



CLASS 12 · CBSE CHEMISTRY (043)

Chemistry Solved Board Papers

Chapter-wise and year-wise CBSE board questions with complete step-by-step solutions

10 years · 2016–2026

- ✓ Part A: every question sorted chapter-wise, grouped by marks, with full solutions
- ✓ Part B: 17 complete board papers, each followed by its solutions
- ✓ Board weightage table and most-asked topics for every chapter
- ✓ Numericals, reactions, mechanisms and name reactions written the way the board awards marks
- ✓ Only the current syllabus: questions on deleted chapters are flagged

notesbazar.in

WHAT YOU GET

10 years of CBSE Chemistry papers. Every question solved. Sorted chapter-wise.

17

board papers

503

solved questions

10

years · 2016–26

10

chapters

0

diagrams

X Questions scattered across years



✓ All in one place, chapter-wise

X Don't know what to study first



✓ Weightage + most-asked topics

X One-line answers online



✓ Full solutions, board-style

X Old books carry deleted topics



✓ Only the 2026-27 syllabus

PART A**Chapter-wise****A**

- ✓ Weightage table
- ✓ Most-asked topics
- ✓ Every question + solution

PART B**Full papers****B**

- ✓ Exactly as set by CBSE
- ✓ Solutions after each paper
- ✓ Timed 3-hour practice

2026 · 56/1/1

2026 · 56/2/1

2025 · 56/1/1

2025 · 56/2/1

2024 · 56/1/1

2024 · 56/2/1

2023 · 56/1/1

2023 · 56/2/1

2022 · 56/1/1

2022 · 56/2/1

2020 · 56/1/1

2020 · 56/2/1

2019 · 56/1/1

2019 · 56/2/1

2018 · 56/1

2017 · 56/1

2016 · 56/1


Complete Notes · Solved PYQs

CLASS 6–12 · ALL SUBJECTS

100%
QUESTIONS
SOLVED
Made for board toppers

How to use this book

Part A puts every board question of a chapter together, from 1-mark MCQs to 5-mark long answers. Finish a chapter in your notes, then solve its Part A questions without looking at the solutions. Check your answer, mark the ones you got wrong, and repeat them a week later.

Each question shows where it was asked, for example **CBSE 2026 · 56/1/1 · Q13**. Use the weightage table and the most-asked topics chart at the start of each chapter to decide what to revise first.

Part B gives full papers. In the last month before the exam, sit with a clock and write one paper in 3 hours, then check it with the solutions that follow the paper.

Solutions are written the way the board awards marks: balanced equations, formulas and units in numericals, and the reagent and product named in every conversion. Write your answers the same way.

Contents

Part A · Chapter-wise questions with solutions

- | | |
|--------------------------------------|--|
| 1. Solutions 46 Qs | 6. Haloalkanes and Haloarenes 45 Qs |
| 2. Electrochemistry 56 Qs | 7. Alcohols, Phenols and Ethers 47 Qs |
| 3. Chemical Kinetics 56 Qs | 8. Aldehydes, Ketones and Carboxylic Acids 54 Qs |
| 4. The d- and f-Block Elements 51 Qs | 9. Amines 44 Qs |
| 5. Coordination Compounds 51 Qs | 10. Biomolecules 53 Qs |

Part B · Full board papers, each followed by its solutions

- | | |
|---------------------------------|----------------------------------|
| 1. CBSE 2026 · 56/1/1 solutions | 9. CBSE 2022 · 56/1/1 solutions |
| 2. CBSE 2026 · 56/2/1 solutions | 10. CBSE 2022 · 56/2/1 solutions |
| 3. CBSE 2025 · 56/1/1 solutions | 11. CBSE 2020 · 56/1/1 solutions |
| 4. CBSE 2025 · 56/2/1 solutions | 12. CBSE 2020 · 56/2/1 solutions |
| 5. CBSE 2024 · 56/1/1 solutions | 13. CBSE 2019 · 56/1/1 solutions |
| 6. CBSE 2024 · 56/2/1 solutions | 14. CBSE 2019 · 56/2/1 solutions |
| 7. CBSE 2023 · 56/1/1 solutions | 15. CBSE 2018 · 56/1 solutions |
| 8. CBSE 2023 · 56/2/1 solutions | 16. CBSE 2017 · 56/1 solutions |
| | 17. CBSE 2016 · 56/1 solutions |

503 questions in all. Questions are taken from the CBSE Class 12 Chemistry board papers and the solutions are our own, checked against the official marking schemes. Questions on chapters deleted from the current syllabus (solid state, surface chemistry, metallurgy, p-block elements, polymers, chemistry in everyday life) are left out of Part A and marked in Part B.

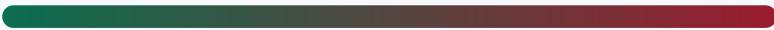
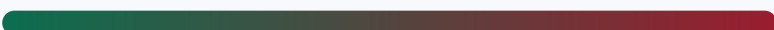
CHAPTER 1

Solutions

Board weightage 2016–2026

Year	2016	2017	2018	2019	2020	2022	2023	2024	2025	2026
Questions	2	2	2	4	7	–	8	8	7	6
Marks	5	10	5	10	14	–	14	19	16	14

Most asked topics

Lowest freezing point		1
Azeotropes (A–R)		1
Phenol–aniline mixture		1
Boiling point with dimerisation		1
Molar mass from elevation in boiling point		1
Osmosis and osmotic pressure (case)		1
Abnormal molar mass on association		1
Mango in salt solution		1

46 questions from 15 papers. Repeated questions are shown once with every year they were asked.

