pure A, P_A0 = 75 mm Hg; Vapour pressure of pure B, P_B0 = 25 mm Hg; Mole fraction of A in liquid, x_A = 0.4; Mole fraction of B in liquid, x_B = 1 - x_A = 0.6.
Total vapour pressure, P_total = x_A*P_A0 + x_B*P_B0 = 0.4*75 + 0.6*25 = 30 + 15 = 45 mm Hg.
Mole fraction of A in vapour phase, y_A = (x_A*P_A0) / P_total = (0.4*75)/45 = 30/45 = 0.6667.
Mole fraction of B in vapour phase, y_B = (x_B*P_B0) / P_total = (0.6*25)/45 = 15/45 = 0.3333.
Therefore, mole fraction of B in vapour phase is 0.3333.

(ii) A colligative property is a property of a solution that depends only on the number of solute particles and not on their nature. Examples include vapor pressure lowering, boiling point elevation, freezing point depression, and osmotic pressure.
Osmotic pressure is preferred for the molar mass determination of macromolecules because it can be measured at very low concentrations, reducing errors, and is highly sensitive to the number of solute particles.

(iii) Equimolar solutions of sodium chloride and glucose are not isotonic because sodium chloride dissociates into two ions (Na+ and Cl-), effectively doubling the number of solute particles compared to glucose which does not dissociate. Hence, their osmotic pressures differ even at the same molar concentration, so they are not isotonic.

Key Points: Use Raoult's law and Dalton's law to find vapor phase composition - Colligative property depends on number of particles not type - Osmotic pressure is best for molar mass of macromolecules - NaCl dissociates to ions increasing particle number - Equimolar solutions of NaCl and glucose differ in osmotic pressure so not isotonic

Question 47.

(i) Account for the following:

(1) The melting and boiling points of Zn, Cd and Hg are low.

(2) Of the d^4 species, Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing.

(3) E^o value of Cu^{2+}/Cu is +0.34 V.

(ii) Complete and balance the following chemical equations:

[5 Marks]

(1) $KMnO_4 \xrightarrow{heat}$

(2) $Cr_2O_7^{2-} + 6\,I^- + 14\,H^+ \longrightarrow$

Answer:

(i) Answer:

(1) The melting and boiling points of Zn, Cd and Hg are low because they have weak metallic bonding due to their electronic configurations and atomic sizes. These metals have completely filled d10 subshells which do not contribute significantly to metallic bonding, resulting in low melting and boiling points.

(2) Cr2+ (d4) is strongly reducing because it has a tendency to lose an electron to achieve a more stable electronic configuration (d3), therefore it acts as a good reducing agent. Mn3+ (d4), on the other hand, is strongly oxidizing because it tends to gain an electron to form Mn2+ (d5), which is a stable half-filled configuration; thus, it acts as a strong oxidizing agent.

(3) The E^o value of Cu2+/Cu is +0.34 V indicating that Cu2+ ions have a strong tendency to gain electrons and get reduced to Cu metal. This positive value shows that copper ions are relatively stable in solution and copper metal is less reactive.

(ii) Complete and balance chemical equations:

(1) $2KMnO_4 \xrightarrow{(heat)} K_2MnO_4 + MnO_2 + O_2$

Potassium permanganate decomposes into potassium manganate, manganese dioxide, and oxygen gas.

(2) $Cr_2O_7^{2-} + 6I^- + 14H^+ \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

Dichromate ions oxidize iodide ions to molecular iodine while being reduced to chromium(III) ions.

Key Points: Low melting boiling points of Zn Cd Hg due to weak metallic bonding - Cr2+ is reducing agent loses electron Mn3+ is oxidizing agent gains electron - Positive E^o of Cu2+/Cu shows copper ion reduction tendency

Question 48.

(i) Out of Cu_2Cl_2 and $CuCl_2$, which is more stable in aqueous solution and why?

(ii) Write the general electronic configuration of f-block elements.

(iii) Predict which of the following will be coloured in aqueous solution and why ? Sc^{3+} , Fe^{3+} , Zn^{2+}

[Atomic number : Sc = 21, Fe = 26, Zn = 30]

(iv) How can you obtain potassium dichromate from sodium chromate ?

(v) Why do transition metals and their compounds show catalytic activities ?

