

# CBSE EXAMINATION PAPER-2025

## CHEMISTRY

(Solved)

Time allowed : 3 hours

Maximum Marks : 28

### General Instructions :

Read the following instructions carefully and follow them :

- i. This question paper contains **22 questions**. All questions are **compulsory**.
- ii. This question paper is divided into **4 sections**.
- iii. **Section A** – questions number **1 to 13** are multiple choice questions Each question carries **1 marks**.
- iv. **Section B** – questions number **14 to 16** are very short answer Each question carries **2 marks**.
- v. **Section C** – questions number **17 to 19** are short answer Each question carries **3 marks**.
- vi. **Section D** – questions number **20 to 22** are case based questions
- vii. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions.
- viii. Use of calculator is NOT allowed.

### Section A

#### Question 1.

The role of a catalyst is to change:

[1 Marks]

(A) Gibbs energy of reaction

(B) enthalpy of reaction

(C) activation energy of reaction

(D) equilibrium constant

**Explanation:** The correct option is 'activation energy of reaction'. A catalyst lowers the activation energy required for a reaction to occur, allowing the reaction to proceed faster without altering the Gibbs energy or the equilibrium constant. It provides a new reaction pathway with lower energy, enhancing the rate of reaction.

### Question 2.

Which of the following molecules is chiral in nature?

[1 Marks]

(A) 1-chlorobutane

(B) 2-chlorobutane

(C) 1-chloropropane

(D) 2-chloropropane

**Explanation:** The correct answer is 2-chlorobutane. Chiral molecules have non-superimposable mirror images, and this occurs when a carbon atom is bonded to four different groups. In 2-chlorobutane, the second carbon is bonded to a chlorine atom, a methyl group, an ethyl group, and a hydrogen atom, thus making it chiral. The other options do not meet this criterion.

### Question 3.

$\text{CH}_3\text{CH}_2\text{OH}$  can be converted to  $\text{CH}_3\text{CHO}$  by:

[1 Marks]

(A) treatment with PCC

(B) treatment with  $\text{KMnO}_4$

(C) treatment with  $\text{LiAlH}_4$

(D) catalytic hydrogenation

**Explanation:** The correct option is 'treatment with PCC.'  $\text{CH}_3\text{CH}_2\text{OH}$  (ethanol) is a primary alcohol that can be oxidized to an aldehyde ( $\text{CH}_3\text{CHO}$ , acetaldehyde) using PCC (Pyridinium Chlorochromate), a mild oxidizing agent. Other options like  $\text{LiAlH}_4$  and catalytic

hydrogenation do not lead to this transformation, and  $\text{KMnO}_4$  typically leads to further oxidation.

#### Question 4.

The IUPAC name for  $\text{CH}_3\text{-CH}_2\text{-N}(\text{CH}_3)\text{-CH}_2\text{-CH}_2\text{-CH}_3$  is:

[1 Marks]

(A) N,N-dimethylpropan-1-amine

**(B) N-ethyl-N-methylpropan-1-amine**

(C) N,N-diethylpropan-1-amine

(D) N-methylpentan-2-amine

#### Explanation:

The correct answer is N-ethyl-N-methylpropan-1-amine. The structure consists of a propanamine base (3 carbon atoms) with an ethyl group ( $\text{C}_2\text{H}_5$ ) and a methyl group ( $\text{CH}_3$ ) attached to the nitrogen atom (N). This naming follows the IUPAC conventions where substituents and the longest carbon chain are identified, hence leading to the correct name.

#### Question 5.

The treatment of ethyl bromide with alcoholic silver nitrite gives:

[1 Marks]

(A) ethyl nitrite

(B) nitromethane

(C) ethene

**(D) nitroethane**

#### Explanation:

On heating with an ethanolic solution of silver nitrate, alkyl halides yield nitroalkanes. Some of the alkyl nitrites are also formed because nitrite is an ambidentate ligand. It has a lone pair of electrons on nitrogen as well as oxygen. Thus it can be bonded to an alkyl halide through oxygen to form alkyl nitrite and via Nitrogen to form nitroalkane. Hence, the treatment of ethyl bromide with alcoholic silver nitrite gives Nitroethane.

### Question 6.

Which of the following aqueous solutions will have the highest freezing point?