1 mark: MCQ and Assertion–Reason

CBSE 2026 · 56/1/1 · Q2

1 mark

Which of the following solutions will have the lowest freezing point in water?

- (A) 0.1 M Glucose (B) 0.1 M CaCl_2
(C) 0.1 M KCl (D) 0.1 M Urea

Solution

Answer: (B) 0.1 M CaCl_2

$\Delta T_f = iK_f m$. At the same molality, CaCl_2 gives 3 ions ($i = 3$), KCl gives 2 and glucose and urea do not dissociate ($i = 1$). The largest depression, hence the lowest freezing point, is for CaCl_2 .

CBSE 2026 · 56/1/1 · Q13

1 mark

Assertion (A): It is not possible to separate the components of an azeotrope by fractional distillation.

Reason (R): Components of an azeotrope have the same composition in liquid and vapour phase and boil at a constant temperature.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Solution

Answer: (A) Both A and R are true and R is the correct explanation of A.

Since the vapour has the same composition as the liquid, distillation cannot change the composition.

CBSE 2025 · 56/1/1 · Q1

1 mark

In case of association, abnormal molar mass of solute will

- (A) increase (B) decrease
(C) remain same (D) first increase and then decrease

Solution**Answer: (A) increase**

On association the number of solute particles falls ($i < 1$), so the colligative property is smaller than expected. Since molar mass is inversely proportional to the colligative property, the calculated (abnormal) molar mass is higher than the true value.

CBSE 2025 · 56/1/1 · Q12

1 mark

An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because ____.

- (A) it gains water due to osmosis (B) it loses water due to reverse osmosis
(C) it gains water due to reverse osmosis (D) it loses water due to osmosis

Solution**Answer: (D) it loses water due to osmosis**

The salt solution is hypertonic; water flows out of the mango cells into the solution through the cell membranes (exosmosis), so it shrivels.

CBSE 2024 · 56/1/1 · Q4

1 mark

For an electrolyte undergoing association in a solvent, the van't Hoff factor :

- (A) is always greater than one (B) has negative value
(C) has zero value (D) is always less than one

Solution**Answer: (D) is always less than one**

$i = \frac{\text{number of particles after association}}{\text{number before}}$. Association reduces the number of particles, so $i < 1$.

CBSE 2024 · 56/1/1 · Q13

1 mark

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

Reason (R) : NaCl undergoes dissociation in water.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Solution**Answer: (B)**

A is true: any non-volatile solute lowers the vapour pressure and hence the freezing point. R is also true ($i \approx 2$), but dissociation only makes the depression larger; it is not the reason why depression occurs.

CBSE 2024 · 56/2/1 · Q8

1 mark

An azeotropic solution of two liquids has boiling point lower than either of them when it :

- (A) is saturated (B) shows positive deviation from Raoult's law
(C) shows negative deviation from Raoult's law (D) shows no deviation from Raoult's law

Solution**Answer: (B)**

In positive deviation the vapour pressure is higher than expected, so at some composition the mixture boils below both components (minimum boiling azeotrope, e.g. 95% ethanol–water).

CBSE 2024 · 56/2/1 · Q9

1 mark

The relative lowering of vapour pressure of an aqueous solution containing non-volatile solute is 0.0225. The mole fraction of the non-volatile solute is :

- (A) 0.80 (B) 0.725
(C) 0.15 (D) 0.0225

Solution**Answer: (D) 0.0225**

Raoult's law: relative lowering of vapour pressure $\frac{p^\circ - p}{p^\circ} = x_{\text{solute}}$.

CBSE 2023 · 56/1/1 · Q1

1 mark

The colligative property used for the determination of molar mass of polymers and proteins is :

- (a) Osmotic pressure (b) Depression in freezing point
(c) Relative lowering in vapour pressure (d) Elevation in boiling point

Solution**Answer: (a) Osmotic pressure**

It is measured at room temperature (biomolecules are not damaged) and its value is large even for very dilute solutions of high molar mass solutes.

CBSE 2023 · 56/1/1 · Q2

1 mark

Low concentration of oxygen in the blood and tissues of people living at high altitude is due to :

- (a) high atmospheric pressure (b) low temperature
(c) low atmospheric pressure (d) both low temperature and high atmospheric pressure

Solution**Answer: (c) low atmospheric pressure**

By Henry's law, solubility of O_2 in blood is proportional to its partial pressure, which is low at high altitude (anoxia).

CBSE 2023 · 56/2/1 · Q7

1 mark

Value of Henry's constant K_H :

- (a) increases with decrease in temperature. (b) decreases with increase in temperature.
(c) increases with increase in temperature. (d) remains constant.

Solution**Answer: (c) increases with increase in temperature**

Solubility of gases falls as temperature rises; since $p = K_H x$, lower solubility (x) at the same pressure means a higher K_H .

CBSE 2023 · 56/2/1 · Q15

1 mark

Assertion (A) : Osmotic pressure is a colligative property.

Reason (R) : Osmotic pressure is proportional to the molality.

(A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Solution**Answer: (c)**

A is true. R is false: osmotic pressure is proportional to the molarity ($\pi = CRT$), not molality.

