

**CAREERS360**  
**PRACTICE** Series

**RBSE Class 12**

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**Chemistry**

**Previous Year Questions  
with Detailed Solution**

# RBSE Class 12 Chemistry Question with Solution - 2024

## SECTION-A

### 1. Multiple Choice Questions :

i) SI unit of conductivity is

(A) S  
 (B)  $\Omega$   
 (C)  $\text{S}\text{cm}^{-1}$   
 (D)  $\text{Sm}^{-1}$

Solution:

The correct answer is:

(D)  $\text{Sm}^{-1}$

Explanation: The SI unit of conductivity is Siemens per meter ( $\text{Sm}^{-1}$ ). Conductivity is the inverse of resistivity, and its unit in the SI system is derived as Siemens (S) per meter (m).

### ii) Element showing the highest number of oxidation states is -

(A) Mn  
 (B) Ni  
 (C) Fe  
 (D) Cr

Solution:

The correct answer is:

(A) Mn (Manganese)

Explanation:

Manganese (Mn) shows the highest number of oxidation states, ranging from -3 to +7. This is due to its ability to lose different numbers of electrons from both its 3d and 4s orbitals, resulting in a variety of oxidation states, particularly +2, +3, +4, +6, and +7.

### iii) Oxidation state of Fe in $[\text{Fe}(\text{Co})_5]$ is -

(A) 0  
 (B) +2  
 (C) +3  
 (D) +4

Solution:

The correct answer is:

(A) 0

Explanation:

In the complex  $[\text{Fe}(\text{CO})_5]$ , carbon monoxide (CO) is a neutral ligand, meaning it does not carry a charge. Since the overall charge of the complex is zero and the CO ligands are neutral, the oxidation state of iron (Fe) in this complex is 0.

iv) The chemical formula of chromite ore is -

- (A)  $\text{MnO}_2$
- (B)  $\text{Na}_2\text{Cr}_2\text{O}_4$
- (C)  $\text{FeCr}_2\text{O}_4$
- (D)  $\text{Na}_2\text{CrO}_4$

Solution:

The correct answer is:

(C)  $\text{FeCr}_2\text{O}_4$

Explanation:

Chromite ore is a mineral composed of iron, chromium, and oxygen with the chemical formula  $\text{FeCr}_2\text{O}_4$ . It is an important source of chromium and is used in the production of chromium-based alloys and compounds.

v) Number of moles of precipitated  $\text{AgCl}$  on adding excess silver nitrate solution in the solution of one mole of  $\text{CoCl}_3 \cdot 5\text{NH}_3$  is -

- (A) 1
- (B) 2
- (C) 3
- (D) 5

Solution:

The correct answer is:

(B) 2

Explanation:

The compound  $\text{CoCl}_3 \cdot 5\text{NH}_3$  is a coordination complex. In such complexes, some of the chloride ions are coordinated to the central metal (Co) and some are free. The formula suggests that it is a cobalt(III) complex with five ammonia molecules as ligands. The structure of this complex is likely to be  $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$ , meaning one chloride ion is coordinated to cobalt, and two chloride ions are free.

When silver nitrate ( $\text{AgNO}_3$ ) is added to this solution, only the free chloride ions will precipitate as silver chloride ( $\text{AgCl}$ ). Since there are 2 free chloride ions, 2 moles of  $\text{AgCl}$  will precipitate for every 1 mole of  $\text{CoCl}_3 \cdot 5\text{NH}_3$ .

vi) Metal present in haemoglobin is -

- (A) Mn
- (B) Fe
- (C) Co
- (D) Ni

Solution:

The correct answer is:

**(B) Fe**

vii) Ambidentate ligand is -

- (A)  $\text{Cl}^-$
- (B)  $\text{H}_2\text{O}$
- (C)  $\text{NH}_3$
- (D)  $\text{NO}_2^-$

Solution:

The correct answer is:

- (D)  $\text{NO}_2^-$

Explanation:

Ambidentate ligands can bind to a central metal atom through two different atoms. In the case of  $\text{NO}_2^-$  (nitrite ion), it can bind either through the nitrogen atom (as nitro) or through an oxygen atom (as nitrito), making it an ambidentate ligand.

viii) The compound obtained from meadow sweet is -

- (A) Salicyl aldehyde
- (B) Cinnamaidehyde
- (C) Valeraldehyde
- (D) Vanillin

Solution:

The correct answer is:

**(A) Salicyl aldehyde**

x) Change occurs in hybridisation state of carbonyl carbon in nucleophilic sciat. reaction is -

- (A)  $\text{sp}^2$  to  $\text{sp}$
- (B)  $\text{spto}^{\text{sp}^2}$
- (C)  $\text{sp}^2$  to  $\text{sp}'$
- (D)  $\text{sp}'$  to  $\text{sp}$

Solution:

The correct answer is:

- (C)  $\text{sp}^2$  to  $\text{sp}'$

Explanation:

In a nucleophilic substitution reaction at a carbonyl carbon, the carbonyl carbon initially has a trigonal planar structure with  $sp^2$  hybridization. When a nucleophile attacks the carbonyl carbon, the carbon undergoes a transition to a tetrahedral intermediate, changing its hybridization from  $sp^2$  to  $sp^3$

xi) The hybridisation state of nitrogen in trimethylamine is -

- (A)  $sp$
- (B)  $sp^2$
- (C)  $sp^3$
- (D)  $dsp^2$

Solution:

The correct answer is:

- (C)  $sp^3$

Explanation:

In trimethylamine ( $N(CH_3)_3$ ), the nitrogen atom is bonded to three methyl groups and has one lone pair of electrons. The nitrogen atom undergoes  $sp^3$  hybridization, forming a tetrahedral arrangement with three bond pairs and one lone pair, leading to a slightly pyramidal shape.

xii) The compound showing the highest basic strength in aqueous solution

- (A)  $(C_2H_4)N$
- (B)  $(C_2H_6)NH$
- (C)  $C^{\circ}HNH_2$
- (D)  $NH$

Solution:

The correct answer is:

- (B)  $(C_2H_5)NH_2$  (Ethylamine)

Explanation: In aqueous solution, the basic strength of amines depends on the electron-donating ability of the alkyl groups attached to the nitrogen atom. Ethylamine ( $C_2H_5)NH_2$  is a primary amine where the ethyl group is electron-donating, which increases the electron density on the nitrogen atom and makes it more basic compared to ammonia  $NH_3$  or amines with less electrondonating groups.

xiii) Secondary amine among the following is -

- (A) Propan-2-amine
- (B) Pentan-3-amine
- (C) N-Methylethanamine
- (D) N,N-Dimethylmethanamine

Solution:

The correct answer is:

(C) N-Methylethanamine

Explanation:

A secondary amine has two alkyl or aryl groups attached to the nitrogen atom. In NMethylethanamine, the nitrogen is attached to two groups: one methyl group ( $-\text{CH}_3$ ) and one ethyl group ( $-\text{C}_2\text{H}_5$ ), making it a secondary amine.

xiv) Globular protein is -

- (A) Insulin
- (B) Keratin
- (C) Myosin
- (D) Collagen

Solution:

The correct answer is:

(A) Insulin

Explanation:

Insulin is a globular protein, which means its polypeptide chains fold into a compact, spherical shape. Globular proteins, like insulin, are typically involved in dynamic functions such as catalysis (enzymes), transport, and regulation. On the other hand, keratin, myosin, and collagen are fibrous proteins, which have structural roles.

xv) Glucose is -

- (A) An aldopentose
- (B) A ketopentose
- (C) An aldohexose
- (D) A ketohexose

Solution:

The correct answer is:

(C) An aldohexose

Explanation:

Glucose is classified as an aldohexose because it contains six carbon atoms (hexose) and has an aldehyde group (aldo) at the first carbon.

xvi) Milk sugar is -

- (A) Sucrose
- (B) Lactose
- (C) Maltose
- (D) Galactose

Solution:

The correct answer is:

(B) Lactose

Explanation:

Lactose is commonly known as milk sugar. It is a disaccharide made up of one molecule of glucose and one molecule of galactose, and it is found in milk and dairy products.

2. Fill in the blanks

i) The unit of molarity is

Solution:

The unit of molarity is:

moles per liter ( mol/L or M )

Explanation:

Molarity is defined as the number of moles of solute per liter of solution. Therefore, its unit is moles of solute per liter of solution, abbreviated as mol/L or simply M.

ii) The mathematical form of Henry's Law is

Solution:

The mathematical form of Henry's Law is:

$$P = k_H \cdot C$$

Where:

- $P$  is the partial pressure of the gas above the solution.
- $C$  is the concentration of the gas in the solution.
- $k_H$  is Henry's law constant, which varies for different gases and depends on the solvent and temperature.

Henry's Law states that the amount of gas dissolved in a liquid is directly proportional to the partial pressure of that gas above the liquid.

iii) The kinetic energy of the maximum fraction of reactant molecules is called

Solution:

The kinetic energy of the maximum fraction of reactant molecules is called the **most probable kinetic energy**.

Explanation:

In a distribution of molecular energies (like the Maxwell-Boltzmann distribution), the most probable kinetic energy corresponds to the peak of the distribution curve, where the largest number of molecules have this particular energy. It represents the kinetic energy at which the majority of molecules are found in a given sample at a specific temperature.

iv) \_\_\_\_\_ and actinoids are called as inner transition elements.

Solution:

Lanthanides (elements with atomic numbers 57–71) and actinoids (elements with atomic numbers 89–103) are referred to as inner transition elements because they involve the filling of inner f-orbitals (4f for lanthanides and 5f for actinoids), unlike transition elements which involve the filling of d-orbitals. These elements are placed in separate rows below the main periodic table for better organization.

v) \_\_\_\_\_ is coordination sphere in  $\text{K}_4[\text{Fe}(\text{CN})_6]$ .

Solution:

In the complex  $\text{K}_4[\text{Fe}(\text{CN})_6]$ , the coordination sphere consists of the central metal ion (Fe) and the ligands (6 cyanide ions,  $\text{CN}^-$ ) directly bonded to it. The  $[\text{Fe}(\text{CN})_6]^{4-}$  ion represents the coordination complex, while the potassium ions ( $\text{K}^+$ ) are outside the coordination sphere as counterions.

vi) In benzylic alcohols -OH group is bonded with \_\_\_\_\_ hybridised carbon.

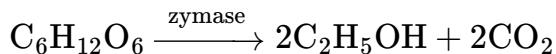
Solution:

In a benzylic alcohol, the hydroxyl ( $-\text{OH}$ ) group is attached to a carbon atom that is directly bonded to a benzene ring. This carbon is  $sp^3$ -hybridized because it forms four single bonds: one with the hydroxyl group and the others with hydrogen atoms or alkyl groups, while also being adjacent to the benzene ring.

vii) Glucose is converted to ethanol in presence of \_\_\_\_\_ enzyme.

Solution:

Zymase is a complex of enzymes that is produced by yeast and catalyzes the fermentation of glucose into ethanol and carbon dioxide. This process is commonly used in the production of alcoholic beverages and biofuels. The overall reaction is:



viii) Sodium benzoate is used as

Solution: Sodium benzoate is commonly added to acidic foods such as sodas, fruit juices, pickles, and salad dressings to inhibit the growth of bacteria, yeasts, and molds, thereby extending shelf life. It works best in acidic conditions (pH below 4.5).

ix) Deficiency of vitamin \_\_\_\_\_ causes Beri-Beri disease.

Solution:

Beri-Beri is a disease that results from a deficiency of thiamine (vitamin B). This vitamin is essential for energy metabolism and the proper functioning of the nervous system. A deficiency can lead to symptoms like weakness, nerve degeneration, and cardiovascular problems.

x) The name of Sugar present in RNA is

Solution:

Ribose is a five-carbon sugar (a pentose) found in RNA (ribonucleic acid). It differs from the sugar in DNA, deoxyribose, by having a hydroxyl group (-OH) attached to the 2' carbon, whereas deoxyribose has just a hydrogen atom at this position.

Very short answer questions

i) Define saturated solution.

Solution:

A **saturated solution** is a solution in which the maximum amount of solute has been dissolved at a given temperature and pressure. In such a solution, no more solute can dissolve, and any additional solute added will remain undissolved and form a precipitate.

At this point, the solution is in equilibrium, meaning the rate of dissolving solute is equal to the rate of solute precipitating out.

ii) Write names of solute and solvent present in sodium amalgam solution.

Solution:

In a **sodium amalgam solution**:

- **Solute:** Sodium (Na)
- **Solvent:** Mercury (Hg)

Explanation:

Sodium amalgam is an alloy or solution where sodium is dissolved in mercury. In this solution, sodium acts as the solute, and mercury serves as the solvent.

iii) Rate =  $K[A]^{1/2}[B]^{3/2}$  Calculate the overall order of a reaction which has above rate expression.

Solution:

To calculate the overall order of a reaction, we sum the powers of the concentration terms in the rate law.

Given rate expression:

$$\text{Rate} = K[A]^{1/2}[B]^{3/2}$$

- The order with respect to  $[A]$  is  $\frac{1}{2}$ .
- The order with respect to  $[B]$  is  $\frac{3}{2}$ .

Now, the overall order of the reaction is:

$$\text{Overall order} = \frac{1}{2} + \frac{3}{2} = 2$$

Thus, the overall order of the reaction is 2.

iv) Write directive influence of  $-\text{OCH}_3$  group present in anisole for electrophilic substitution reaction.

Solution:

The  $-\text{OCH}_3$  group present in anisole is an electron-donating group due to its  $+\text{M}$  (mesomeric) effect, where the lone pair of electrons on the oxygen atom is delocalized into the aromatic ring. As a result, it directs electrophilic substitution reactions to the ortho and para positions relative to itself on the benzene ring.

Therefore, the directive influence of the  $-\text{OCH}_3$  group in anisole for electrophilic substitution reactions is ortho and para directing.

v) Write the chemical name of the white precipitate obtained on the reaction of phenol with bromine water.

Solution:

When phenol reacts with bromine water, the bromine atoms substitute the hydrogen atoms at the ortho and para positions of the phenol ring due to the activating nature of the hydroxyl group ( $-\text{OH}$ ). This leads to the formation of 2,4,6-tribromophenol, which appears as a white precipitate.

vi) Write chemical name of  $\text{NH}_2 - \text{NHCO}^{\text{NH}_3}$ .

Solution:

Semicarbazide is an organic compound with the structure  $\text{NH}_2 - \text{NH} - \text{CO} - \text{NH}_2$ . It contains an amine group ( $\text{NH}_2$ ) attached to a hydrazine unit ( $\text{NH}-$ ) and a carbonyl group ( $\text{CO}-$ ).