[1 Marks]

(A) 1.0 M  $\text{Na}_2\text{SO}_4$

(B) 1.0 M KCl

(C) 1.0 M Glucose

(D) 1.0 M  $\text{AlCl}_3$

**Explanation:** 1.0 M Glucose will have the highest freezing point among the options because it is a non-electrolyte and does not dissociate into ions in solution, resulting in a van 't Hoff factor (i) of 1. In contrast,  $\text{AlCl}_3$ ,  $\text{Na}_2\text{SO}_4$ , and KCl are strong electrolytes that dissociate into multiple ions, increasing the number of particles in solution and thus causing greater freezing point depression. Therefore, since glucose has the least effect on lowering the freezing point, it has the highest freezing point.

### Question 7.

In which of the following groups are both ions coloured in aqueous solution?

I.  $\text{Cu}^+$  II.  $\text{Ti}^{4+}$  III.  $\text{Co}^{2+}$  IV.  $\text{Fe}^{2+}$

[Atomic number : Cu = 29, Ti = 22, Co = 27, Fe = 26]

[1 Marks]

(A) I and IV

(B) II and III

(C) I and II

(D) III and IV

### Explanation:

The correct option is 'III and IV' because  $\text{Co}^{2+}$  (Cobalt ion) and  $\text{Fe}^{2+}$  (Iron ion) are known to be coloured in aqueous solution.  $\text{Co}^{2+}$  typically appears blue while  $\text{Fe}^{2+}$  can appear green or yellow depending on its concentration.  $\text{Cu}^+$  is generally colourless and  $\text{Ti}^{4+}$  is often colourless as well, which eliminates I and II as options.

### Question 8.

$\text{CH}_3\text{CH}_2\text{CHO}$  and  $\text{CH}_3\text{CH}_2\text{COOH}$  can be distinguished by:

[1 Marks]

(A) Iodoform test

**(B) Sodium bicarbonate test**

(C) Hinsberg test

(D) Lucas test

### Explanation:

- **Sodium bicarbonate test:** Carboxylic acids (like  $\text{CH}_3\text{CH}_2\text{COOH}$ ) react with sodium bicarbonate ( $\text{NaHCO}_3$ ) to produce carbon dioxide gas, which causes effervescence. Aldehydes (like  $\text{CH}_3\text{CH}_2\text{CHO}$ ) do not react with sodium bicarbonate.

### Question 9.

While doing qualitative analysis in chemistry lab, Abhishek added yellow coloured potassium chromate solution into a test tube. He was surprised to see the colour of the solution changing immediately to orange. He realised that the test tube was not clean and contained a few drops of some liquid. Which of the following substances will be the most likely liquid to be present in the test tube before adding potassium chromate solution?

[1 Marks]

(A) Sodium hydroxide solution

(B) Methyl orange solution

**(C) HCl solution**

(D) Sodium hydrogen carbonate solution

### Explanation:

The correct answer is HCl solution. The color change from yellow to orange occurs due to the conversion of chromate ions ( $\text{CrO}_4^{2-}$ ) to dichromate ions ( $\text{Cr}_2\text{O}_7^{2-}$ ) in acidic conditions. Since hydrochloric acid (HCl) is an acid, its presence in the test tube would facilitate this transformation when potassium chromate is added.

### Question 10.

Assertion (A) : For measuring resistance of an ionic solution an AC source is used.

Reason (R) : Concentration of ionic solution will change if DC source is used.

[1 Marks]

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

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

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

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

### Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). Assertion (A) is correct because an AC source is used to prevent changes in the ionic solution, while Reason (R) is a separate fact that explains a consequence of using DC but does not directly clarify why AC is preferred.

### Question 11.

Assertion (A) : Henry's law constant (KH) decreases with increase in temperature.

Reason (R) : As the temperature increases, solubility of gases in liquids decreases.

[1 Marks]

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

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

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

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

### Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A). The context reveals that higher KH indicates lower solubility, which means that as temperature increases, KH actually increases, leading to lower solubility of gases.

Therefore, even though both statements are true, the reasoning does not correctly explain the assertion.

### Question 12.

Assertion (A) : The solubility of aldehydes and ketones in water decreases with increase in size of the alkyl group.

Reason (R) : Aldehydes and ketones have dipole-dipole interaction.

[1 Marks]

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

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

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

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

### Explanation:

Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A). The assertion is true as the solubility of aldehydes and ketones decreases with increasing size of the alkyl group due to their hydrophobic nature. However, the reason provided does not directly explain this as it refers to dipole-dipole interactions, which do not account for the significant effect of the hydrophobic alkyl chains on solubility.