CBSE 2020 · 56/1/1 · Q6

1 mark

Identify which liquid will have a higher vapour pressure at 90°C if the boiling points of two liquids A and B are 140°C and 180°C, respectively.

Solution

Liquid A. The lower the boiling point, the weaker the intermolecular forces and the higher the vapour pressure at a given temperature.

CBSE 2020 · 56/2/1 · Q11

1 mark

50 mL of an aqueous solution of glucose $C_6H_{12}O_6$ (Molar mass : 180 g/mol) contains 6.02×10^{22} molecules. The concentration of the solution will be

- (A) 0.1 M (B) 0.2 M
(C) 1.0 M (D) 2.0 M

Solution**Answer: (D) 2.0 M**

$$\text{Moles} = \frac{6.02 \times 10^{22}}{6.02 \times 10^{23}} = 0.1 \text{ mol. Molarity} = \frac{0.1}{0.050 \text{ L}} = 2.0 \text{ M.}$$

2 marks: very short answer

CBSE 2026 · 56/1/1 · Q17

2 marks

What type of deviation from Raoult's law is shown by a mixture of phenol and aniline? Give reason. What will happen to the boiling point of the solution on mixing phenol and aniline?

Solution

Negative deviation. The hydrogen bonding between the phenolic –OH and the lone pair on the nitrogen of aniline (solute–solvent interaction) is stronger than the interactions in the pure components. So the vapour pressure is lower than expected by Raoult's law.

The boiling point of the solution **increases** (a maximum-boiling azeotrope can form).

CBSE 2025 · 56/1/1 · Q17(a)

2 marks

Give reasons : (a) Cooking is faster in pressure cooker than in an open pan. (b) On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution ? What change in temperature would you observe after mixing liquids X and Y ?

Solution

(a) Inside a pressure cooker the pressure is higher than 1 atm, so water boils at a higher temperature (above 100 °C). Food cooks faster at the higher temperature.

(b) A decrease in volume ($\Delta_{mix} V < 0$) means the X–Y attractions are stronger than X–X and Y–Y attractions: the solution shows **negative deviation** from Raoult's law. Heat is released ($\Delta_{mix} H < 0$), so the **temperature increases**.

CBSE 2025 · 56/1/1 · Q17(b)

2 marks

Define Azeotrope. What type of Azeotrope is formed by negative deviation from Raoult's law ? Give an example.

Solution

Azeotropes are binary mixtures that have the same composition in liquid and vapour phase and boil at a constant temperature, so they cannot be separated by fractional distillation.

Negative deviation gives a **maximum boiling azeotrope**. Example: nitric acid and water, about 68% HNO_3 and 32% water by mass (boils at 393.5 K).

CBSE 2024 · 56/2/1 · Q17

2 marks

A 6% solution of glucose (molar mass = 180 g mol^{-1}) is isotonic with 2.5% solution of an unknown organic substance. Calculate the molecular weight of the unknown organic substance.

Solution

Isotonic solutions have equal osmotic pressure, and at the same temperature equal molar concentrations ($\pi = CRT$).

$$\text{In 100 mL: glucose } \frac{6}{180} \text{ mol; unknown } \frac{2.5}{M} \text{ mol.}$$

$$\frac{6}{180} = \frac{2.5}{M}, \text{ so } M = \frac{2.5 \times 180}{6} = 75 \text{ g mol}^{-1}$$

CBSE 2023 · 56/1/1 · Q19

2 marks

What is Henry's law ? Give one application of it.

Solution

Henry's law: at a constant temperature, the solubility of a gas in a liquid is directly proportional to the partial pressure of the gas above the liquid. In terms of mole fraction: $p = K_H x$, where p is the partial pressure, x the mole fraction of the gas in solution and K_H Henry's constant.

Application (any one): soft-drink and soda-water bottles are sealed under high pressure to increase the solubility of CO_2 ; scuba divers use air diluted with helium to avoid "bends"; low partial pressure of O_2 at high altitude causes anoxia.

CBSE 2023 · 56/2/1 · Q19

2 marks

The vapour pressure of pure liquid X and pure liquid Y at 25°C are 120 mm Hg and 160 mm Hg respectively. If equal moles of X and Y are mixed to form an ideal solution, calculate the vapour pressure of the solution.

Solution

Equal moles: $x_X = x_Y = 0.5$

Raoult's law: $p_{\text{total}} = p_X^\circ x_X + p_Y^\circ x_Y = 120 \times 0.5 + 160 \times 0.5$

$p_{\text{total}} = 60 + 80 = \mathbf{140 \text{ mm Hg}}$

CBSE 2020 · 56/1/1 · Q22(a)

2 marks

For a 5% solution of urea (Molar mass = 60 g/mol), calculate the osmotic pressure at 300 K. [$R = 0.0821 \text{ L atm K}^{-1} \text{ mol}^{-1}$]

Solution

5% solution: 5 g urea in 100 mL (0.1 L) of solution.

$$n = \frac{5}{60} = 0.0833 \text{ mol}; C = \frac{0.0833}{0.1} = 0.833 \text{ mol L}^{-1}$$

$$\pi = CRT = 0.833 \times 0.0821 \times 300 = \mathbf{20.5 \text{ atm}}$$

CBSE 2020 · 56/1/1 · Q22(b)

2 marks

Visha took two aqueous solutions — one containing 7.5 g of urea (Molar mass = 60 g/mol) and the other containing 42.75 g of substance Z in 100 g of water, respectively. It was observed that both the solutions froze at the same temperature. Calculate the molar mass of Z.