Semicarbazide is often used in organic chemistry for the formation of semicarbazones, which are derivatives formed by the reaction with aldehydes and ketones.

vii) Write name of the product obtained from the reaction between benzenediazonium chloride and phenol.

Solution:

This reaction is an example of a coupling reaction, where benzenediazonium chloride reacts with phenol in basic medium to form an azo compound. The diazonium group ( $-\text{N}_2^+$ ) from benzenediazonium chloride couples with the phenol ring at the para position relative to the hydroxyl group ( $-\text{OH}$ ), resulting in the formation of p-hydroxyazobenzene, which is an orange-colored compound.

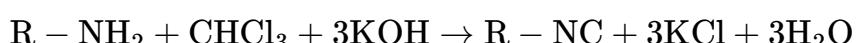
viii) Write isocyanide test for primary amines.

Solution:

The isocyanide test (or carbylamine test) for primary amines involves the following procedure:

1. Reagents: The primary amine is heated with chloroform ( $\text{CHCl}_3$ ) and alcoholic potassium hydroxide (KOH).
2. Reaction: The primary amine reacts with chloroform and potassium hydroxide to produce an isocyanide (also known as a carbylamine), which has a very foul smell.

The reaction is:



- $\text{R} - \text{NH}_2$  is the primary amine.
- $\text{R-NC}$  is the isocyanide (carbylamine) formed, which has a characteristic unpleasant odor.

This test is specific for primary amines (both aliphatic and aromatic), as secondary and tertiary amines do not give this reaction. The presence of the foul-smelling isocyanide confirms the presence of a primary amine.

## SECTION-B

4. Calculate the mole fraction of gas  $\Lambda$  in the solution made on mixing 0.5 moles of gas A and 4.5 moles of gas B.

Solution:

To calculate the mole fraction of gas  $\Lambda$  (which is gas A) in the solution:

Given:

- Moles of gas A = 0.5
- Moles of gas B = 4.5

Total moles = Moles of gas A + Moles of gas B

Total moles =  $0.5 + 4.5 = 5.0$

The mole fraction of gas  $\Lambda$  (A) is calculated as:

$$\text{Mole fraction of A} = \frac{\text{Moles of A}}{\text{Total moles}} = \frac{0.5}{5.0} = 0.1$$

So, the mole fraction of gas  $\Lambda$  (A) is 0.1.

5. 0.05 moles of ethanoic acid is dissolved in 250 g benzene. Calculate the molality of the solution.

Solution:

Given:

- Moles of ethanoic acid = 0.05 moles
- Mass of benzene = 250 g = 0.250 kg

Molality is calculated using the formula:

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

Substituting the given values:

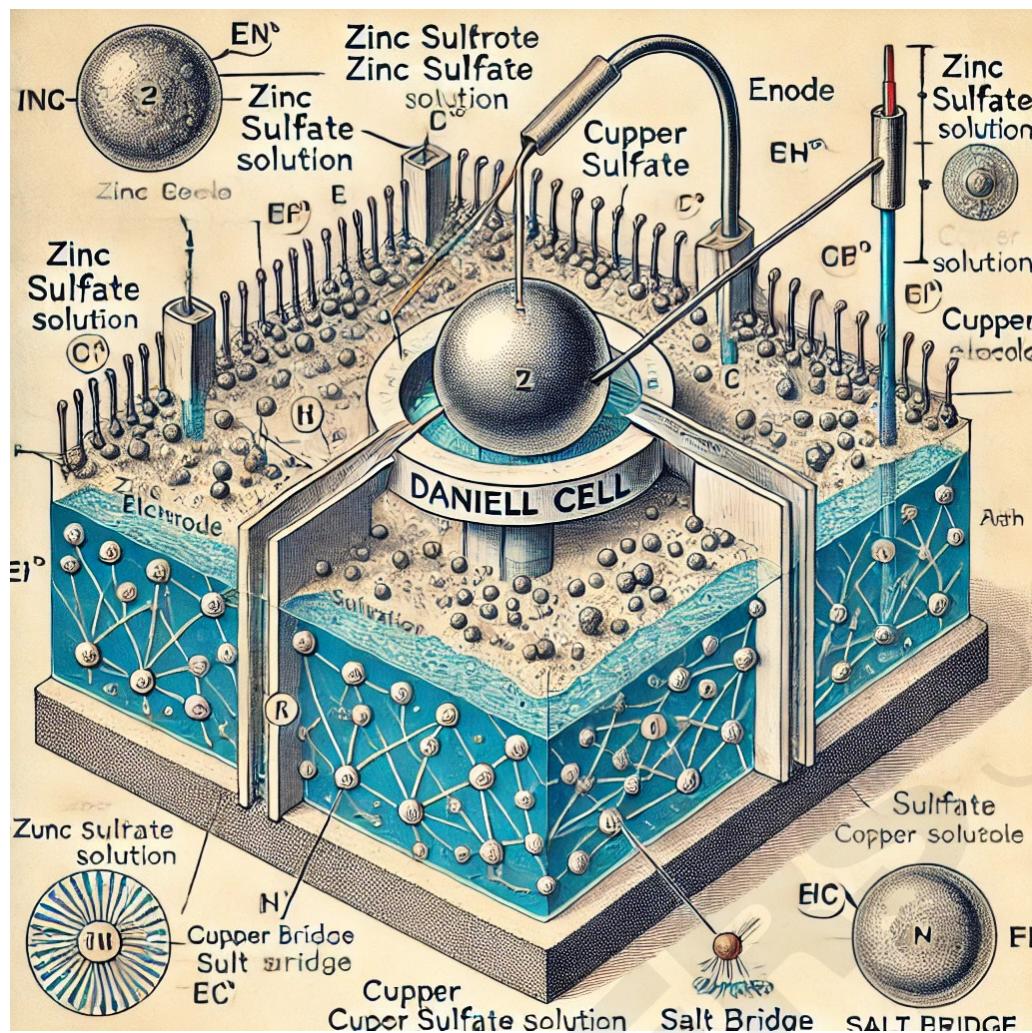
$$\text{Molality} = \frac{0.05}{0.250} = 0.2 \text{ mol/kg}$$

Thus, the molality of the solution is 0.2 mol/kg.

6. Draw the Daniell cell.

Solution:

Here is the diagram of a Daniell cell, illustrating the zinc electrode in zinc sulfate solution, the copper electrode in copper sulfate solution, and the salt bridge connecting the two solutions. It also shows the flow of electrons from the zinc to the copper electrode and the movement of ions through the salt bridge.



7. The rate constant of a first-order reaction is  $1.386 \times 10^{-14} \text{ S}^{-1}$  calculate the half-life of the reaction.

**Solution:**

To calculate the half-life ( $t_{1/2}$ ) of a first-order reaction, we use the formula:

$$t_{1/2} = \frac{\ln(2)}{k}$$

Where:

- $k$  is the rate constant.
- $\ln(2) \approx 0.693$

Given:

$$-k = 1.386 \times 10^{-14} \text{ s}^{-1}$$

Substituting the values:

$$t_{1/2} = \frac{0.693}{1.386 \times 10^{-14}} = 5.00 \times 10^{13} \text{ seconds}$$

Thus, the half-life of the reaction is  $5.00 \times 10^{13}$  seconds.

8. Write any three physical characteristics of interstitial compounds.

Solution:

Here are three physical characteristics of interstitial compounds:

- 1. Hardness:** Interstitial compounds are generally very hard. The small atoms (like carbon, nitrogen, or boron) occupy interstitial spaces in the metal lattice, which strengthens the overall structure.
- 2. High Melting Points:** These compounds typically have high melting points because the small interstitial atoms create strong metallic bonds, making the lattice more rigid and resistant to heat.
- 3. Electrical Conductivity:** Interstitial compounds often retain the electrical conductivity of the parent metals, as the small atoms occupying the interstitial spaces do not significantly disrupt the conduction of electrons.

These properties make interstitial compounds highly useful in industrial applications, such as in the production of hard materials and alloys.

9. Why do transition metals exhibit catalytic properties? Explain.

Solution:

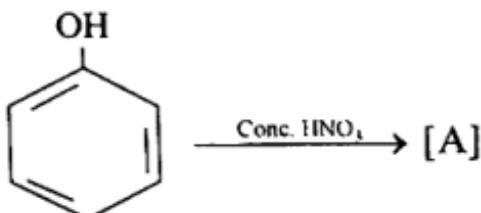
Transition metals exhibit catalytic properties due to their ability to exist in multiple oxidation states and form complex compounds. This allows them to easily gain or lose electrons, facilitating the breaking and formation of chemical bonds during reactions. Additionally, their partially filled d-orbitals enable them to adsorb reactant molecules onto their surface, providing an active site for reactions to occur. These characteristics make them highly effective catalysts in various chemical processes.

10. Despite being an electron-withdrawing group why Cl -group is ortho-and paradirecting in electrophilic aromatic substitution? Give reason.

Solution:

Despite being an electron-withdrawing group due to its electronegativity and -I (inductive) effect, the chlorine (Cl) group is ortho- and para-directing in electrophilic aromatic substitution because of its  $+R$  (resonance) effect. Chlorine has lone pairs of electrons that can be donated to the benzene ring through resonance, stabilizing the positive charge on the ring when an electrophile attacks the ortho and para positions. This resonance donation compensates for its electron-withdrawing inductive effect, making the ortho and para positions more reactive than the meta position.

11. Write IUPAC name and chemical formula of [A] in the above reaction.



Solution:

The image you have uploaded depicts a phenol ( $C_6H_5OH$ ) reacting with concentrated nitric acid ( $HNO_3$ ). The reaction shown is a nitration of phenol, where the hydroxyl group ( $-OH$ ) on the benzene ring is an activating group, making the ring more reactive to electrophilic substitution.

When phenol undergoes nitration with concentrated nitric acid, the product [A] is 2,4,6trinitrophenol (also known as picric acid). In this reaction, three nitro groups ( $-NO_2$ ) are introduced at the ortho and para positions relative to the hydroxyl group due to its strong electron-donating effect.

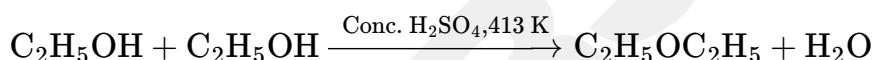
12) Compound [x] is formed on heating ethanol with conc.  $H_2SO_4$  at 413 k temperature. Write IUPAC name of [x] and chemical equation of the reaction involved.

Solution:

When ethanol ( $C_2H_5OH$ ) is heated with concentrated sulfuric acid ( $H_2SO_4$ ) at 413 K, the compound ethoxyethane (diethyl ether) is formed. This reaction is an example of a dehydration of alcohols to form ethers, also known as the Williamson ether synthesis.

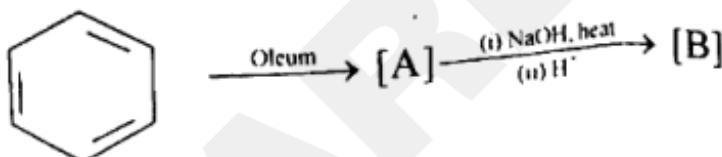
The IUPAC name of the compound [x] is ethoxyethane.

Chemical equation of the reaction:



In this reaction, two molecules of ethanol react to form one molecule of ethoxyethane (diethyl ether) and water.

13) Write chemical formula of [A] and [B] in above reaction sequence.

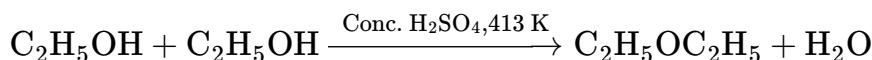


Solution:

Based on the reaction sequence involving the heating of ethanol with concentrated  $H_2SO_4$  at 413 K, the following can be deduced:

1. Compound [A] is ethanol with the chemical formula  $C_2H_5OH$ .
2. Compound [B] is ethoxyethane (diethyl ether) with the chemical formula  $C_2H_5OC_2H_5$ .

Thus, in the reaction:



- [A] =  $C_2H_5OH$  (ethanol)
- [B] =  $C_2H_5OC_2H_5$  (ethoxyethane or diethyl ether).

14) Compare basic strength of aniline with ammonia.

Solution:

When comparing the basic strength of aniline ( $C_6H_5NH_2$ ) and ammonia ( $NH_3$ ), ammonia is generally stronger as a base than aniline. Here's why:

1. Ammonia: In ammonia, the nitrogen atom has a lone pair of electrons that is readily available for protonation. The lack of any electron-withdrawing or electron-donating groups makes ammonia a relatively strong base, as its lone pair is easily accessible for reaction with protons.
2. Aniline: In aniline, the lone pair of electrons on the nitrogen atom is delocalized into the benzene ring due to resonance. This delocalization reduces the availability of the nitrogen's lone pair for protonation, weakening the basicity of aniline. Additionally, the electron-withdrawing effect of the benzene ring further reduces the electron density on nitrogen, making aniline a weaker base compared to ammonia.