### Question 13.

Assertion (A) : The boiling points of alkyl halides decrease in the order  $RI > RBr > RCl > RF$ .

Reason (R) : The van der Waals forces of attraction decrease in the order  $RI > RBr > RCl > RF$

[1 Marks]

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

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

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

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

### Explanation:

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

The assertion is true as the boiling points of alkyl halides decrease in the order  $RI > RBr > RCl > RF$  due to the increasing strength of van der Waals forces with increasing atomic size and mass of the halogen atom. The reason is also true because van der Waals forces are stronger in heavier halogens (like iodine) due to greater polarizability. Since stronger intermolecular forces require more energy to overcome, the boiling point increases. Therefore, the reason correctly explains the assertion.

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## Section B

### Question 14.

Calculate the elevation of boiling point of a solution when 3 g of  $\text{CaCl}_2$  (Molar mass = 111 g  $\text{mol}^{-1}$ ) was dissolved in 260 g of water, assuming that  $\text{CaCl}_2$  undergoes complete dissociation. ( $K_b$  for water = 0.52 K kg  $\text{mol}^{-1}$ )

[2 Marks]

**Answer:** To find the elevation of the boiling point, we first determine the number of moles of  $\text{CaCl}_2$ : moles = mass / molar mass = 3 g / 111 g/mol = 0.027 moles. Since  $\text{CaCl}_2$  dissociates into 3 ions (1  $\text{Ca}^{2+}$  and 2  $\text{Cl}^-$ ), the effective particle concentration ( $i$ ) is 3. The molality ( $m$ ) = moles of solute / kg of solvent = 0.027 moles / 0.260 kg = 0.1046 mol/kg. Therefore, the boiling point elevation ( $\Delta T_b$ ) =  $K_b \times m \times i = 0.52 \text{ K kg/mol} \times 0.1046 \text{ mol/kg} \times 3 = 0.163 \text{ K}$ .

### Question 15.

Liquids 'X' and 'Y' form an ideal solution. The vapour pressure of pure 'X' and pure 'Y' are 120 mm Hg and 160 mm Hg respectively. Calculate the vapour pressure of the solution containing equal moles of 'X' and 'Y'.

[2 Marks]

**Answer:** Since liquids X and Y form an ideal solution, we use Raoult's law.

Given:

Vapour pressure of pure X,  $P_X = 120 \text{ mm Hg}$

Vapour pressure of pure Y,  $P_Y = 160 \text{ mm Hg}$

Number of moles are equal, so mole fraction of X,  $x_X = 0.5$  and mole fraction of Y,  $x_Y = 0.5$

According to Raoult's law, vapor pressure of solution,  $P = x_X \cdot P_X + x_Y \cdot P_Y = 0.5 \cdot 120 + 0.5 \cdot 160 = 60 + 80 = 140 \text{ mm Hg}$ .

Therefore, vapour pressure of the solution is 140 mm Hg.

### Question 16.

Explain the mechanism of acid catalysed hydration of ethene.

[2 Marks]

**Answer:** The mechanism involves three steps. First, ethene is protonated by an acid, forming a carbocation. This step is slow and forms a positively charged intermediate. Next, water acts as a nucleophile, attacking the carbocation to form an alcohol. Finally, a proton is eliminated, regenerating the acid catalyst and producing ethanol. To favor product formation, ethene is continuously removed from the reaction. This process follows Markovnikov's rule when unsymmetrical alkenes are involved.

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## Section C

### Question 17.

Shweta mixed two liquids A and B of 10 mL each. After mixing, the volume of the solution was found to be 20.2 mL.

- (i) Why was there a volume change after mixing the liquids ?
- (ii) Will there be an increase or decrease of temperature after mixing ?
- (iii) Give one example for this type of solution.

[3 Marks]

**Answer:** The volume change when mixing liquids A and B occurs due to molecular interactions between the liquid components. When these two liquids combine, some molecules occupy the volume between others, leading to a total volume lower than the expected combined volume of 20 mL. Typically, the temperature will decrease upon mixing due to endothermic interactions where energy is absorbed during the mixing process. An example of such a solution is the mixing of ethanol and water, where significant volume contraction is observed.

### Question 18.

- (i) How does sprinkling of salt help in clearing the snow covered roads in hilly areas ?
- (ii) What happens when red blood cells are kept in 0.5% (mass/vol) NaCl solution ? Justify your answer.
- (iii) Write an application of reverse osmosis.