Solution

Same freezing point means equal $\Delta T_f = K_f m$, so equal molalities (both non-electrolytes, same solvent mass).

$$\frac{7.5/60}{0.1} = \frac{42.75/M_Z}{0.1}, \text{ so } \frac{7.5}{60} = \frac{42.75}{M_Z}$$

$$M_Z = \frac{42.75 \times 60}{7.5} = \mathbf{342 \text{ g mol}^{-1}}$$

CBSE 2020 · 56/2/1 · Q27

2 marks

Predict the state of the solute in the solution in the following situations : (a) When 'i' is found to be more than one. (b) When 'i' is found to be less than one.

Solution

(a) $i > 1$: the solute is **dissociated** into ions (e.g. KCl, $i \approx 2$).

(b) $i < 1$: the solute is **associated** (e.g. ethanoic acid dimerises in benzene, $i \approx 0.5$).

CBSE 2019 · 56/1/1 · Q7

2 marks

State Raoult's law for a solution containing volatile components. Write two characteristics of the solution which obeys Raoult's law at all concentrations.

Solution

Raoult's law: for a solution of volatile liquids, the partial vapour pressure of each component is directly proportional to its mole fraction in the solution: $p_A = p_A^\circ x_A$, $p_B = p_B^\circ x_B$.

A solution obeying it at all concentrations is an **ideal solution**: (i) $\Delta_{mix}H = 0$; (ii) $\Delta_{mix}V = 0$; (the A-B attractions are nearly the same as A-A and B-B attractions).

CBSE 2019 · 56/2/1 · Q7

2 marks

Give reasons : (a) Cooking is faster in pressure cooker than in cooking pan. (b) Red Blood Cells (RBC) shrink when placed in saline water but swell in distilled water.

Solution

(a) The pressure inside the cooker is high, so water boils at a higher temperature; food cooks faster at the higher temperature.

(b) Saline water is hypertonic: water flows out of the RBCs by osmosis, so they shrink. Distilled water is hypotonic: water flows into the cells, so they swell (and may burst).

CBSE 2018 · 56/1 · Q6

2 marks

Calculate the freezing point of a solution containing 60 g of glucose (Molar mass = 180 g mol^{-1}) in 250 g of water. (K_f of water = $1.86 \text{ K kg mol}^{-1}$)

Solution

$$\Delta T_f = K_f \times \frac{w_2 \times 1000}{M_2 \times w_1} = 1.86 \times \frac{60 \times 1000}{180 \times 250} = 1.86 \times 1.333 = 2.48 \text{ K}$$

$$\text{Freezing point} = 273.15 - 2.48 = \mathbf{270.67 \text{ K}} \text{ } (-2.48^\circ\text{C})$$

CBSE 2016 · 56/1 · Q6

2 marks

(i) Write the colligative property which is used to find the molecular mass of macromolecules. (ii) In non-ideal solution, what type of deviation shows the formation of minimum boiling azeotropes ?

Solution

(i) **Osmotic pressure** (large even for dilute solutions; measured at room temperature).

(ii) **Positive deviation** from Raoult's law (e.g. about 95% ethanol–water).

3 marks: short answer

CBSE 2026 · 56/1/1 · Q24

3 marks

Calculate the boiling point of a solution containing 0.61 g of benzoic acid (Molar mass = 122 g mol^{-1}) in 5 g of CS_2 in which it dimerises to the extent of 88%. The boiling point and K_b of CS_2 are 46.2°C and $2.3 \text{ K kg mol}^{-1}$ respectively.

Solution

$$\text{Dimerisation } 2 \text{ A} \rightleftharpoons \text{A}_2 \text{ with degree } \alpha = 0.88: i = 1 - \frac{\alpha}{2} = 1 - 0.44 = 0.56.$$

$$\text{Molality } m = \frac{0.61/122}{5/1000} = \frac{0.005}{0.005} = 1 \text{ mol kg}^{-1}.$$

$$\Delta T_b = iK_b m = 0.56 \times 2.3 \times 1 = 1.288 \text{ K}$$

$$\text{Boiling point} = 46.2 + 1.29 \approx \mathbf{47.49^\circ \text{C}}.$$

CBSE 2026 · 56/2/1 · Q22

3 marks

When 1.5 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point of benzene got raised from 353.23 K to 353.93 K. Calculate the molar mass of the solute. (Given K_b for benzene = 2.52 K kg mol⁻¹)

Solution

$$\Delta T_b = 353.93 - 353.23 = 0.70 \text{ K}$$

$$M_2 = \frac{K_b \times w_2 \times 1000}{\Delta T_b \times w_1} = \frac{2.52 \times 1.5 \times 1000}{0.70 \times 90}$$

$$M_2 = \frac{3780}{63} = \mathbf{60 \text{ g mol}^{-1}}$$

CBSE 2025 · 56/1/1 · Q22

3 marks

A solution of glucose (molar mass = 180 g mol⁻¹) in water has a boiling point of 100.20 °C. Calculate the freezing point of the same solution. Molal constants for water K_f and K_b are 1.86 K kg mol⁻¹ and 0.512 K kg mol⁻¹ respectively.