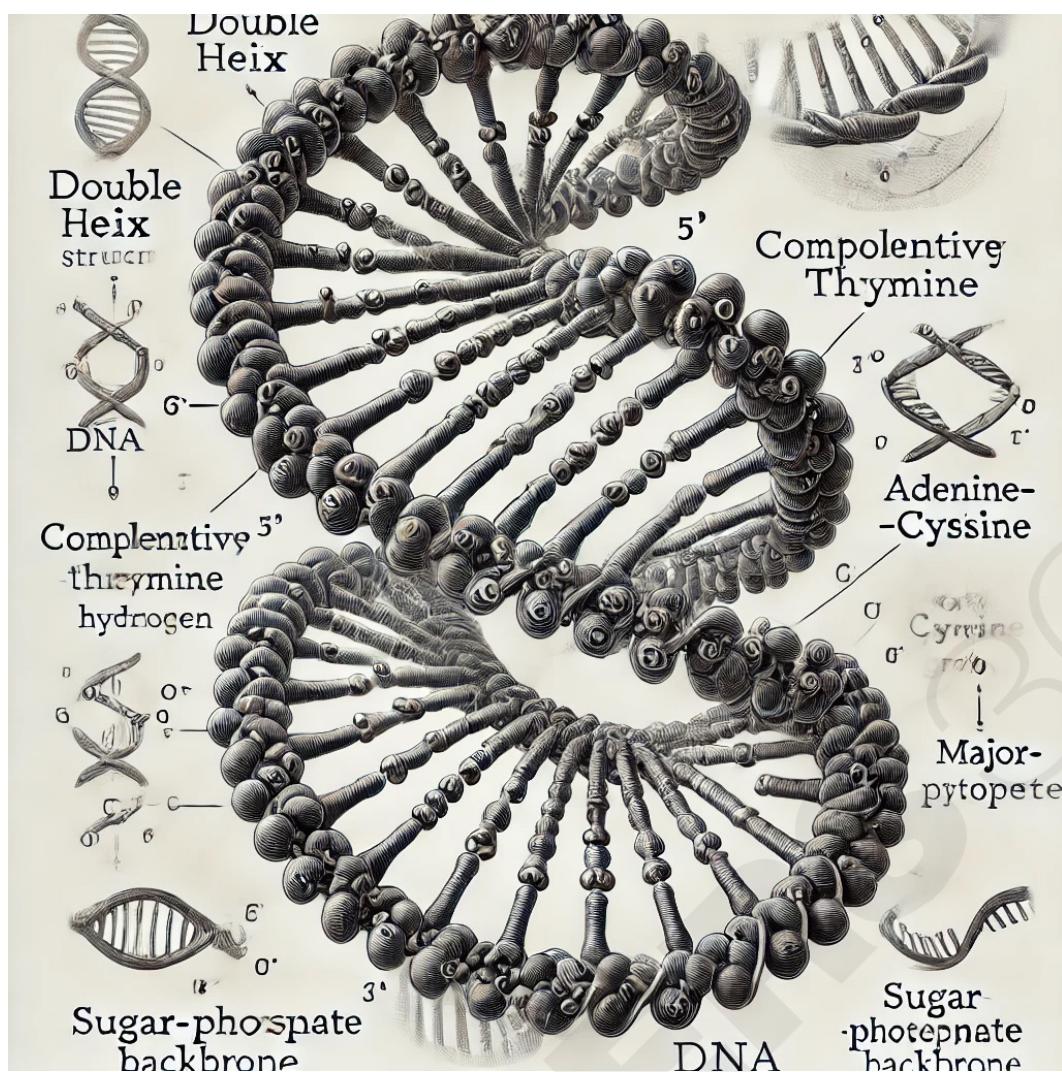
Conclusion:

Ammonia is a stronger base than aniline because, in aniline, the lone pair on nitrogen is less available for protonation due to resonance with the benzene ring.

15) Draw the double strand helix structure of DNA.

Solution:

Here is the illustration of the double helix structure of DNA, showing the complementary base pairs, sugar-phosphate backbone, and the helical twist. It highlights key aspects such as the 5' to 3' orientation of each strand and the major and minor grooves.



16)

i) Define order of reaction.

Solution:

The order of a reaction refers to the sum of the powers of the concentration terms of the reactants in the rate law equation. It indicates how the rate of the reaction depends on the concentration of each reactant. For a general reaction:

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

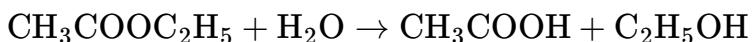
- The order of reaction is  $m + n$ , where  $m$  and  $n$  are the exponents representing the orders with respect to each reactant  $A$  and  $B$ .

ii) Explain pseudo first order reaction by giving appropriate example.

Solution:

A pseudo first-order reaction is a reaction that is originally of higher order but behaves like a first-order reaction under certain conditions. This happens when one of the reactants is present in such a large excess that its concentration remains nearly constant during the reaction.

Example: The hydrolysis of an ester, such as ethyl acetate ( $\text{CH}_3\text{COOC}_2\text{H}_5$ ), in water is normally a second-order reaction because it depends on the concentration of both the ester and water:



However, since water is present in a large excess, its concentration does not change significantly during the reaction.

17) Explain the geometry and the magnetic nature of complex  $[\text{CoF}_6]^{3-}$  on the basis of valence bond theory.

Solution:

1. Oxidation State of Cobalt: In the complex  $[\text{CoF}_6]^{3-}$ , the oxidation state of cobalt can be calculated as follows:

Let the oxidation state of cobalt be  $x$ .

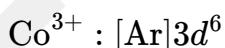
$$x + 6(-1) = -3 \Rightarrow x = +3$$

So, cobalt is in the  $\text{Co}^{3+}$  state.

2. Electronic Configuration: The electronic configuration of the free cobalt atom (Co) is:



For  $\text{Co}^{3+}$ , it loses 3 electrons ( 2 from 4 s and 1 from 3 d ), giving the configuration:



3. Nature of Ligand: Fluoride ion ( $\text{F}^-$ ) is a weak field ligand, which does not cause strong splitting of the  $d$ -orbitals. This means that pairing of electrons within the  $d$ -orbitals is not forced.

4. Hybridization and Geometry: In the presence of weak field ligands like  $\text{F}^-$ , the  $d$ -electrons of  $\text{Co}^{3+}$  remain unpaired. The complex adopts outer orbital complex hybridization, where the  $3d$ -orbitals are used for the electron configuration and the  $4s$  and  $4p$  orbitals participate in hybridization.

The six fluoride ligands form bonds with  $\text{Co}^{3+}$ , and the complex undergoes  $sp^3d^2$  hybridization using the outer  $4s$ ,  $4p$ , and  $4d$ -orbitals. This results in an octahedral geometry for the complex.

5. Magnetic Nature: Since fluoride is a weak field ligand, it does not cause the pairing of electrons in the  $3d$ -orbitals of cobalt. As a result, the  $3d^6$  configuration in  $\text{Co}^{3+}$  retains four unpaired electrons in the  $t_{2g}$  and  $e_g$  orbitals.

Therefore, the complex is paramagnetic due to the presence of these unpaired electrons.

18) Explain-

i) The boiling points of isomeric haloalkanes decrease with increase in branching.

Solution:

As the branching in haloalkanes increases, the molecular shape becomes more compact and spherical. This reduces the surface area available for intermolecular forces, specifically **van der Waals forces** (London dispersion forces), to act between the molecules. With a smaller surface area, these forces become weaker, resulting in a lower boiling point. In contrast, straight-chain isomers have a larger surface area, leading to stronger intermolecular attractions and higher boiling points.

ii) The melting point of *p* - isomer is higher than those of *o* - and *m* - isomers of isomeric dichlorobenzenes.

Solution:

In the case of para- (*p*-) dichlorobenzene, the molecular symmetry is higher compared to the ortho- (*o* -) and meta- (*m*-) isomers. The symmetrical structure of the *p* -isomer allows for better packing in the solid state, which results in stronger intermolecular forces, specifically lattice forces. This tighter packing leads to a higher melting point. In contrast, the *o* - and *m*-isomers are less symmetrical, leading to less efficient packing and lower melting points.

iii) The racemic mixture of a optically active compound is always optically inactive.

Solution:

A racemic mixture contains equal amounts of both enantiomers (the two mirror-image forms of a chiral molecule). Since one enantiomer rotates plane-polarized light in one direction (clockwise, +) and the other enantiomer rotates it in the opposite direction (counterclockwise, -) by the same magnitude, the net effect is that the two rotations cancel each other out. As a result, the racemic mixture does not rotate plane-polarized light, making it optically inactive.

19

i) Describe the construction of standard hydrogen electrode.

Solution:

The Standard Hydrogen Electrode (SHE) is used as a reference electrode to measure the standard electrode potential of other electrodes. It has a potential of 0.00 V by definition under standard conditions. The construction of the SHE includes the following key components:

1. Platinum Electrode: A platinum electrode ( Pt) is used because it is chemically inert and provides a surface for the hydrogen gas to adsorb and participate in the reaction.
2. Hydrogen Gas: Pure hydrogen gas ( $H_2$ ) is bubbled over the platinum electrode at a pressure of 1 atm.
3. Acidic Solution: The electrode is immersed in an acidic solution (commonly **1 M HCl**) to provide hydrogen ions ( $H^+$ ) at a concentration of 1 M .
4. Reaction: At the interface between the platinum electrode and the acidic solution, the following equilibrium reaction occurs:



5. Temperature: The SHE is maintained at a temperature of 298 K ( $25^\circ C$ ) for standard conditions.

The platinum electrode serves as the surface for hydrogen ion reduction or hydrogen gas oxidation, depending on whether the electrode is acting as the cathode or anode in a cell.

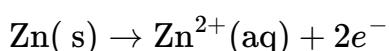
ii) Write equations of cell reactions taking place at anode and cathode during use of dry cell.

Solution:

A dry cell (commonly used in batteries such as zinc-carbon cells) involves the following reactions at the anode and cathode during use:

1. At the Anode (Oxidation):

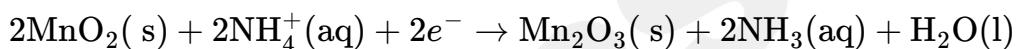
The zinc container of the cell serves as the anode, where zinc is oxidized to zinc ions. The reaction at the anode is:



This oxidation reaction results in the release of electrons, which then flow through the external circuit.

2. At the Cathode (Reduction):

The cathode contains a mixture of manganese dioxide ( $\text{MnO}_2$ ) and a carbon rod, where reduction occurs. The reduction of manganese dioxide in the presence of ammonium chloride occurs as follows:



The overall cell reaction can be summarized as:



This reaction generates the electric current in a dry cell.

20 i) Write IUPAC name of an acid present in red-ant sting.

Solution:

The acid present in red ant stings is **formic acid**, and its IUPAC name is **methanoic acid**.

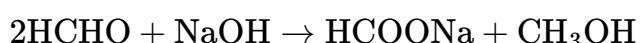
ii) Explain the Cannizzaro reaction by giving suitable chemical equation. above reaction.

Solution:

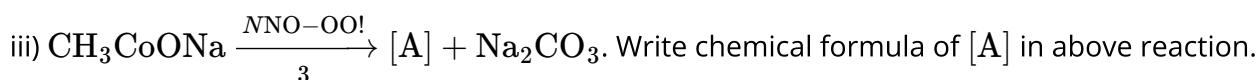
The Cannizzaro reaction is a chemical reaction in which an aldehyde without an alpha-hydrogen undergoes disproportionation when treated with a strong base (usually concentrated sodium hydroxide,  $\text{NaOH}$ ). In this reaction, one molecule of the aldehyde is oxidized to a carboxylic acid, and another molecule is reduced to an alcohol.

Chemical Equation:

For example, in the case of formaldehyde (  $\text{HCHO}$  ), the Cannizzaro reaction proceeds as follows:

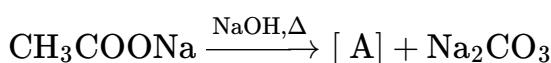


- Formaldehyde (HCHO) is the aldehyde without an alpha-hydrogen.
- One molecule of formaldehyde is oxidized to sodium formate ( HCOONa).
- The other molecule is reduced to methanol (CH<sub>3</sub>OH).



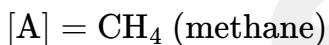
Solution:

In the given reaction:



This is an example of the soda-lime decarboxylation reaction. In this reaction, sodium acetate (CH<sub>3</sub>COONa) is heated with sodium hydroxide (NaOH) and calcium oxide (soda-lime). The product of this reaction is methane (CH<sub>4</sub>), along with sodium carbonate (Na<sub>2</sub>CO<sub>3</sub>).

Thus, the chemical formula of [A] is:



# RBSE Class 12 Chemistry Question with Solution - 2023

## SECTION-A

i) When concentration of  $\text{Zn}^{2+}$  and  $\text{Cu}^{2+}$  ions is unity ( $1 \text{ mol dm}^{-3}$ ), then electrical potential of Daniell cell will be -

- (A) 0.00 V
- (B) 1.10 V
- (C) 1.35 V
- (D) 2.00 V

Answer:

The electrical potential of the Daniell cell under standard conditions (with  $\text{Zn}^{2+}$  and  $\text{Cu}^{2+}$  ion concentrations of  $1 \text{ mol/dm}^3$ ) is 1.10 V, calculated using the standard electrode potentials of zinc and copper.

The correct answer is:

1.10 V

ii) Expression  $k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$  is integrated rate equation of order of reaction -

- (A) Zero order
- (B) First order
- (C) Second order
- (D) Third order

Answer:

The given expression:

$$k = \frac{2.303}{t} \log \frac{[R]_0}{[R]}$$

is the integrated rate equation for a first-order reaction. It shows the relationship between the rate constant  $k$ , time  $t$ , initial concentration  $[R]_0$ , and concentration at time  $t$ ,  $[R]$ .

The correct answer is:

First order (B)

iii) To express the rate at a particular moment of time we determine the

- (A) Initial rate

- (B) Instantaneous rate
- (C) Average rate
- (D) Standard rate

Answer:

To express the rate at a particular moment of time, we determine the instantaneous rate, which gives the rate of reaction at a specific point in time.

The correct answer is:

Instantaneous rate (B)

iv) Colloidal antimony is used in curing of -

- (A) Kalazzar
- (B) Stomach disorders
- (C) Skin disease
- (D) Sexual disease

Answer:

Colloidal antimony is used in the treatment of Kala-azar (also known as visceral leishmaniasis), a parasitic disease.

The correct answer is:

Kalazar (A)

v) Calamine is ore of -

- (A) Al
- (B) Fe
- (C) Cu
- (D) Zn

Answer:

Calamine is an ore of zinc (Zn).

The correct answer is:

Zn(D)

vi) Didentate Ligand is -

- (A)  $\text{C}_2\text{O}_4^{2-}$
- (B)  $\text{SCN}^-$
- (C)  $\text{NH}_3$
- (D)  $\text{Cl}^-$

Answer:

A didentate ligand is a ligand that can form two bonds with a central metal ion. The oxalate ion  $\text{C}_2\text{O}_4^{2-}$  can donate two pairs of electrons from two oxygen atoms to a metal ion, making it a didentate ligand.

The correct answer is:

$$\text{C}_2\text{O}_4^{2-}(\text{A})$$

vii) The name of  $\text{CF}_2\text{Cl}_2$  in freon method is -

- (A) Freon 112
- (B) Freon 12
- (C) Freon 122
- (D) Freon 11

Answer:

The compound  $\text{CF}_2\text{Cl}_2$  is commonly known as Freon 12 in the Freon naming system.

The correct answer is:

Freon 12 (B)

viii) In reaction of manufacture of phenol from cumene the by-product is

- (A) Tribromophenol
- (B) Benzoquinone
- (C) Picric acid
- (D) Acetone

Answer:

The compound  $\text{CF}_2\text{Cl}_2$  is commonly known as Freon 12 in the Freon naming system.