[3 Marks]

**Answer:** Sprinkling salt on snow-covered roads helps melt the snow because salt lowers the freezing point of water, a process known as freezing point depression. When salt is added to the snow, it dissolves and creates a brine solution that remains liquid at lower temperatures, thus effectively melting the ice and preventing further accumulation. This is crucial in hilly areas where snow can cause dangerous driving conditions. Moreover, red blood cells in a 0.5% NaCl solution will swell and may burst due to the hypotonic nature of the solution, prompting water to enter the cells. An application of reverse osmosis is in water purification, where it removes impurities from water by applying pressure to overcome osmotic pressure, allowing clean water to be obtained.

### Question 19.

An organic compound 'A' (molecular formula  $C_8H_8O$ ) gives 2,4-DNP test. It does not give Tollen's test, but gives a yellow precipitate 'B' with NaOH and  $I_2$ . On drastic oxidation, it gives a carboxylic acid 'C' with formula  $C_7H_6O_2$ . Identify 'A', 'B', 'C' and write the reactions involved.

[3 Marks]

**Answer:** The organic compound 'A' is likely to be phenylacetone ( $C_8H_8O$ ). It gives a positive 2,4-DNP test indicating the presence of a carbonyl group, and it does not give a Tollen's test, suggesting it is a ketone. The yellow precipitate 'B' formed with NaOH and  $I_2$  is iodoform, confirming the presence of a methyl ketone. Upon oxidation, it forms 'C', which is benzoic acid ( $C_7H_6O_2$ ). The reactions are as follows:

- For 2,4-DNP test:  
 $A + 2,4-DNP \rightarrow A-2,4-DNP$  (yellow precipitate)
- For iodoform reaction:  
 $A + I_2 + NaOH \rightarrow B$  (yellow precipitate)
- For oxidation:  
 $A + [O] \rightarrow C$  (benzoic acid)

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## Section D

**Question 20.** Carbohydrates are polyhydroxy aldehydes or ketones that represent enormous structural diversity in terms of the arrangement of atoms in space, resulting in hundreds of stereoisomers. Although the chemical properties of most stereoisomers may not be very different, their metabolic rate and utilization in biological systems is significantly different and known to influence the overall carbohydrate metabolism. Structural variants, which arise due to a different arrangement of atoms in three-dimensional space are known as stereoisomers. The number of stereoisomers can be theoretically estimated by using the formula  $2^n$ , where 'n' is the number of stereocenters or asymmetric (chiral) carbon atoms in a molecule. Out of these stereoisomers, there are some structures, which are mirror images of each other, and they are referred to as enantiomers.

## Question 21.

Carbohydrates are polyhydroxy aldehydes or ketones that represent enormous structural diversity in terms of the arrangement of atoms in space, resulting in hundreds of stereoisomers. Although the chemical properties of most stereoisomers may not be very different, their metabolic rate and utilization in biological systems is significantly different and known to influence the overall carbohydrate metabolism. Structural variants, which arise due to a different arrangement of atoms in three-dimensional space are known as stereoisomers. The number of stereoisomers can be theoretically estimated by using the formula  $2^n$ , where 'n' is the number of stereocenters or asymmetric (chiral) carbon atoms in a molecule. Out of these stereoisomers, there are some structures, which are mirror images of each other, and they are referred to as enantiomers.

Answer the following questions :

(1)

Give chemical reactions to show the presence of an aldehydic group and straight chain in glucose.

[2 Marks]

**Answer:** Glucose contains an aldehydic group, which can be demonstrated by its reaction with Tollens' reagent ( $\text{AgNO}_3 + \text{NH}_3$ ) resulting in the formation of a silver mirror. The straight-chain form of glucose can be represented by its structural formula:  $\text{C}_6\text{H}_{12}\text{O}_6$ , where the  $-\text{CHO}$  group indicates the aldehyde functional group. The presence of the straight chain is confirmed in its open chain form, which has the structure  $\text{HOCH}_2-(\text{CHOH})_4-\text{CHO}$ .

**Key Points:** Presence of aldehyde group shown by reaction with Tollens' reagent - Structural formula of glucose confirms straight chain - Reaction indicating glucose's aldehydic nature

(2)

Draw the structure of  $\beta$ -D-Glucopyranose.