Solution

$$\Delta T_b = 100.20 - 100 = 0.20 \text{ K}$$

$$\Delta T_b = K_b m, \text{ so } m = \frac{0.20}{0.512} = 0.390 \text{ mol kg}^{-1}$$

$$\Delta T_f = K_f m = 1.86 \times 0.390 = 0.726 \text{ K}$$

$$(\text{Shortcut: } \frac{\Delta T_f}{\Delta T_b} = \frac{K_f}{K_b}, \text{ so } \Delta T_f = 0.20 \times \frac{1.86}{0.512} = 0.726 \text{ K.})$$

$$\text{Freezing point} = 0 - 0.726 = \mathbf{-0.726^\circ \text{C}} \text{ (about 272.42 K)}$$

CBSE 2025 · 56/2/1 · Q22

3 marks

At 25 °C the saturated vapour pressure of water is 24 mm Hg. Find the saturated vapour pressure of a 5% aqueous solution of urea at the same temperature. (Molar mass of urea = 60 g mol⁻¹)

Solution

5% (by mass) urea: 5 g urea in 100 g solution, i.e. in 95 g water.

$$n_2 = \frac{5}{60} = 0.0833 \text{ mol}; n_1 = \frac{95}{18} = 5.278 \text{ mol}$$

$$\text{Raoult's law: } \frac{p^\circ - p}{p^\circ} = x_2 = \frac{n_2}{n_1 + n_2} = \frac{0.0833}{5.361} = 0.01554$$

$$p = p^\circ (1 - x_2) = 24 \times (1 - 0.01554) = 24 \times 0.98446$$

$$p = \mathbf{23.63 \text{ mm Hg}} \text{ (the marking scheme gives } \approx 23.64 \text{ mm Hg)}$$

CBSE 2024 · 56/2/1 · Q26

3 marks

The vapour pressure of a solvent at 283 K is 100 mm Hg. Calculate the vapour pressure of a dilute solution containing 1 mole of a strong electrolyte AB in 50 moles of the solvent at 283 K (assuming complete dissociation of solute AB).

Solution

$AB \longrightarrow A^+ + B^-$: complete dissociation gives $i = 2$.

For a dilute solution: $\frac{p^\circ - p_s}{p^\circ} = i \frac{n_2}{n_1} = 2 \times \frac{1}{50} = 0.04$

$$100 - p_s = 0.04 \times 100 = 4$$

$$p_s = \mathbf{96 \text{ mm Hg}}$$

CBSE 2023 · 56/1/1 · Q26

3 marks

(a) Differentiate between Ideal solution and Non-ideal solution. (b) 30 g of urea is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23.8 mm Hg.

Solution

(a) An **ideal solution** obeys Raoult's law at all concentrations; $\Delta_{mix}H = 0$ and $\Delta_{mix}V = 0$ (A-B interactions equal to A-A and B-B). A **non-ideal solution** does not obey Raoult's law; $\Delta_{mix}H \neq 0$ and $\Delta_{mix}V \neq 0$ (shows positive or negative deviation).

(b) Urea NH_2CONH_2 , $M = 60 \text{ g mol}^{-1}$; $n_2 = \frac{30}{60} = 0.5 \text{ mol}$; water $n_1 = \frac{846}{18} = 47 \text{ mol}$

$$x_{water} = \frac{47}{47 + 0.5} = \frac{47}{47.5}$$

$$p = x_{water} p^\circ = \frac{47}{47.5} \times 23.8 = \mathbf{23.55 \text{ mm Hg}} (\approx 23.5 \text{ mm Hg})$$

CBSE 2023 · 56/2/1 · Q29

3 marks

When 19.5 g of $F-CH_2-COOH$ (Molar mass = 78 g mol^{-1}), is dissolved in 500 g of water, the depression in freezing point is observed to be 1°C . Calculate the degree of dissociation of $F-CH_2-COOH$. [Given : K_f for water = $1.86 \text{ K kg mol}^{-1}$]

Solution

$$\text{Molality } m = \frac{19.5/78}{0.500} = \frac{0.25}{0.5} = 0.5 \text{ mol kg}^{-1}$$

$$\Delta T_f = i K_f m: 1 = i \times 1.86 \times 0.5, \text{ so } i = \frac{1}{0.93} = 1.075$$

$$FCH_2COOH \rightleftharpoons FCH_2COO^- + H^+ (n = 2): \alpha = \frac{i - 1}{n - 1} = \frac{1.075 - 1}{2 - 1} = \mathbf{0.075} (7.5\%)$$

CBSE 2020 · 56/1/1 · Q34

3 marks

Calculate the mass of ascorbic acid (Molar mass = 176 g mol^{-1}) to be dissolved in 75 g of acetic acid, to lower its freezing point by 1.5°C . ($K_f = 3.9 \text{ K kg mol}^{-1}$)

Solution

$$\Delta T_f = K_f \times \frac{w_2 \times 1000}{M_2 \times w_1}$$

$$1.5 = 3.9 \times \frac{w_2 \times 1000}{176 \times 75}$$

$$w_2 = \frac{1.5 \times 176 \times 75}{3.9 \times 1000} = \frac{19800}{3900} = \mathbf{5.08 \text{ g}}$$