[5 Marks]

Answer:

(i) $CuCl_2$ is more stable in aqueous solution than Cu_2Cl_2. This is because Cu(I) compounds like Cu_2Cl_2 tend to undergo disproportionation in water where Cu(I) oxidises to Cu(II) and reduces to Cu metal, making them less stable. Meanwhile, $CuCl_2$ contains Cu(II) which is more stable in aqueous solution.
(ii) The general electronic configuration of f-block elements is [Noble gas] $4f^{1-14}\ 5d^{0-1}\ 6s^2$. This means electrons are filling the 4f orbitals, with variable occupancy of 5d and 6s orbitals.
(iii) Fe^{3+} will be coloured in aqueous solution because it has unpaired d electrons leading to d-d transitions that absorb visible light. Sc^{3+} and Zn^{2+} are colourless because Sc^{3+} has no d electrons ($3d^0$) and Zn^{2+} has a full d shell ($3d^{10}$), so no d-d transitions occur.
(iv) Potassium dichromate can be obtained from sodium chromate by acidifying sodium chromate solution with dilute sulfuric acid. The reaction is:
$2Na_2CrO_4 + H_2SO_4 \rightarrow K_2Cr_2O_7 + Na_2SO_4 + H_2O$ (Potassium dichromate formed as an orange solid)
(v) Transition metals and their compounds show catalytic activity because they can adopt multiple oxidation states and have partially filled d orbitals. This allows them to form temporary bonds with reactants, providing an alternative reaction pathway with lower activation energy, thus increasing reaction rates.

Key Points: $CuCl_2$ is more stable than Cu_2Cl_2 due to disproportionation of Cu(I) - General electronic configuration is [Noble gas] $4f^{1-14}\ 5d^{0-1}\ 6s^2$ - Fe^{3+} is coloured due to unpaired d electrons; Sc^{3+} and Zn^{2+} are colourless - Potassium dichromate prepared by acidifying sodium chromate solution - Catalytic activity due to variable oxidation states and ability to form intermediate complexes

Question 49.

Answer any five questions of the following:

(a) N,N-diethyl-benzenesulphonamide is insoluble in alkali. Give reason.

(b) Aniline does not undergo Friedel-Crafts reaction. Why ?

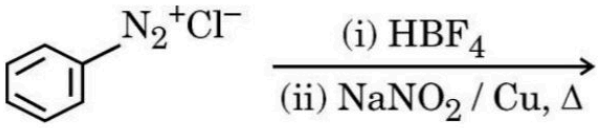
(c) Write a simple chemical test to distinguish between methylamine and aniline.

(d) Write the chemical reaction involved in Gabriel phthalimide synthesis.

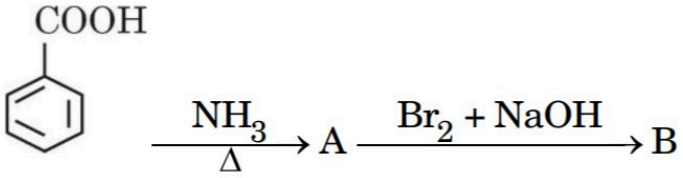
(e) How will you convert aniline to p-bromoaniline ?

[5 Marks]

(f) Complete the following reaction :



(g) Write the structures of A and B in the following reaction :



Answer: (a) N,N-diethyl-benzenesulphonamide is insoluble in alkali because it is a neutral compound and does not have acidic hydrogen atoms to react with alkali to form salts. Sulphonamides are weakly acidic but the N,N-diethyl substitution reduces acidity making it insoluble in alkali.

(b) Aniline does not undergo Friedel-Crafts reaction because the lone pair of electrons on the nitrogen atom of the amino group strongly interacts with the Lewis acid catalyst (like $AlCl_3$), forming a complex. This deactivates the benzene ring and prevents the electrophilic substitution required for Friedel-Crafts reaction.

(c) To distinguish between methylamine and aniline, take a small amount of each solution and add nitrous acid (HNO_2) at 0-5 deg C. Methylamine gives a diazonium salt which decomposes to form a yellow solution or precipitate (dimethyl diazene), whereas aniline forms a diazonium salt which is stable at low temperature and gives a clear solution.- This difference in the behavior with nitrous acid can distinguish methylamine from aniline.

(d) Gabriel phthalimide synthesis involves reacting phthalimide with potassium hydroxide (KOH) to form potassium phthalimide which then reacts with a primary alkyl halide (R-X) to form N-alkyl phthalimide, which upon hydrolysis gives a primary amine (R-NH_2). The reactions are:

K-phthalimide + R-X → N-alkyl phthalimide

N-alkyl phthalimide + $2H_2O$ + heat → R-NH_2 + phthalic acid

(e) To convert aniline to p-bromoaniline, brominate aniline by adding bromine water at room temperature. Due to the activating -NH_2 group, bromination occurs easily and substitutes bromine at the para position giving p-bromoaniline as the major product. The reaction is:

C_6H_5-NH_2 + Br_2 → p-Bromoaniline + HBr

Key Points: N,N-diethyl-benzenesulphonamide is neutral and insoluble in alkali - Aniline forms complex with Lewis acid, deactivating benzene ring in Friedel-Crafts - Nitrous acid test distinguishes methylamine and aniline - Gabriel synthesis involves potassium phthalimide reacting with alkyl halide then hydrolysis - Bromination of aniline gives p-bromoaniline due to activating amino group