The correct answer is:

Freon 12( B)

ix) The nitrogenous base not present in DNA -

- (A) Adenine
- (B) Cytosine
- (C) Guanine
- (D) Uracil

Answer:

The nitrogenous base uracil is not present in DNA. Instead, uracil is found in RNA, while thymine is present in DNA.

The correct answer is:

## Uracil (D)

## 2. Fill in the blanks -

i) When the added substance reduces the rate of reaction, then it is called in place of catalyst.

Answer:

## inhibitor

ii) The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed .

Answer:

### **adsorption**

iii) In Williamson synthesis the reacts with sodium alkoxide and give dialkyl ether.

Answer:

### **alkyl halide**

iv) The aqueous solution of is called fehling solution A .

Answer:

### **copper(II) sulfate**

3. Very short answer type questions :

i) Write order of reaction of natural and artificial nuclear (radioactive) decay.

Answer:

The order of reaction for both natural and artificial nuclear (radioactive) decay follows first-order kinetics. This means the rate of decay is directly proportional to the number of radioactive nuclei present at any given time.

In first-order reactions, the rate of decay is expressed as:

$$\text{Rate} = k[N]$$

where:

- $k$  is the decay constant,
- $[N]$  is the number of radioactive nuclei at a given time.

The decay follows the exponential law:

$$N = N_0 e^{-kt}$$

where  $N_0$  is the initial number of nuclei and  $t$  is the time elapsed.

ii) Write the name of enzyme used in decomposition of urea into ammonia and carbondioxide.

Answer:

The enzyme used in the decomposition of urea into ammonia and carbon dioxide is urease.

The reaction catalyzed by urease is:



iii) Represent sucrose by Haworth structure.

Answer:

Sucrose is a disaccharide composed of glucose and fructose units. In the Haworth structure:

- The glucose unit is in the  $\alpha$ -D-glucopyranose form (a six-membered ring with an oxygen atom).
- The fructose unit is in the  $\beta$ -D-fructofuranose form (a five-membered ring with an oxygen atom).
- The two monosaccharides are linked by a glycosidic bond between carbon 1 of the glucose unit and carbon 2 of the fructose unit.

Let me describe it in a simplified way:

1. Glucose Unit ( $\alpha$ -D-glucopyranose):

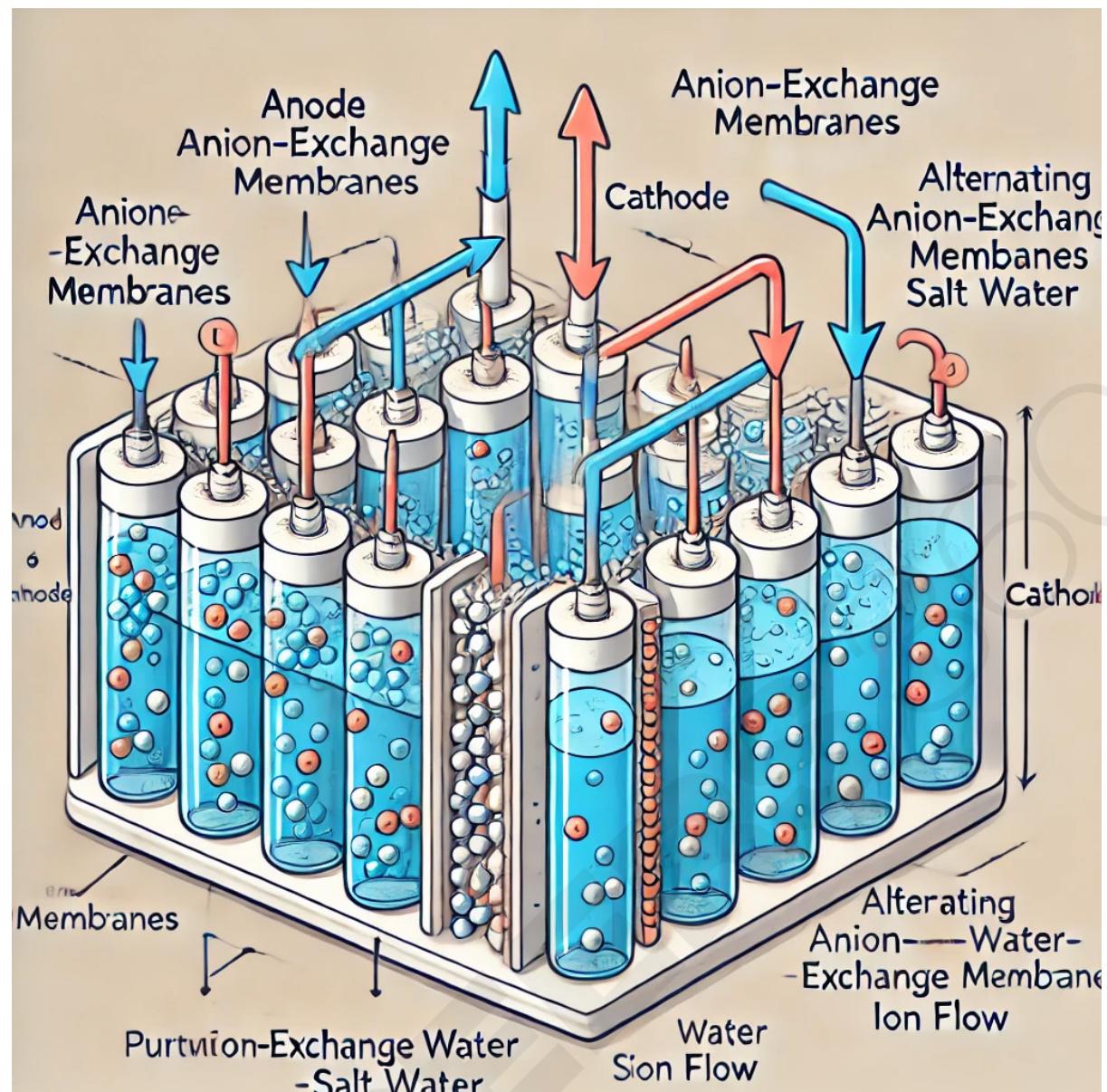
- A six-membered ring with an oxygen atom at the top-right.
- Carbon 1 (the anomeric carbon) is attached to oxygen and linked to carbon 2 of the fructose unit.
- The hydroxyl group on carbon 1 is below the plane (a configuration).

2. Fructose Unit ( $\beta$ -D-fructofuranose):

- A five-membered ring with an oxygen atom at the top-right.
- Carbon 2 (the anomeric carbon) is attached to carbon 1 of the glucose unit.
- The hydroxyl group on carbon 2 is  $\downarrow$  ve the plane ( $\beta$  configuration).

iv) Draw labeled diagram of electro-dialysis.

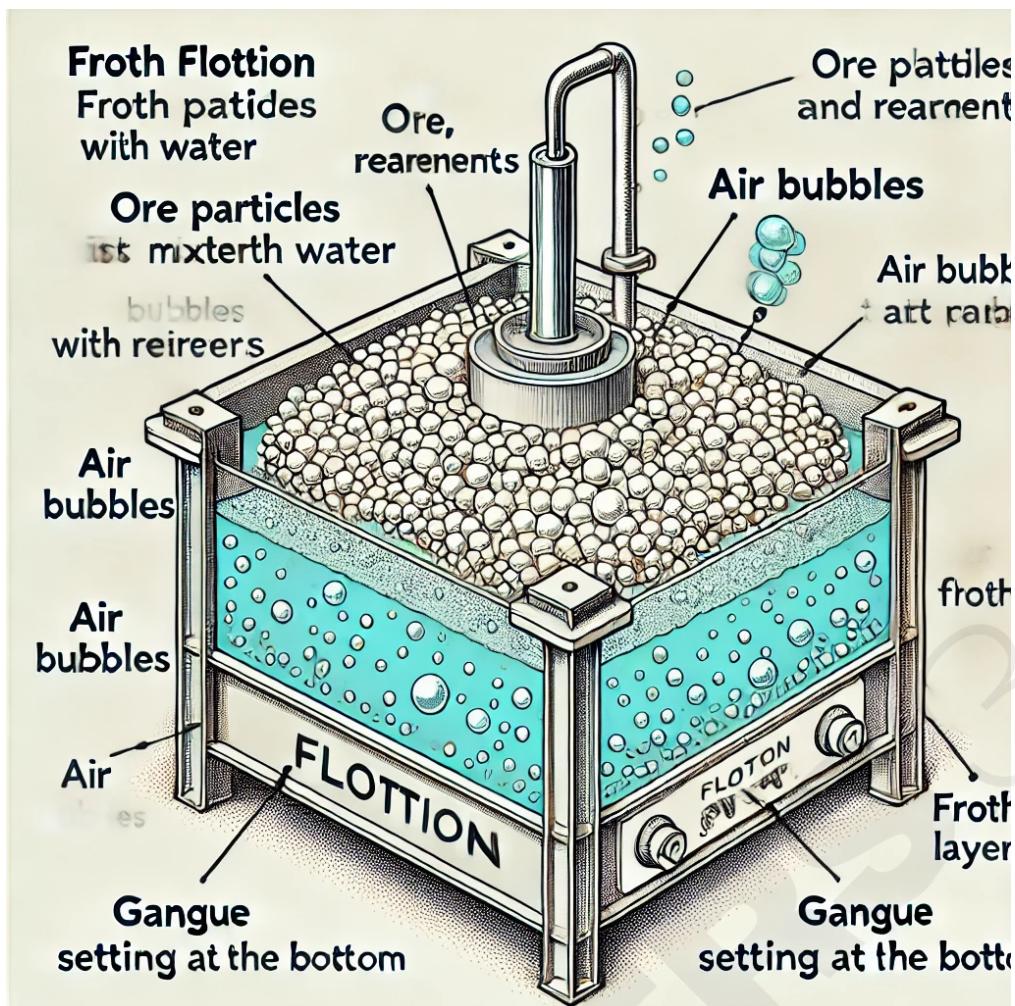
Answer:



Here is the labeled diagram of electro-dialysis. It shows the key components, including the anode, cathode, anion-exchange membranes, cation-exchange membranes, and the flow of ions.

v) Draw labeled diagram of froth floatation process.

Answer:



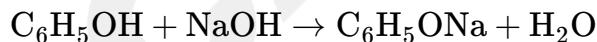
Here is the labeled diagram of the froth flotation process, showing all the key components.

vi) Write chemical equation to prepare salicylic acid from phenol.

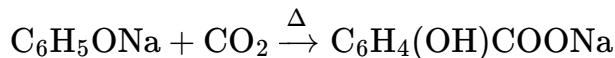
Answer:

The preparation of salicylic acid from phenol involves the Kolbe-Schmitt reaction. In this process, phenol reacts with sodium hydroxide and carbon dioxide under heat and pressure, followed by acidification, to form salicylic acid. The reaction can be written as follows:

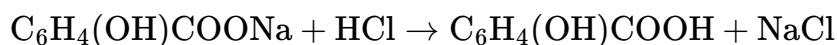
Step 1: Formation of sodium phenoxide



Step 2: Reaction with carbon dioxide



Step 3: Acidification to obtain salicylic acid



Thus, salicylic acid is prepared from phenol through the Kolbe-Schmitt reaction.

vii) Write IUPAC name of isobutyl alcohol.

Answer:

The IUPAC name of isobutyl alcohol is 2-methylpropan-1-ol.

This name reflects the structure where a methyl group ( $-\text{CH}_3$ ) is attached to the second carbon of a three-carbon chain (propane), with a hydroxyl group ( $-\text{OH}$ ) attached to the first carbon.

viii) Write chemical formula of benzene diazonium chloride.

Answer:

The chemical formula of benzene diazonium chloride is  $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$ .

## SECTION-B

Short Answer Type Questions

4) Calculate number of particles in face centred cubic unit cell.

Answer:

In a face-centered cubic (FCC) unit cell, the particles (atoms, ions, or molecules) are located at:

1. 8 corners of the cube, each corner particle is shared among 8 adjacent unit cells, so each corner contributes  $\frac{1}{8}$  of a particle to the unit cell.
2. 6 face centers, where each particle is shared between two adjacent unit cells, so each facecentered particle contributes  $\frac{1}{2}$  of a particle to the unit cell.

Calculation:

- Contribution from 8 corners:

$$8 \times \frac{1}{8} = 1 \text{ particle}$$

- Contribution from 6 face centers:

$$6 \times \frac{1}{2} = 3 \text{ particles}$$

Total number of particles in an FCC unit cell:

$$1 + 3 = 4 \text{ particles}$$

Thus, the number of particles in a face-centered cubic unit cell is 4.

5) Explain P - type semiconductor by one example.

Answer:

A P-type semiconductor is formed by doping a pure semiconductor (typically silicon or germanium) with a small amount of a trivalent impurity, which has three valence electrons. This doping creates "holes," which are the majority charge carriers in P-type semiconductors.

Example: Silicon doped with boron

In pure silicon (which has four valence electrons), each silicon atom forms covalent bonds with four neighboring silicon atoms. When silicon is doped with a small amount of boron (which has three

valence electrons), the boron atom forms covalent bonds with three neighboring silicon atoms, but one bond remains incomplete, creating a hole (a missing electron in the bond). This hole can move through the lattice as electrons from neighboring atoms fill the vacancy, making it behave like a positive charge carrier.

Thus, in a P-type semiconductor, the holes (positive charge carriers) are the majority carriers, while electrons are the minority carriers.

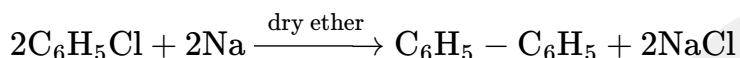
Summary:

- Doping element: Boron (B)
- Majority carriers: Holes
- Minority carriers: Electrons

6) Write chemical equation to prepare diphenyl from chlorobenzene.

Answer:

Diphenyl can be prepared from chlorobenzene using the Wurtz-Fittig reaction. In this reaction, chlorobenzene is treated with sodium metal in the presence of dry ether to form diphenyl. The chemical equation is:



7) A 35% (V/V) solution of ethylene glycol is used in vehicle for cooling the engine. Determine the volume of water in millilitre.

Answer:

To determine the volume of water in a 35% (V/V) solution of ethylene glycol, let's assume you have 100 mL of the solution. A 35% (V/V) solution means 35 mL of ethylene glycol in every 100 mL of solution.