CBSE 2020 · 56/2/1 · Q34

3 marks

An antifreeze solution is prepared by dissolving 31 g of ethylene glycol (Molar mass = 62 g mol⁻¹) in 600 g of water. Calculate the freezing point of the solution. (K_f for water = 1.86 K kg mol⁻¹)

Solution

$$m = \frac{31/62}{0.600} = \frac{0.5}{0.6} = 0.833 \text{ mol kg}^{-1}$$

$$\Delta T_f = K_f m = 1.86 \times 0.833 = 1.55 \text{ K}$$

$$\text{Freezing point} = 273.15 - 1.55 = \mathbf{271.6 \text{ K}} (-1.55^\circ \text{C})$$

CBSE 2019 · 56/1/1 · Q16

3 marks

A 4% solution (w/w) of sucrose (M = 342 g mol⁻¹) in water has a freezing point of 271.15 K. Calculate the freezing point of 5% glucose (M = 180 g mol⁻¹) in water. (Given : Freezing point of pure water = 273.15 K)

Solution

Sucrose: 4 g in 96 g water; $\Delta T_f = 273.15 - 271.15 = 2 \text{ K}$

$$K_f = \frac{\Delta T_f \times M_2 \times w_1}{w_2 \times 1000} = \frac{2 \times 342 \times 96}{4 \times 1000} = 16.4 \text{ K kg mol}^{-1}$$

$$\text{Glucose: 5 g in 95 g water: } \Delta T_f = \frac{K_f \times w_2 \times 1000}{M_2 \times w_1} = \frac{16.4 \times 5 \times 1000}{180 \times 95} = 4.8 \text{ K}$$

$$\text{Freezing point} = 273.15 - 4.8 = \mathbf{268.35 \text{ K}}$$

CBSE 2019 · 56/2/1 · Q16

3 marks

A solution containing 1.9 g per 100 mL of KCl (M = 74.5 g mol⁻¹) is isotonic with a solution containing 3 g per 100 mL of urea (M = 60 g mol⁻¹). Calculate the degree of dissociation of KCl solution. Assume that both the solutions have same temperature.

Solution

Isotonic: $\pi_{\text{urea}} = \pi_{\text{KCl}}$, so $C_{\text{urea}} RT = i C_{\text{KCl}} RT$ (same volume).

$$\frac{3}{60} = i \times \frac{1.9}{74.5}, \text{ so } 0.05 = i \times 0.0255, i = 1.96$$

$$\text{KCl} \longrightarrow \text{K}^+ + \text{Cl}^- \text{ (n = 2): } \alpha = \frac{i - 1}{n - 1} = \frac{1.96 - 1}{1} = \mathbf{0.96 \text{ (96\%)}}$$

CBSE 2018 · 56/1 · Q11

3 marks

Give reasons for the following : (a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers. (b) Aquatic animals are more comfortable in cold water than in warm water. (c) Elevation of boiling point of 1 M KCl solution is nearly double than that of 1 M sugar solution.

Solution

(a) Osmotic pressure is large even for very dilute solutions, and it is measured at room temperature (macromolecules are unstable at higher temperatures and polymers have poor solubility); molarity is

used instead of molality.

(b) The solubility of oxygen in water is greater at low temperature (Henry's constant K_H increases with temperature), so cold water holds more dissolved oxygen.

(c) KCl dissociates into K^+ and Cl^- ($i \approx 2$), so it gives nearly twice the number of particles as sugar ($i = 1$); $\Delta T_b = iK_b m$ is nearly doubled.

CBSE 2016 · 56/1 · Q15

3 marks

Calculate the boiling point of solution when 2 g of Na_2SO_4 ($M = 142 \text{ g mol}^{-1}$) was dissolved in 50 g of water, assuming Na_2SO_4 undergoes complete ionization. (K_b for water = $0.52 \text{ K kg mol}^{-1}$)

Solution



$$m = \frac{2/142}{0.050} = 0.2817 \text{ mol kg}^{-1}$$

$$\Delta T_b = iK_b m = 3 \times 0.52 \times 0.2817 = 0.44 \text{ K}$$

$$\text{Boiling point} = 373.15 + 0.44 = \mathbf{373.59 \text{ K}} \text{ (373.44 K taking 373 K)}$$

4 marks: case-based / source-based

CBSE 2026 · 56/2/1 · Q29

4 marks

Osmosis is a process by which the molecules of a solvent pass from a solution of low solute concentration to a solution of high solute concentration through a semi-permeable membrane. Osmotic pressure is a colligative property. When the applied pressure on a solution exceeds its osmotic pressure, reverse osmosis occurs. When two solutions are separated by a semipermeable membrane and they have same osmotic pressure they are said to be isotonic. Of the two solutions separated by a semipermeable membrane, if one is a lower osmotic pressure, it is said to be hypotonic relative to the second solution. If it has a higher osmotic pressure, than the second solution, it is said to be hypertonic relative to the second solution. The osmotic pressure associated with the fluid inside the blood cell is equivalent to that of 0.9% (mass/volume) sodium chloride solution called normal saline solution and it is safe to inject intravenously. Osmotic pressure is vital in daily life and nature. It helps in explain, why IV fluids match blood's osmotic pressure, its also the principle behind food preservation using salt or sugar.