[1 Marks]

**Answer:** The structure of  $\beta$ -D-Glucopyranose is represented as a six-membered ring where the oxygen atom is part of the ring. The carbon atoms are numbered from 1 to 6, with the hydroxyl (OH) group attached to the first carbon (C1) in equatorial position, indicating the beta form. The structure can be depicted in a Haworth projection, as

shown below:  
O[C@H]1[C@@H](O)[C@H](O)[C@@H](O)CO1  
This structure illustrates the glucopyranose form of glucose.

**Key Points: Cyclic structure; six-membered ring; beta anomer; Haworth representation; hydroxyl group position**

(3)

Define anomers.

[1 Marks]

**Answer:** Anomers are a specific type of stereoisomer found in carbohydrates that differ in configuration around the anomeric carbon atom, which is the carbon atom that is derived from the carbonyl carbon during the formation of a cyclic structure. They can exist as alpha ( $\alpha$ ) or beta ( $\beta$ ) forms, depending on the orientation of the hydroxyl group attached to the anomeric carbon.

**Key Points: Type of stereoisomerism- differ around anomeric carbon- exist as alpha or beta forms**

(4)

Sucrose is known as invert sugar. Explain.

[1 Marks]

**Answer:** Sucrose is known as invert sugar because it can be hydrolyzed into its constituent monosaccharides, glucose and fructose, which optically rotate light in opposite directions. This inversion of optical activity occurs due to the formation of these two different enantiomers from the non-reducing sugar sucrose during hydrolysis.

**Key Points: Sucrose as invert sugar-hydrolyzed into glucose and fructose- opposite optical rotation**

## Question 22.

Werner's coordination theory in 1893 was the first attempt to explain the bonding in coordination complexes. It must be remembered that this theory was put forward before the electron had been discovered by J.J. Thomson in 1897, and before the electronic theory of valency. Werner did not have any of the modern instrumental techniques and all his studies were made using simple experimental techniques. Werner was able to explain the nature of bonding in complexes and he concluded that in complexes, the metal shows two different sorts of valency : primary and secondary. Primary valences are normally ionisable whereas secondary valences are non ionisable.

Answer the following questions :

(1)

One mole of  $\text{CrCl}_3 \cdot 4\text{H}_2\text{O}$  precipitates one mole of  $\text{AgCl}$  when treated with excess of  $\text{AgNO}_3$  solution. Write (i) the structural formula of the complex, and (ii) the secondary valency of Cr.

[2 Marks]

**Answer:** (i) The structural formula of the complex is  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$ . (ii) The secondary valency of Cr in this complex is 6, as it is satisfied by four water molecules and two chloride ions.

**Key Points:** The structural formula is  $[\text{Cr}(\text{H}_2\text{O})_4\text{Cl}_2]\text{Cl}$ —primary valence is 3—non ionisable secondary valence is 6

(2)

What is the difference between a complex and a double salt ?

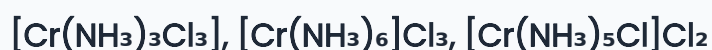
[1 Marks]

**Answer:** A complex consists of a central metal atom bonded to surrounding ligands, which can be ions or molecules, forming coordination compounds. In contrast, a double salt is a compound formed by the combination of two different salts that crystallize together, but do not have a coordination complex structure.

**Key Points:** Complex involves a central metal atom and ligands-Double salt is formed by two salts crystallizing together-Complexes have coordination bonds while double salts do not

(3)

Arrange the following complexes in the increasing order of conductivity of their solution :



[1 Marks]

**Answer:**  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3 < [\text{Cr}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2 < [\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$ . This order is based on the ionization of the complexes in solution, where  $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$  has the least number of ions since it only dissociates into Cr(III) and 3  $\text{Cl}^-$ , making it the weakest conductor.  $[\text{Cr}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$  dissociates into Cr(III), 2  $\text{Cl}^-$  ions, and an additional  $\text{Cl}^-$  in solution, which increases its conductivity. Finally,  $[\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$  dissociates into Cr(III) and 3  $\text{Cl}^-$  ions, providing the highest conductivity among them.

**Key Points:** Conductivity depends on the number of ions produced in solution-Primary valence associated with  $\text{Cl}^-$  ions-Degree of ionization of complexes

(4)

Write two differences between primary and secondary valences in coordination compounds.

[1 Marks]

**Answer:** Primary valences in coordination compounds are ionisable and are satisfied by negative ions, while secondary valences are non-ionisable and are typically satisfied by neutral molecules or negative ions.

**Key Points:** Primary valences are ionisable; Primary valences are satisfied by negative ions; Secondary valences are non-ionisable; Secondary valences are satisfied by neutral molecules or negative ions