- Volume of ethylene glycol = 35 mL
- Volume of the total solution = 100 mL
- Volume of water = Total volume - Volume of ethylene glycol

$$\text{Volume of water} = 100 \text{ mL} - 35 \text{ mL} = 65 \text{ mL}$$

Thus, the volume of water is 65 mL.

8) Write definition of osmosis. Write name of method used in desalination of sea water.

Answer:

**Osmosis** is the process in which solvent molecules pass through a semipermeable membrane from a region of lower solute concentration to a region of higher solute concentration, aiming to equalize the concentrations on both sides of the membrane.

The method used for the **desalination** of seawater is **reverse osmosis**. In reverse osmosis, pressure is applied to overcome the natural osmotic pressure, forcing water through a semipermeable membrane that blocks salts and impurities, producing purified water.

9) Draw the geometries of geometrical isomers of  $[\text{Pt}_2\text{H}_2\text{O}]_2\text{Br}_2$  and write their configurations.

Answer:

This complex is square planar because platinum typically forms square planar complexes. The geometrical isomers of  $[\text{Pt}(\text{H}_2\text{O})_2\text{Br}_2]$  arise due to the possible different spatial arrangements of the ligands (water and bromide) around the platinum center.

There are two possible geometrical isomers:

1. Cis-isomer: The two bromide ligands are adjacent to each other (  $90^\circ$  apart), and the two water molecules are adjacent.

- Configuration: Cis

- Geometry: Square planar

2. Trans-isomer: The two bromide ligands are opposite to each other (  $180^\circ$  apart ), and the two water molecules are also opposite to each other.

- Configuration: Trans

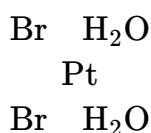
- Geometry: Square planar

The structures are as follows:

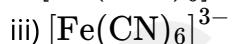
- Cis-isomer:



- Trans-isomer:



10) Write IUPAC names of following.



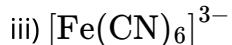
Answer:



IUPAC Name: Tetraaquacopper(II) ion



IUPAC Name: Hexaamminecobalt(III) bromide



IUPAC Name: Hexacyanidoferrate(III) ion

11) Write short note on Hoffmann bromamide degradation reaction.

Answer:

The Hoffmann Bromamide Degradation Reaction is a chemical reaction in which a primary amide is converted into a primary amine with one fewer carbon atom. The reaction involves the treatment of the amide with bromine and a strong base, typically sodium hydroxide (NaOH).

Reaction Mechanism:

1. The reaction begins with the deprotonation of the amide by NaOH, forming an anion.
2. Bromine ( $Br_2$ ) reacts with the deprotonated amide, leading to the formation of an intermediate.
3. The intermediate undergoes rearrangement, resulting in the loss of the carbonyl group.
4. The final product is a primary amine with one fewer carbon atom than the original amide, and a molecule of carbon dioxide is released.

General Reaction:



12) Give reason that trimethyl amine is less basic than methyl amine.

Answer:

Trimethylamine is less basic than methylamine due to the following reasons:

1. Steric Hindrance:

- In trimethylamine ( $N(CH_3)_3$ ), the nitrogen atom is surrounded by three bulky methyl groups.

These groups create steric hindrance, making it difficult for the nitrogen lone pair to accept a proton ( $H^+$ ). In contrast, methylamine ( $CH_3NH_2$ ) has only one methyl group, which allows the lone pair on nitrogen to be more readily available for protonation.

2. Electron Donating Effect:

- Although methyl groups are electron-donating via the inductive effect ( $+I$ ), in trimethylamine, the three methyl groups cause an overcrowded electron environment around nitrogen. This reduces the nitrogen's ability to stabilize the protonated form ( $N^+H$ ), thus lowering its basicity. Methylamine, with just one methyl group, experiences less electron crowding, and the lone pair on nitrogen is more available for protonation.

3. Solvent Effects (for aqueous solutions):

- In aqueous solutions, methylamine forms stronger hydrogen bonds with water, which helps stabilize the protonated form ( $CH_3NH_3^+$ ). However, trimethylamine, due to its bulkier structure, is less able to form such strong hydrogen bonds with water, leading to a lower stabilization of the protonated form and hence lower basicity.

12) Give reason that trimethyl amine is less basic than methyl amine.

Answer:

Trimethylamine is less basic than methylamine due to the following reasons:

1. Steric Hindrance:

- In trimethylamine ( $N(CH_3)_3$ ), the nitrogen atom is surrounded by three bulky methyl groups.

These bulky groups hinder the approach of a proton ( $H^+$ ) to the lone pair of electrons on nitrogen, making it less accessible for protonation. In contrast, methylamine ( $CH_3NH_2$ ) has only one methyl group, so the nitrogen's lone pair is more exposed and easily available to accept a proton.

## 2. Solvent Interaction:

- In aqueous solutions, methylamine ( $\text{CH}_3\text{NH}_2$ ) can form strong hydrogen bonds with water, which helps stabilize the protonated form ( $\text{CH}_3\text{NH}_3^+$ ). Trimethylamine, due to its bulkier structure, forms weaker hydrogen bonds with water, which reduces its ability to stabilize the protonated form ( $\text{N}(\text{CH}_3)_3\text{H}^+$ ).

## 3. Electron Donating Effects:

- While methyl groups are electron-donating ( $+I$ ), which generally increases the basicity of amines, in trimethylamine, the three methyl groups create electron crowding around the nitrogen atom. This crowding diminishes the nitrogen's ability to stabilize the positive charge after accepting a proton, thereby reducing its basicity compared to methylamine, which only has one methyl group.

13) Explain artificial sweetening agents by any two examples.

Answer:

**Artificial sweetening agents** are chemical compounds that are used as substitutes for sugar to provide a sweet taste, but they typically contain fewer or no calories. These compounds are often used by individuals who need to control their calorie intake, such as people with diabetes or those trying to manage their weight.

Here are two common examples of artificial sweetening agents:

### 1. Aspartame:

- Structure: Aspartame is a dipeptide ester made from two amino acids, aspartic acid and phenylalanine.
- Sweetness: It is approximately 200 times sweeter than sucrose (table sugar).
- Uses: Aspartame is used in various low-calorie foods and beverages, such as diet sodas, sugar-free gum, and desserts.
- Properties: Despite its high sweetness, aspartame provides about 4 calories per gram, but

99% of it is used in very small amounts due to its high sweetness, the overall calorie contribution is negligible.

- Note: Aspartame is not stable at high temperatures, so it is not suitable for baking.

### 2. Saccharin:

- Structure: Saccharin is a synthetic organic compound belonging to the sulfonamide family.
- Sweetness: It is approximately 300-400 times sweeter than sucrose.
- Uses: Saccharin is commonly used in soft drinks, candies, and table-top sweeteners like Sweet'N Low.
- Properties: Saccharin is heat-stable and can be used in cooking and baking. It has no caloric value, making it a popular choice for calorie-conscious consumers.
- Note: Saccharin can leave a slightly bitter or metallic aftertaste, which is why it is sometimes

14) Give any one example of following -

- i) Antibiotics
- ii) Narcotic analgesics
- iii) Antacids

Answer:

Here is one example for each:

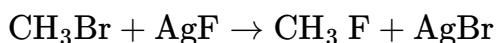
- Antibiotics: Penicillin - a widely used antibiotic effective against bacterial infections.
- Narcotic analgesics: Morphine - a powerful pain reliever often used for severe pain.
- Antacids: Magnesium hydroxide - commonly used to neutralize stomach acid and relieve indigestion or heartburn.

15) Explain Swarts reaction by any one example.

Answer:

The Swarts reaction is a chemical reaction used to prepare alkyl fluorides by treating alkyl halides (typically chlorides or bromides) with metal fluorides, such as silver fluoride ( $\text{AgF}$ ), antimony trifluoride ( $\text{SbF}_3$ ), or mercurous fluoride ( $\text{Hg}_2\text{F}_2$ ). This reaction is primarily used for the fluorination of organic compounds.

Example:



In this example, methyl bromide ( $\text{CH}_3\text{Br}$ ) reacts with silver fluoride ( $\text{AgF}$ ) to produce methyl fluoride ( $\text{CH}_3\text{F}$ ) and silver bromide ( $\text{AgBr}$ ) as a by-product.

Thus, the Swarts reaction is used to substitute a halogen atom (usually chlorine or bromine) in an alkyl halide with a fluorine atom to form the corresponding alkyl fluoride.

## SECTION-C

16 i) Describe structure of fuel cell.  
ii) Draw labeled diagram of fuel cell.

Answer:

i) Structure of a Fuel Cell:

**A fuel cell** is an electrochemical device that converts chemical energy from a fuel (such as hydrogen) and an oxidizing agent (such as oxygen) directly into electricity through a pair of redox reactions. The basic components of a fuel cell include:

**Electrodes:**

**Anode:** The negative electrode where the fuel (e.g., hydrogen) is oxidized, releasing electrons.

**Cathode:** The positive electrode where the oxidizing agent (e.g., oxygen) gains electrons and gets reduced.

**Electrolyte:**

The electrolyte allows ions (but not electrons) to move between the anode and cathode, facilitating the electrochemical reaction. It can be in solid or liquid form, depending on the type of fuel cell.

## Catalyst:

A catalyst (such as platinum) is used at the electrodes to speed up the redox reactions without being consumed.

## External Circuit:

The flow of electrons generated at the anode travels through an external circuit to perform electrical work (e.g., powering a device), and then returns to the cathode.

## Reactants and Products:

At the **anode**, hydrogen (or another fuel) is supplied, and it is split into protons (H ions) and electrons.

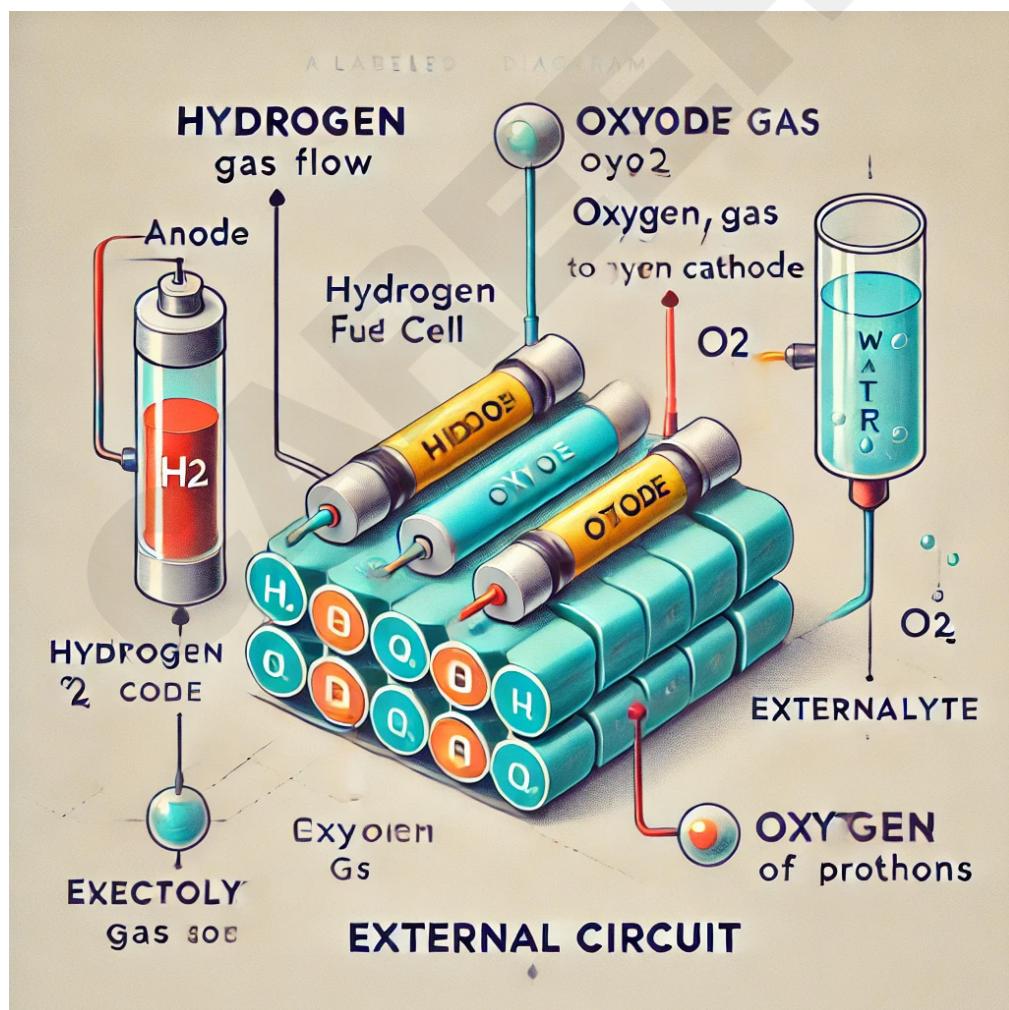
At the **cathode**, oxygen reacts with the protons and electrons to form water as a by-product.

Overall Reaction for Hydrogen Fuel Cell:



## ii) Labeled Diagram of a Fuel Cell:

I'll create a labeled diagram of a fuel cell showing the main components: anode, cathode, electrolyte, external circuit, flow of hydrogen and oxygen, and the formation of water.



17 i) Calculate the 'Spin only' magnetic moment of  $\text{Cu}_{(aq)}^{2+}$  ion.

Answer:

The magnetic moment of a transition metal ion is given by the formula:

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

where:

- $\mu$  is the magnetic moment,
- $n$  is the number of unpaired electrons,
- BM stands for Bohr Magnetons.

For  $\text{Cu}^{2+}$ , the electron configuration is  $[\text{Ar}]3d^9$ . This means that the  $\text{Cu}^{2+}$  ion has one unpaired electron in its  $3d$  subshell.

Substituting  $n = 1$  into the formula:

$$\mu = \sqrt{1(1+2)} = \sqrt{3} \text{BM} \approx 1.73 \text{BM}$$

Thus, the 'spin only' magnetic moment of  $\text{Cu}^{2+}$  is approximately 1.73 Bohr Magnetons (BM).

ii) Give reason that Zn, Cd, Hg, and Cn are not transition elements.

Answer:

- Definition of transition elements: Transition elements are defined as those elements that have an incomplete  $d$ -subshell either in their atomic state or in one of their oxidation states.
- Electron configurations:
- Zn :  $[\text{Ar}]3d^{10}4s^2$
- Cd:  $[\text{Kr}]4d^{10}5s^2$
- Hg :  $[\text{Xe}]4f^{14}5d^{10}6s^2$
- Cn (Copernicium): Expected to have a  $5d^{10}6s^2$  configuration.