(a) Calculate the amount of $CaCl_2$ ($i = 2.59$) dissolved in 2.46 litre of water such that its osmotic pressure is 0.70 atm at 27°C . [Given : $R = 0.082 \text{ L atm K}^{-1} \text{ mol}^{-1}$, molar mass of $CaCl_2 = 111 \text{ g mol}^{-1}$] (2)

(b) When raisins are kept in water, they get swollen. Name the phenomenon involved in this process. (1)
OR

(b) Why osmotic pressure is more advantageous than other colligative properties ? (1)

(c) Which phenomenon is responsible for desalination of sea water ? (1)

Solution

$$(a) \pi = iCRT = i \frac{n}{V} RT, \text{ so } n = \frac{\pi V}{iRT}; T = 27 + 273 = 300 \text{ K.}$$

$$n = \frac{0.70 \times 2.46}{2.59 \times 0.082 \times 300} = \frac{1.722}{63.71} = 0.0270 \text{ mol}$$

$$\text{Mass of } CaCl_2 = 0.0270 \times 111 = \mathbf{3.0 \text{ g}} \text{ (about 3 g)}$$

(b) **Osmosis** (endosmosis): water enters the raisins through the skin, which acts as a semipermeable membrane.

OR (b) Osmotic pressure is measured at room temperature and its magnitude is large even for dilute solutions, so it is used for molar masses of biomolecules and polymers, which are unstable at high

temperature and have poor solubility.

(c) **Reverse osmosis:** a pressure larger than the osmotic pressure is applied on sea water, so pure water is pushed out through the semipermeable membrane.

CBSE 2025 · 56/2/1 · Q29

4 marks

The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable. The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.

- (a) Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis. (2)
 (b) (i) What do you expect to happen when red blood corpuscles (RBC's) are placed in 0.5% NaCl solution ? (1)
 OR
 (b) (ii) Which one of the following will have higher osmotic pressure in 1 M KCl or 1 M urea solution. Justify your answer. (1)
 (c) Why osmotic pressure is a colligative property ? (1)

Solution

- (a) **Reverse osmosis:** when a pressure larger than the osmotic pressure is applied on the solution side, the solvent flows from the solution to the pure solvent through the semipermeable membrane, i.e. the direction of osmosis is reversed. SPM: **cellulose acetate** film.
 (b) (i) 0.5% NaCl is hypotonic compared with blood cell fluid (0.9%). Water enters the RBCs by osmosis (endosmosis); they **swell and may burst**.
 OR (b) (ii) **1 M KCl**. $\pi = iCRT$; KCl dissociates into K^+ and Cl^- ($i \approx 2$) while urea does not dissociate ($i = 1$). At equal concentration, KCl gives about twice the number of particles.
 (c) Osmotic pressure depends only on the number of solute particles in a given volume of solution ($\pi = CRT$), not on the nature of the solute; that is the definition of a colligative property.

5 marks: long answer

CBSE 2024 · 56/1/1 · Q31(a)

5 marks

- (i) At the same temperature, CO_2 gas is more soluble in water than O_2 gas. Which one of them will have higher value of K_H and why ? (ii) How does the size of blood cells change when placed in an aqueous solution containing more than 0.9% (mass/volume) sodium chloride ? (iii) 1 molal aqueous solution of an electrolyte A_2B_3 is 60% ionized. Calculate the boiling point of the solution. (Given : K_b for $H_2O = 0.52 \text{ K kg mol}^{-1}$)

Solution

- (i) O_2 . By Henry's law $p = K_H x$; at a given pressure, the higher the K_H , the lower the solubility. O_2 is less soluble, so its K_H is higher.
 (ii) The solution is hypertonic; water flows out of the cells (exosmosis), so the blood cells **shrink**.
 (iii) $A_2B_3 \longrightarrow 2 A^{3+} + 3 B^{2-}$; $n = 5$ ions. $i = 1 + (n - 1)\alpha = 1 + 4 \times 0.6 = 3.4$

$$\Delta T_b = iK_b m = 3.4 \times 0.52 \times 1 = 1.768 \text{ K}$$

Boiling point = $373 + 1.768 = 374.768 \text{ K}$ (374.918 K if water boils at 373.15 K)

CBSE 2024 · 56/1/1 · Q31(b)

5 marks

(i) The vapour pressures of A and B at 25°C are 75 mm Hg and 25 mm Hg, respectively. If A and B are mixed such that the mole fraction of A in the mixture is 0.4, then calculate the mole fraction of B in vapour phase. (ii) Define colligative property. Which colligative property is preferred for the molar mass determination of macromolecules? (iii) Why are equimolar solutions of sodium chloride and glucose not isotonic?

Solution

(i) $x_A = 0.4, x_B = 0.6$

$p_A = 75 \times 0.4 = 30 \text{ mm Hg}; p_B = 25 \times 0.6 = 15 \text{ mm Hg}; p_{\text{total}} = 45 \text{ mm Hg}$

Mole fraction of B in vapour: $y_B = \frac{p_B}{p_{\text{total}}} = \frac{15}{45} = 0.33$

(ii) A **colligative property** depends only on the number of solute particles in a given amount of solution, not on their nature. **Osmotic pressure** is preferred for macromolecules (measured at room temperature; large even for dilute solutions).

(iii) NaCl dissociates into Na^+ and Cl^- ($i \approx 2$) while glucose does not ($i = 1$). Since $\pi = iCRT$, the NaCl solution has about twice the osmotic pressure, so they are not isotonic.