All these elements have a completely filled  $d$ -subshell in both their atomic states and their most common oxidation states (2+ oxidation state). As a result, they do not exhibit the characteristic properties of transition metals, such as variable oxidation states or incomplete  $d$ -subshells.

Hence, Zn, Cd, Hg, and Cn are not considered transition elements because they have fully filled  $d$ -orbitals in their ground state and common oxidation states.

iii) Write names of components of brass.

Answer:

Brass is an alloy primarily made up of:

1. Copper (Cu) : Typically around 60 – 70%.
2. Zinc (Zn) : Typically around 30 – 40%.

Brass may also contain small amounts of other elements like lead (Pb) or tin(Sn), but the primary components are copper and zinc.

18) Write differences -

i) Low density polythene and High density polythene.

Answer:

Property	Low-Density Polythene (LDPE)	High-Density Polythene (HDPE)
Structure	Highly branched, less compact	Linear structure, more compact
Density	Low (0.91–0.94 g/cm <sup>3</sup> )	High (0.94–0.97 g/cm <sup>3</sup> )
Strength	Lower tensile strength	Higher tensile strength
Flexibility	More flexible and softer	Rigid and harder
Melting Point	Lower melting point (~110°C)	Higher melting point (~130°C)
Crystallinity	Lower degree of crystallinity (50-60%)	Higher degree of crystallinity (90%)
Uses	Plastic bags, squeeze bottles, insulation	Bottles, pipes, containers, toys

ii) Homopolymers and copolymers.

Answer:

Property	Homopolymers	Copolymers
Definition	Polymers made from a single type of monomer	Polymers made from two or more types of monomers
Monomer Unit	Only one type of repeating unit	Two or more different repeating units
Example	Polyethylene (from ethylene)	Nylon 6,6 (from hexamethylene diamine and adipic acid)

Uniformity	More uniform structure	Variable structure depending on monomers
Types	No specific types	Types: random, alternating, block, graft copolymers
Uses	Plastics, fibers	Specialty plastics, rubber-like materials

iii) Natural polymers and synthetic polymers.

Answer:

Property	Natural Polymers	Synthetic Polymers
Source	Occur naturally in plants or animals	Man-made, synthesized in laboratories
Examples	Proteins, DNA, starch, cellulose, rubber	Nylon, Teflon, PVC, polyethylene
Biodegradability	Generally biodegradable	Many are not biodegradable
Environmental Impact	Lower environmental impact	Can contribute to pollution if not disposed properly
Applications	Biological and food materials	Industrial products, plastics, textiles
Processing	Limited modification possible	Easily modified and tailored for specific uses

## SECTION-D

19 i) Write structural formula of pyrophosphoric acid and cyclo trimetaphosphoric acid.

Answer:

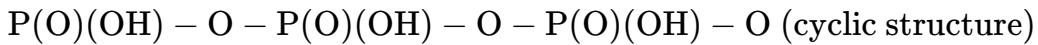
1. Pyrophosphoric Acid ( $H_4P_2O_7$ ) :

- Pyrophosphoric acid is a diphosphoric acid, and its structural formula consists of two phosphate ( $PO_4$ ) units joined by an oxygen atom.



2. Cyclo Trimetaphosphoric Acid  $[(HPO_3)_3]$  :

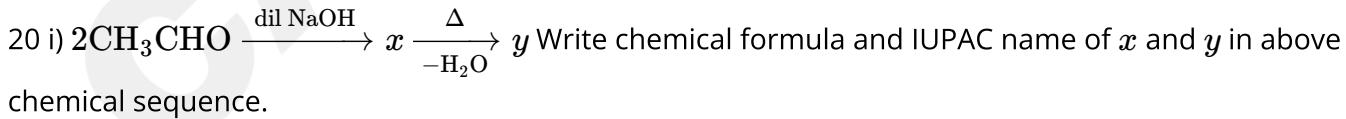
- Cyclo trimetaphosphoric acid is a cyclic compound consisting of three phosphate ( $PO_4$ ) units linked in a ring structure. Its general structural formula looks like this:



ii) Write any two differences between rhombic sulphur and monoclinic sulphur.

Answer:

Property	Rhombic Sulphur	Monoclinic Sulphur
Crystal System	Orthorhombic crystal structure	Monoclinic crystal structure
Stability	Stable at room temperature (below 96°C)	Stable only between 96°C and 119°C
Density	Higher density (2.07 g/cm <sup>3</sup> )	Lower density (1.98 g/cm <sup>3</sup> )
Transition	Converts to monoclinic sulphur above 96°C	Converts to rhombic sulphur below 96°C



Solution:

The reaction sequence given is a crossed aldol condensation followed by dehydration.

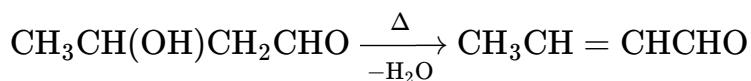
- The first step involves two molecules of acetaldehyde ( $CH_3CHO$ ) undergoing aldol condensation in the presence of dilute sodium hydroxide ( $NaOH$ ). The product  $x$  is 3hydroxybutanal (also known as aldol).



Chemical formula of  $x$  :  $\text{C}_4\text{H}_8\text{O}_2$

IUPAC name of  $x$  : 3-Hydroxybutanal

- In the second step, the product undergoes dehydration (loss of water) upon heating, leading to the formation of  $y$ , which is crotonaldehyde (an  $\alpha, \beta$ -unsaturated aldehyde).



Chemical formula of  $y$  :  $\text{C}_4\text{H}_6\text{O}$

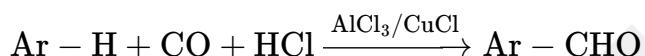
IUPAC name of  $y$  : But-2-enal (Crotonaldehyde)

ii) Write short note on Gattermann - Koch reaction.

Solution:

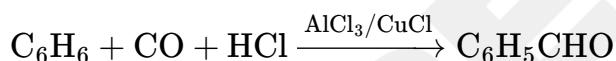
The Gattermann-Koch reaction is a method used to introduce a formyl group (- CHO) into an aromatic ring, producing an aryl aldehyde. This reaction is particularly useful for formylation of benzene and other aromatic compounds. The reaction is performed by treating the aromatic compound with a mixture of carbon monoxide ( CO ) and hydrogen chloride ( HCl ) in the presence of a Lewis acid catalyst, such as aluminum chloride (  $\text{AlCl}_3$  ) or cuprous chloride ( CuCl ).

General Reaction:



Example:

Benzene reacts with carbon monoxide and hydrogen chloride in the presence of aluminum chloride and cuprous chloride to form benzaldehyde.



# RBSE Class 12 Chemistry Question with Solution - 2022

## SECTION-A

### 1. Multiple Choice Questions :

i) When concentration of  $\text{Zn}^{2+}$  and  $\text{Cu}^{2+}$  ions is unity ( $1 \text{ mol dm}^{-3}$ ), then electrical potential of Daniell cell will be -

(A) 0.00 V  
 (B) 1.10 V  
 (C) 1.35 V  
 (D) 2.00 V

Solution:

The electrical potential of a Daniell cell under standard conditions, where the concentration of both  $\text{Zn}^{2+}$  and  $\text{Cu}^{2+}$  ions is  $1 \text{ mol dm}^{-3}$ , is:

1.10 V

Answer: (B) 1.10 V .

ii) Expression  $k = \frac{2.303}{t} \log \frac{[R]_s}{[R]}$  is integrated rate equation of order of reaction

(A) Zero order  
 (B) First order  
 (C) Second order  
 (D) Third order

Solution:

The given integrated rate equation is:

$$k = \frac{2.303}{t} \log \frac{[R]_s}{[R]}$$

This is the integrated rate equation for a first-order reaction, where  $[R]_s$  is the initial concentration of the reactant and  $[R]$  is the concentration at time  $t$ . The presence of a logarithmic relationship with the concentration indicates that the reaction follows first-order kinetics.

Thus, the correct answer is:

(B) First order

iii) To express the rate at a particular moment of time we determine the

(A) Initial rate

- (B) Instantaneous rate
- (C) Average rate
- (D) Standard rate

Solution:

To express the rate at a particular moment of time, we determine the instantaneous rate of reaction. The instantaneous rate is the rate of reaction at a specific time and is obtained by finding the slope of the concentration vs. time graph at that particular time.

Thus, the correct answer is:

- (B) Instantaneous rate

iv) Colloidal antimony is used in curing of -

- (A) Kalaazar
- (B) Stomach disorders
- (C) Skin disease
- (D) Sexual disease

Solution:

Colloidal antimony is used in the treatment of Kala-azar (also known as visceral leishmaniasis), a parasitic disease caused by the Leishmania parasite.

Thus, the correct answer is:

- (A) Kalaazar

v) Calamine is ore of -

- (A) Al
- (B) Fe
- (C) Cu
- (D) Zn

Solution:

Calamine is an ore of zinc (Zn). It primarily consists of zinc carbonate ( $ZnCO_3$ ).

Thus, the correct answer is:

- (D) Zn

vi) Didentate Ligand is -

- (A)  $C_2O_4^{2-}$
- (B)  $SCN^-$
- (C)  $NH_3$
- (D)  $Cl^-$

Solution:

A didentate ligand is a ligand that can form two bonds with a central metal ion through two donor atoms. Among the given options:

-  $\text{C}_2\text{O}_4^{2-}$  (oxalate ion) has two donor oxygen atoms that can coordinate with the metal ion, making it a didentate ligand.

Thus, the correct answer is:

(A)  $\text{C}_2\text{O}_4^{2-}$

vii) The name of  $\text{CF}_2\text{Cl}_2$  in freon method is -

(A) Freon 112

(B) Freon 12

(C) Freon 122

(D) Freon 11

Solution:

The compound  $\text{CF}_2\text{Cl}_2$  is known as Freon 12 in the Freon nomenclature system.

Thus, the correct answer is:

(B) Freon 12

viii) In reaction of manufacture of phenol from cumene the by-product is

(A) Tribromophenol

(B) Benzoquinone

(C) Picric acid

(D) Acetone

Solution:

In the manufacturing of phenol from cumene (cumene process), acetone is produced as a byproduct.

Thus, the correct answer is:

(D) Acetone

ix) The nitrogenous base not present in DNA

(A) Adenine

(B) Cytosine

(C) Guanine

(D) Uracil

Solution:

The nitrogenous base uracil is not present in DNA; it is found in RNA instead. In DNA, thymine takes the place of uracil.

Thus, the correct answer is:

(D) Uracil

2. Fill in the blanks

i) When the added substance reduces the rate of reaction, then it is called \_\_\_\_\_ in place of catalyst.

Solution:

When the added substance reduces the rate of reaction, then it is called **inhibitor** in place of catalyst.

ii) The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed \_\_\_\_\_.

Solution:

The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed **adsorption**.

iii) In Williamson synthesis the \_\_\_\_\_ reacts with sodium alkoxide and gives dialkyl ether.

Solution:

In Williamson synthesis, the **alkyl halide** reacts with sodium alkoxide and gives dialkyl ether.

iv) The aqueous solution of \_\_\_\_\_ is called Fehling solution A.

Solution:

The aqueous solution of **copper sulfate** is called Fehling's solution A.

3. Very short answer type questions :

i) Write order of reaction of natural and artificial nuclear (radioactive) decay.

Solution:

The order of reaction for both natural and artificial nuclear (radioactive) decay follows first-order kinetics.

In first-order reactions:

- The rate of decay is directly proportional to the number of undecayed nuclei (or the concentration of the radioactive substance).
- The rate law is expressed as:

$$\text{Rate} = k[\text{Nuclei}]$$

where  $k$  is the decay constant.

For radioactive decay, the amount of substance decreases exponentially over time, and the decay is independent of the initial concentration of the substance. This behavior aligns with the characteristics of a first-order process.

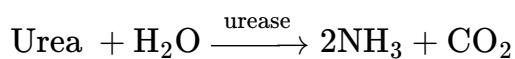
Thus, the order of reaction for both natural and artificial radioactive decay is first-order.

ii) Write the name of enzyme used in decomposition of urea into ammonia and carbondioxide.

Solution:

The enzyme used in the decomposition of urea into ammonia and carbon dioxide is called urease.

The reaction catalyzed by urease is:



Thus, urease is the enzyme responsible for this decomposition reaction.

iii) Represent sucrose by Haworth structure.

Solution:

The Haworth structure of sucrose can be represented as follows:

Sucrose is a disaccharide made up of  $\alpha$ -D-glucopyranose and  $\beta$ -D-fructofuranose linked by a glycosidic bond between carbon 1 of glucose and carbon 2 of fructose.

Here's how the Haworth structure is represented:

1. Glucose ( $\alpha$ -D-glucopyranose): This has a six-membered ring (pyranose) structure where carbon 1 (C1) is involved in the glycosidic bond.
2. Fructose ( $\beta$ -D-fructofuranose): This has a five-membered ring (furanose) structure where carbon 2 (C2) is involved in the glycosidic bond.

The glycosidic bond between the two monosaccharides is an  $\alpha(1 \rightarrow 2)$  linkage.

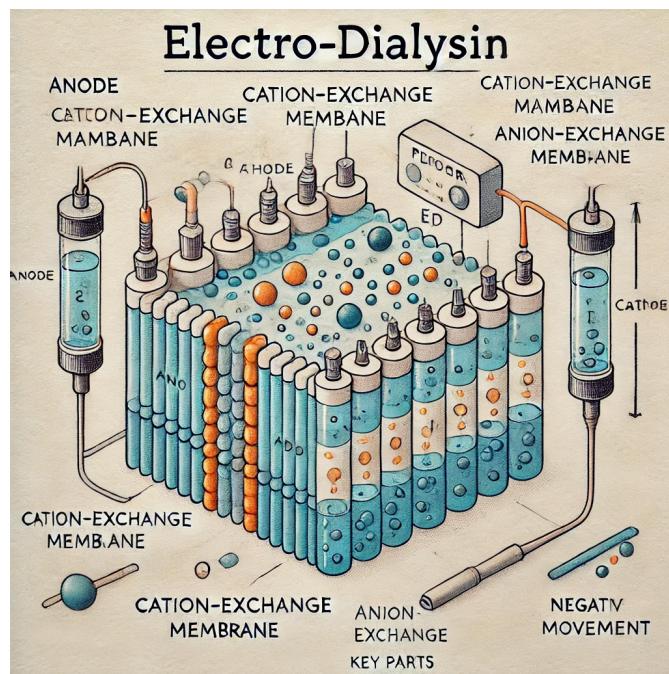
Let me describe the arrangement for you:

- The glucose ring is in its cyclic  $\alpha$ -pyranose form (a six-membered ring), with the hydroxyl group at carbon 1 pointing downward, indicating the  $\alpha$ -anomer.
- The fructose ring is in its cyclic  $\beta$ -furanose form (a five-membered ring), with the hydroxyl group at carbon 2 pointing upward, indicating the  $\beta$ -anomer.

The two monosaccharides are connected by a glycosidic bond between the hydroxyl group on carbon 1 of glucose and carbon 2 of fructose.

iv) Draw labeled diagram of electro-dialysis.

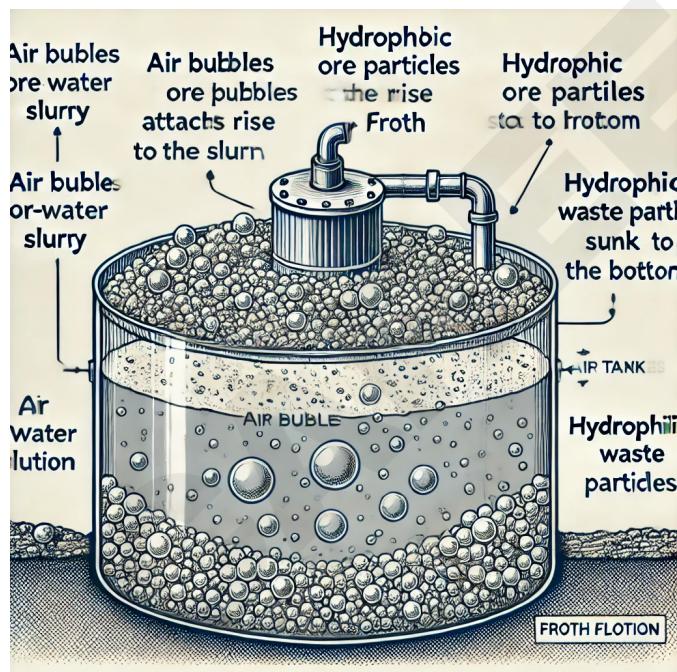
Solution:



Here is the labeled diagram of electro-dialysis as requested. Let me know if you need any further adjustments.

v) Draw labeled diagram of froth floatation process.

Solution:

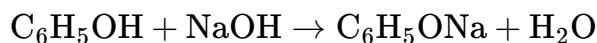


vi) Write chemical equation to prepare salicylic acid from phenol.

Solution:

To prepare salicylic acid from phenol, the Kolbe-Schmitt reaction is used. This process involves the carboxylation of sodium phenoxide with carbon dioxide, followed by acidification. The chemical equation is as follows:

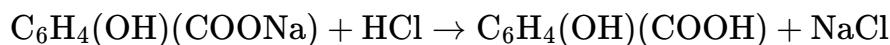
1. First, phenol reacts with sodium hydroxide ( $\text{NaOH}$ ) to form sodium phenoxide:



2. Then, sodium phenoxide reacts with carbon dioxide under pressure to form sodium salicylate:



3. Finally, sodium salicylate is acidified with hydrochloric acid (HCl) to yield salicylic acid:



Thus, salicylic acid is produced from phenol.

vii) Write IUPAC name of isobutyl alcohol.

Solution:

The IUPAC name of isobutyl alcohol is 2-methylpropan-1-ol.

This name reflects the structure of the compound, where a methyl group ( $-\text{CH}_3$ ) is attached to the second carbon of a three-carbon chain (propane), and the hydroxyl group ( $-\text{OH}$ ) is attached to the first carbon.

viii) Write the chemical formula of benzene diazonium chloride.

## SECTION-B

The chemical formula of benzene diazonium chloride is  $\text{C}_6\text{H}_5\text{N}_2\text{Cl}$ .

SECTION - B

Short answer type questions :

4) Calculate number of particles in face centred cubic unit cell.

Solution:

In a face-centered cubic (FCC) unit cell, the atoms are located at:

1. The 8 corners of the cube.
2. The 6 faces, with one atom at the center of each face.

Now, let's calculate the total number of atoms (or particles) per unit cell in an FCC structure:

1. Atoms at the corners: There are 8 corners, and each corner atom is shared by 8 adjacent unit cells. So, the contribution of each corner atom to a single unit cell is  $\frac{1}{8}$ .

Contribution from corners =  $8 \times \frac{1}{8} = 1$  atom

2. Atoms at the faces: There are 6 faces, and each face-centered atom is shared by 2 adjacent unit cells. So, the contribution of each face-centered atom to a single unit cell is  $\frac{1}{2}$ .

Contribution from faces  $= 6 \times \frac{1}{2} = 3$  atoms

So, the total number of atoms in a face-centered cubic (FCC) unit cell is:

Total atoms  $= 1$  (from corners)  $+ 3$  (from faces)  $= 4$  atoms

Thus, the number of particles in a face-centered cubic unit cell is 4.

5) Explain P - type semiconductor by one example.

Solution:

A **P-type semiconductor** is formed when a small amount of trivalent impurity (an element with three valence electrons) is added to a pure semiconductor like silicon or germanium. The impurity atoms create "holes" (positive charge carriers) in the semiconductor, which increases its conductivity.

- **Silicon (Si)** has four valence electrons and forms covalent bonds with four neighboring silicon atoms in a crystal structure.
- When **boron (B)**, a trivalent impurity with three valence electrons, is introduced into the silicon lattice, it can form only three covalent bonds with neighboring silicon atoms.
- The fourth bond remains incomplete, creating a "hole" (a missing electron), which acts as a positive charge carrier.
- These holes can move through the crystal as electrons from neighboring atoms fill the holes, thus facilitating electrical conduction.

In a P-type semiconductor, **holes are the majority charge carriers**, while electrons are the minority charge carriers.

6) Write chemical equation to prepare diphenyl from chlorobenzene.

Solution:

Diphenyl (or biphenyl) can be prepared from chlorobenzene using the Wurtz-Fittig reaction, which involves the coupling of two chlorobenzene molecules in the presence of sodium metal in dry ether. The reaction proceeds as follows:



Explanation:

- Chlorobenzene ( $\text{C}_6\text{H}_5\text{Cl}$ ) reacts with sodium metal in dry ether.
- The sodium metal facilitates the coupling of two phenyl groups, resulting in the formation of diphenyl ( $\text{C}_6\text{H}_5 - \text{C}_6\text{H}_5$ ).
- Sodium chloride ( $\text{NaCl}$ ) is formed as a by-product.

Thus, diphenyl is prepared from chlorobenzene using the Wurtz-Fittig reaction.

7) A 35% (V/V) solution of ethylene glycol is used in vehicle for cooling the engine. Determine the volume of water in millilitre.

Solution:

To determine the volume of water in a 35% (V/V) solution of ethylene glycol, we first need to understand the meaning of this concentration:

- A 35% (V/V) solution means that 35% of the solution's volume is ethylene glycol, and the

remaining 65% is water.

Let's assume the total volume of the solution is  $V_{\text{total}}$ . Then, 65% of this volume will be the volume of water.

If you know the total volume of the solution, you can calculate the volume of water using the following formula:

$$V_{\text{water}} = 0.65 \times V_{\text{total}}$$

If you provide the total volume of the solution, I can calculate the exact volume of water in milliliters.

8) Write definition of osmosis. Write name of method used in desalination of sea water.

Solution:

Definition of Osmosis:

**Osmosis** is the process by which solvent molecules (typically water) move across a semi-permeable membrane from a region of lower solute concentration to a region of higher solute concentration. This movement continues until equilibrium is reached, where the concentrations on both sides of the membrane become equal.

Method Used in Desalination of Sea Water:

The most commonly used method for desalination of sea water is **reverse osmosis**. This process involves applying pressure to force water through a semi-permeable membrane that allows water molecules to pass while blocking salts and other impurities.

9) Draw the geometries of geometrical isomers of  $[\text{Pt}(\text{H}_2\text{O})_2\text{Br}_2]$  and write their configurations.

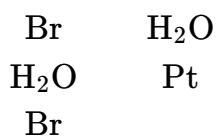
Solution:

The coordination complex  $[\text{Pt}(\text{H}_2\text{O})_2\text{Br}_2]$  exhibits square planar geometry, which is common for platinum(II) complexes. This complex can show geometrical isomerism due to the different possible arrangements of the ligands (water and bromine) around the platinum atom.

There are two possible geometrical isomers:

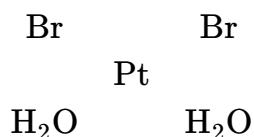
1. Cis-isomer:

- In the cis configuration, the two water molecules ( $\text{H}_2\text{O}$ ) are adjacent to each other, and the two bromine atoms ( $\text{Br}_2$ ) are also adjacent.
- The ligands are arranged such that similar ligands are  $90^\circ$  apart.



2. Trans-isomer:

- In the trans configuration, the two water molecules are opposite each other, and the two bromine atoms are also opposite each other.
- The ligands are arranged such that similar ligands are  $180^\circ$  apart.

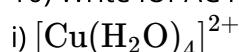


Summary of Configurations:

- Cis configuration: Water molecules are adjacent to each other, and bromine atoms are adjacent.
- Trans configuration: Water molecules are opposite each other, and bromine atoms are opposite.

These are the two possible geometrical isomers for  $[\text{Pt}(\text{H}_2\text{O})_2\text{Br}_2]$ .

10) Write IUPAC names of following.



Solution:

- The IUPAC name is tetraaquacopper(II) ion.
- Explanation: The ligand is water (aqua), there are four water molecules, and the oxidation state of copper is +2.

ii)  $[\text{Co}(\text{NH}_3)_6]\text{Br}_3$

Solution:

The IUPAC name is hexaamminecobalt(III) bromide.

Explanation: The ligand is ammonia (ammine), there are six ammonia molecules, and the oxidation state of cobalt is +3. Since three bromide ions are present, they are named after the complex.



Solution:

The IUPAC name is hexacyanoferrate(III).

Explanation: The ligand is cyanide (cyano), there are six cyanide ions, and the oxidation state of iron is +3. The suffix "ferrate" is used for iron in anionic complexes.

11) Write short note on Hoffmann bromamide degradation reaction.

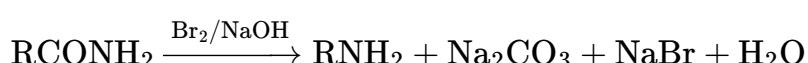
Solution:

Hoffmann Bromamide Degradation Reaction:

The Hoffmann Bromamide Degradation is an organic reaction in which a primary amide is converted to a primary amine with one fewer carbon atom. This reaction is particularly useful for shortening carbon chains in organic synthesis.

Reaction:

The general reaction can be represented as:



Where:

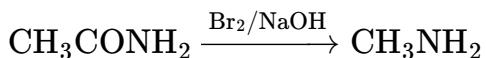
- $\text{RCONH}_2$  is the primary amide,
- $\text{Br}_2$  is bromine,
- $\text{NaOH}$  is sodium hydroxide (a strong base).

**Mechanism:**

1. The amide reacts with bromine in the presence of sodium hydroxide to form an N-bromoamide.
2. The N-bromoamide undergoes deprotonation and rearrangement, resulting in the loss of a carbonyl group (CO).
3. The intermediate formed then undergoes nucleophilic attack by hydroxide ions, leading to the formation of the primary amine.

**Key Features:**

- The reaction leads to a one-carbon reduction in the chain length of the amide.
- The primary amine produced has one less carbon atom than the starting amide.

**Example:**

In this example, acetamide is converted to methylamine.

**Applications:**

- This reaction is widely used in organic synthesis to reduce the number of carbon atoms in a compound.
- It is particularly useful for preparing primary amines from primary amides.

12) Give reason that trimethyl amine is less basic than methyl amine.

**Solution:**

Trimethylamine ( $\text{N}(\text{CH}_3)_3$ ) is less basic than methylamine ( $\text{CH}_3\text{NH}_2$ ) due to a combination of electronic and steric factors. Here's why:

**1. Electron Donating Effect (Inductive Effect):**

- In both trimethylamine and methylamine, the nitrogen atom has a lone pair of electrons that can accept a proton, making them bases.
- Methyl groups ( $\text{CH}_3-$ ) are electron-donating through the +1 (inductive) effect, which increases the electron density on nitrogen and enhances its ability to donate electrons (basicity).
- In methylamine ( $\text{CH}_3\text{NH}_2$ ), only one methyl group donates electron density, leading to a moderate increase in the basicity of nitrogen.
- In trimethylamine ( $\text{N}(\text{CH}_3)_3$ ), three methyl groups donate electron density to the nitrogen.

However, this high electron density on nitrogen leads to crowding and steric hindrance.

**2. Steric Hindrance:**

- In trimethylamine, the three bulky methyl groups create significant steric hindrance around the nitrogen atom, making it more difficult for a proton to approach and bond with the nitrogen's lone pair.
- In methylamine, there is only one methyl group, so there is much less steric hindrance, making it easier for the nitrogen to accept a proton.

**3. Solvation Effect:**

- In an aqueous solution, basicity is also influenced by how well the conjugate acid (formed after accepting a proton) is stabilized by water molecules.
- Methylamine ( $\text{CH}_3\text{NH}_2$ ) can be well-solvated by water molecules because it has fewer steric

hindrances, allowing for better hydrogen bonding with the conjugate acid.

- Trimethylamine ( $\text{N}(\text{CH}_3)_3$ ), due to its bulky methyl groups, is less efficiently solvated, reducing the stability of the conjugate acid and thus lowering its basicity in aqueous solution.

Conclusion:

Due to steric hindrance and less effective solvation, trimethylamine is less basic than methylamine, despite having more electron-donating groups.

13) Explain artificial sweetening agents by any two examples.

Solution:

**Artificial sweetening agents** are synthetic compounds that mimic the taste of sugar but provide little to no caloric value, making them useful for people who want to reduce their sugar intake, manage weight, or control blood sugar levels. They are widely used in various food and beverage products. Here are two examples:

### 1. Aspartame

- **Chemical Composition:** Aspartame is composed of two amino acids: aspartic acid and phenylalanine.
- **Sweetness:** It is about 200 times sweeter than sucrose (table sugar).
- **Uses:** It is used in soft drinks, sugar-free gum, yogurt, and a variety of low-calorie or sugar-free foods.
- **Properties:** Aspartame is not stable under high temperatures, which makes it unsuitable for baking. However, it is widely used in cold or room-temperature foods.
- **Health Considerations:** Aspartame is considered safe for the general population, but individuals with a rare genetic disorder called phenylketonuria (PKU) must avoid it due to their inability to metabolize phenylalanine.

### 2. Saccharin

- **Chemical Composition:** Saccharin is an organic compound made from a combination of toluene derivatives.
- **Sweetness:** It is about 300 to 400 times sweeter than sucrose.
- **Uses:** Saccharin is often used in beverages, candy, and baked goods, and as a tabletop sweetener.
- **Properties:** Saccharin is heat-stable and can be used in cooking and baking.
- **Health Considerations:** Saccharin has been the subject of controversy due to early studies linking it to cancer in laboratory rats. However, subsequent studies found it safe for human consumption, and it has been approved by food safety authorities like the FDA.

Both of these artificial sweeteners allow people to enjoy the sweet taste without the calories or impact on blood sugar levels associated with regular sugar.

14) Give any one example of following -

- i) Antibiotics
- ii) Narcotic analgesics
- iii) Antacids

Solution:

Here are examples for each category:

**Antibiotic: Penicillin**

Penicillin is one of the earliest discovered and widely used antibiotics. It works by inhibiting the synthesis of bacterial cell walls, leading to the death of the bacteria. It is effective against a variety of bacterial infections.

### **Narcotic Analgesic: Morphine**

Morphine is a powerful pain-relieving medication used to treat moderate to severe pain. It works by binding to opioid receptors in the brain, reducing the perception of pain.

### **Antacid: Magnesium Hydroxide**

Magnesium hydroxide, also known as milk of magnesia, is an antacid used to neutralize stomach acid. It provides relief from indigestion, heartburn, and acid reflux.

15) Explain Swarts reaction by any one example.

Solution:

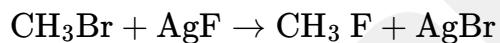
Swarts Reaction is a chemical reaction used to introduce a fluorine atom into an organic compound, typically an alkyl halide. In this reaction, an alkyl chloride or bromide is treated with a metallic fluoride such as silver fluoride ( $\text{AgF}$ ), mercurous fluoride ( $\text{Hg}_2\text{F}_2$ ), or antimony trifluoride ( $\text{SbF}_3$ ), resulting in the formation of an alkyl fluoride.

Example of Swarts Reaction:

Conversion of Methyl Bromide ( $\text{CH}_3\text{Br}$ ) to Methyl Fluoride ( $\text{CH}_3\text{F}$ ) :

When methyl bromide ( $\text{CH}_3\text{Br}$ ) is reacted with silver fluoride ( $\text{AgF}$ ), it undergoes the Swarts reaction to form methyl fluoride ( $\text{CH}_3\text{F}$ ) and silver bromide ( $\text{AgBr}$ ) as a byproduct.

Reaction:



In this reaction, the bromine atom in methyl bromide is replaced by a fluorine atom, yielding methyl fluoride, a useful compound in various industrial and pharmaceutical applications.

Long answer type questions

i) Describe structure of fuel cell.

Solution:

A **fuel cell** is an electrochemical device that converts the chemical energy of a fuel (typically hydrogen) and an oxidizing agent (often oxygen) into electricity through redox reactions. The structure of a typical hydrogen-oxygen fuel cell consists of the following key components:

1. **Anode:** The electrode where the fuel (e.g., hydrogen) is oxidized. Hydrogen molecules lose electrons at the anode and produce protons ( $\text{H}^+$  ions).
2. **Cathode:** The electrode where oxygen is reduced. Oxygen combines with the protons and electrons to form water at the cathode.

**3. Electrolyte:** The electrolyte is a medium that allows ions (protons, in the case of hydrogen fuel cells) to move between the anode and cathode while preventing the flow of electrons directly between them. This forces the electrons to travel through an external circuit, creating an electric current.

**4. Catalyst:** A catalyst is used at both the anode and cathode to speed up the reactions. Platinum is commonly used as a catalyst for both electrodes in hydrogen-oxygen fuel cells.

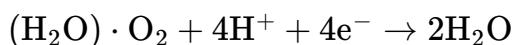
**5. External Circuit:** This is where the electrons flow from the anode to the cathode, generating an electric current that can be used to power external devices.

Process:

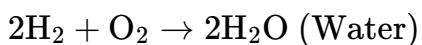
- At the anode: Hydrogen gas ( $H_2$ ) is oxidized, splitting into protons ( $H^+$ ) and electrons ( $e^-$ ).



- At the cathode: Oxygen ( $O_2$ ) reacts with the protons ( $H^+$ ) and electrons ( $e^-$ ) to form water



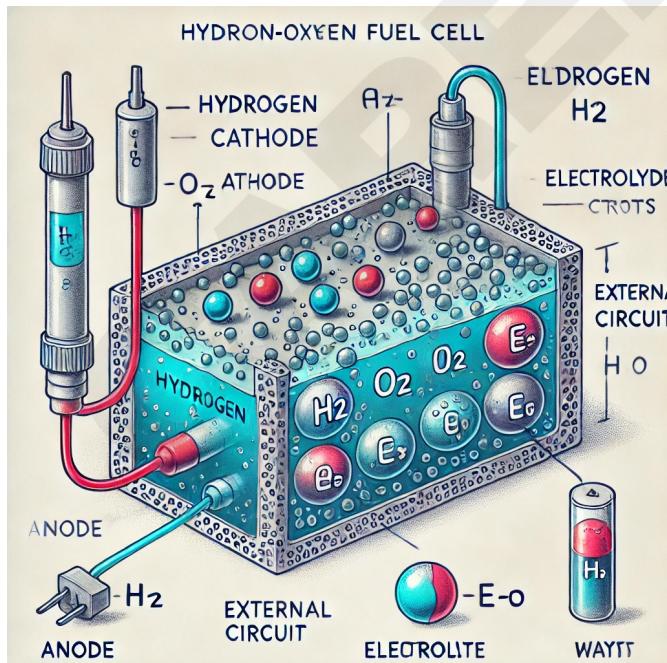
Overall reaction:



This produces electricity, heat, and water as byproducts.

ii) Draw labeled diagram of fuel cell.

Here is the labeled diagram of a hydrogen-oxygen fuel cell. It shows the main components such as the anode, cathode, electrolyte, external circuit, and catalyst, along with the flow of hydrogen and oxygen through the cell to generate electricity and water.



i) Calculate the 'Spin only' magnetic moment of  $Cu^{2+}_{(aq)}$  ion.

Solution:

To calculate the spin-only magnetic moment ( $\mu_s$ ) of a transition metal ion, we use the following formula:

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

where  $n$  is the number of unpaired electrons and BM stands for Bohr Magnetons.

For  $\text{Cu}^{2+}$ :

- The electron configuration of neutral copper (Cu) is:  $[\text{Ar}]3d^{10}4s^1$ .
- In  $\text{Cu}^{2+}$ , it loses two electrons, one from the 4 s orbital and one from the 3d orbital, resulting in the configuration:  $[\text{Ar}]3d^9$ .
- $\text{Cu}^{2+}$  has one unpaired electron in the 3 d subshell, so  $n = 1$ .

Substitute  $n = 1$  into the formula:

$$\mu_s = \sqrt{1(1+2)} = \sqrt{3} \approx 1.73 \text{BM}$$

Thus, the 'spin only' magnetic moment of  $\text{Cu}_{(aq)}^{2+}$  is approximately 1.73 BM.

ii) Give reason that Zn, Cd, Hg, and Cn are not transition elements.

Solution:

Transition elements are typically defined as elements that have an incomplete d-subshell in either their elemental form or in one or more of their common oxidation states.

- Zinc (Zn), Cadmium (Cd), Mercury (Hg), and Copernicium (Cn) have the electronic configuration of  $d^{10}$  in both their elemental state and in their most common oxidation states ( $\text{Zn}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Hg}^{2+}$ ,  $\text{Cn}^{2+}$ ).
- In these cases, their d-orbital is fully filled, and they do not exhibit the characteristic variable oxidation states or incomplete d-subshells that are typical of transition metals.

Hence, Zn, Cd, Hg, and Cn are not considered transition elements because they do not have an incomplete d-subshell.

iii) Write names of components of brass.

Solution:

Brass is an alloy made primarily of:

1. Copper (Cu) : 60 – 70% (the major component).
2. Zinc (Zn) : 30 – 40%.

In some cases, small amounts of other elements like lead (Pb) or tin (Sn) may be added to enhance specific properties of the alloy, but copper and zinc are the primary components of brass.

18) Write differences -

- i) Low density polythene and High density polythene.

Solution:

Property	Low Density Polythene (LDPE)	High Density Polythene (HDPE)
Structure	Branched structure with considerable chain branching	Linear structure with minimal or no branching
Density	Lower density (0.910–0.940 g/cm <sup>3</sup> )	Higher density (0.941–0.965 g/cm <sup>3</sup> )
Tensile Strength	Lower tensile strength due to branched structure	Higher tensile strength due to linear structure
Flexibility	More flexible and softer	Less flexible and more rigid
Melting Point	Lower melting point (about 110°C)	Higher melting point (about 130°C)
Applications	Used in plastic bags, squeeze bottles, toys, and insulation	Used in containers, pipes, bottles, and household goods

ii) Homopolymers and copolymers.

Solution:

Property	Homopolymers	Copolymers
Definition	Polymers made from a single type of monomer	Polymers made from two or more different types of monomers
Composition	Repeating units of only one kind of monomer	Repeating units of at least two different monomers
Example	Polyethylene (from ethylene monomers)	Nylon-6,6 (from hexamethylene diamine and adipic acid)
Properties	Uniform properties due to identical repeating units	Can exhibit a combination of properties from different monomers

Applications	Used in simpler, uniform applications (e.g., plastics, fibers)	Used in specialized applications requiring combined properties
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iii) Natural polymers and synthetic polymers.

Solution:

Property	Natural Polymers	Synthetic Polymers
Source	Derived from natural sources like plants, animals, and microbes	Man-made polymers, synthesized from petrochemicals or other raw materials
Examples	Proteins (e.g., silk, wool), polysaccharides (e.g., starch, cellulose), natural rubber	Polyethylene, nylon, polyester, polystyrene
Biodegradability	Generally biodegradable	Often non-biodegradable (though some are made biodegradable)
Applications	Used in food, textiles, and biological systems	Used in plastics, packaging, electronics, textiles, and more
Synthesis	Occur naturally through biological processes	Produced through controlled chemical processes in industries

## SECTION-C

19)

i) Write structural formula of pyrophosphoric acid and cyclo trimetaphosphoric acid.

Solution:

1. Pyrophosphoric Acid ( $H_4P_2O_7$ )

The structural formula of pyrophosphoric acid consists of two phosphate groups ( $PO_4$ ) linked by an oxygen atom. Each phosphate group is bonded to four oxygen atoms, with two hydrogens attached to the terminal oxygens.

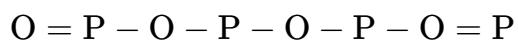
Structural formula:



## 2. Cyclo Trimetaphosphoric Acid ( $\text{H}_3\text{P}_3\text{O}_9$ )

Cyclo trimetaphosphoric acid is a cyclic compound where three phosphate units ( $\text{PO}_4$ ) are linked in a ring, sharing oxygen atoms between them.

Structural formula:



ii) Write any two differences between rhombic sulphur and monoclinic sulphur.

Solution:

Property	Rhombic Sulphur ( $\alpha$ -Sulphur)	Monoclinic Sulphur ( $\beta$ -Sulphur)
Crystal Structure	Rhombic (orthorhombic) crystal structure	Monoclinic crystal structure
Stability	Stable at room temperature and below $96^\circ\text{C}$	Stable between $96^\circ\text{C}$ and $119^\circ\text{C}$ but reverts to rhombic sulphur below $96^\circ\text{C}$
Shape of Crystals	Has octahedral crystal shape	Has needle-shaped crystals

20)

i)  $2\text{CH}_3\text{CHO} \xrightarrow{\text{dil. NaOH}} x \xrightarrow[-\text{H}_2\text{O}]{\Delta} y$  Write chemical formula and IUPAC name of  $x$  and  $y$  in above chemical sequence.

Solution:

The given reaction sequence involves the aldol condensation reaction followed by dehydration.

Step 1: Aldol Addition

In the first step, acetaldehyde ( $\text{CH}_3\text{CHO}$ ) reacts with dilute sodium hydroxide ( $\text{NaOH}$ ) to undergo aldol addition, forming a  $\beta$ -hydroxy aldehyde.



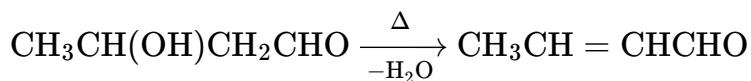
This product,  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO}$ , is known as 3-hydroxybutanal.

- Chemical Formula of  $x$  :  $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO}$

- IUPAC Name of  $x$  : 3-hydroxybutanal

Step 2: Dehydration

In the next step, 3-hydroxybutanal undergoes dehydration (loss of water) upon heating ( $\Delta$ ), resulting in the formation of an  $\alpha, \beta$ -unsaturated aldehyde called crotonaldehyde.



- Chemical Formula of  $\gamma$  :  $\text{CH}_3\text{CH} = \text{CHCHO}$
- IUPAC Name of  $\gamma$  : Crotonaldehyde (or  $\gamma$  butenal)

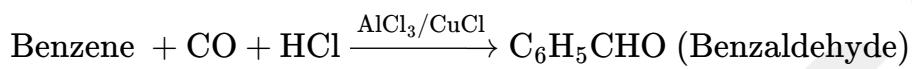
ii) Write short note on Gattermann - Koch reaction.

Solution:

The Gattermann-Koch reaction is a method used to form benzaldehyde derivatives by introducing a formyl group ( -CHO ) into an aromatic ring. It is a type of formylation reaction.

Reaction Mechanism:

In this reaction, an aromatic compound such as benzene is treated with a mixture of carbon monoxide ( CO ) and hydrogen chloride ( HCl ) in the presence of a Lewis acid catalyst, typically anhydrous aluminum chloride (  $\text{AlCl}_3$  ) or cuprous chloride ( CuCl ).



Key Points:

- The Gattermann-Koch reaction introduces a formyl group ( -CHO ) onto the aromatic ring.
- It is useful for producing benzaldehyde and its derivatives.
- The reaction requires a strong Lewis acid catalyst such as  $\text{AlCl}_3$  and CuCl .

This reaction is widely used in organic synthesis for the preparation of aldehyde-containing aromatic compounds.