CBSE 2017 · 56/1 · Q25(a)

5 marks

(a) A 10% solution (by mass) of sucrose in water has a freezing point of 269.15 K. Calculate the freezing point of 10% glucose in water if the freezing point of pure water is 273.15 K. (Molar mass of sucrose = 342 g mol^{-1} , glucose = 180 g mol^{-1}) (b) Define the following terms: (i) Molality (m) (ii) Abnormal molar mass

Solution

(a) Both solutions: 10 g solute in 90 g water. $\Delta T_f(\text{sucrose}) = 273.15 - 269.15 = 4 \text{ K}$.

$$m_{\text{sucrose}} = \frac{10/342}{0.090} = 0.325 \text{ mol kg}^{-1}, \text{ so } K_f = \frac{4}{0.325} = 12.3 \text{ K kg mol}^{-1}$$

$$m_{\text{glucose}} = \frac{10/180}{0.090} = 0.617 \text{ mol kg}^{-1}; \Delta T_f = 12.3 \times 0.617 = 7.6 \text{ K}$$

(Equivalently $\Delta T_f \propto 1/M$: $4 \times \frac{342}{180} = 7.6 \text{ K}$.)

Freezing point of glucose solution = $273.15 - 7.6 = 265.55 \text{ K}$

(b) (i) **Molality**: number of moles of solute per kilogram of solvent (mol kg^{-1}).

(ii) **Abnormal molar mass**: a molar mass, found from a colligative property, that differs from the true value because the solute associates or dissociates in solution.

CBSE 2017 · 56/1 · Q25(b)

5 marks

(a) 30 g of urea ($M = 60 \text{ g mol}^{-1}$) is dissolved in 846 g of water. Calculate the vapour pressure of water for this solution if vapour pressure of pure water at 298 K is 23.8 mm Hg. (b) Write two differences between ideal solutions and non-ideal solutions.

Solution

(a) $n_2 = \frac{30}{60} = 0.5 \text{ mol}; n_1 = \frac{846}{18} = 47 \text{ mol}$

$$p = p^{\circ} \times x_{\text{water}} = 23.8 \times \frac{47}{47.5} = \mathbf{23.55 \text{ mm Hg}}$$

(b) (i) Ideal solutions obey Raoult's law at all concentrations; non-ideal solutions do not. (ii) For ideal solutions $\Delta_{\text{mix}}H = 0$ and $\Delta_{\text{mix}}V = 0$; for non-ideal solutions they are not zero (heat is absorbed or evolved, volume changes).

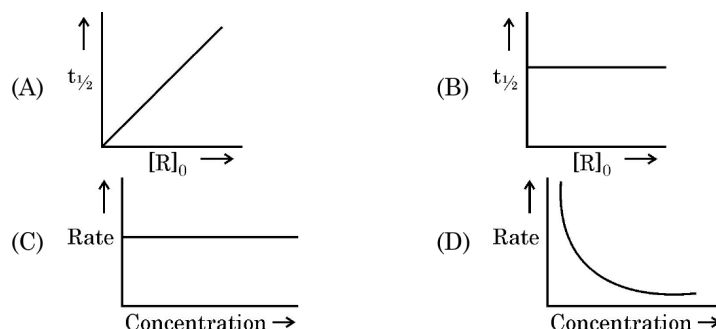
CBSE BOARD PAPER

2026 · Q.P. Code 56111

Time: 3 hours
Maximum marks: 70

Section A · Multiple choice and Assertion–Reason (1 mark each)

1. Which of the following curve represents the first order reaction?



2. Which of the following solutions will have the lowest freezing point in water?

(A) 0.1 M Glucose (B) 0.1 M CaCl_2
(C) 0.1 M KCl (D) 0.1 M Urea

3. Which of the following is not a transition metal?

(A) Sc (B) Ag
(C) Hg (D) Cu

4. Which of the following represents the fraction of molecules with energies equal to or greater than E_a ?

(A) $+\frac{E_a}{RT}$ (B) $e^{-E_a/RT}$
(C) $-\frac{E_a}{RT}$ (D) $e^{+E_a/RT}$

5. What will happen during the electrolysis of aqueous solution of CuCl_2 by using platinum electrodes?

(A) Cu will deposit at Anode (B) H_2 gas will be released at cathode
(C) O_2 gas will be released at anode (D) Cl_2 gas will be released at anode

6. Aspirin is obtained by acetylation of

(A) Phenol (B) Salicylaldehyde
(C) 2-Hydroxybenzoic acid (D) Benzoic acid

7. The secondary valency of Co in the complex $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]^{2+}$ is

(A) 5 (B) 1
(C) 4 (D) 6

8. At low temperature, phenol reacts with dil. HNO_3 to yield

(A) 2, 4, 6-Trinitrophenol (B) o-Nitrophenol only
(C) p-Nitrophenol only (D) ortho-and para-nitrophenol

9. Which of the following is 'not' true about enantiomers? 1
 (A) They have the same chemical reactivity. (B) They have the same specific rotation.
 (C) They have the same melting or boiling point. (D) They have the same refractive index.
10. Aniline on direct nitration yields 1
 (A) 51%-ortho, 47%-para, 2%-meta derivatives (B) 51%-meta, 47%-ortho, 2%-para derivatives
 (C) 51%-para, 47%-meta, 2%-ortho derivatives (D) 51%-ortho, 47%-meta, 2%-para derivatives
11. Which of the following amines has lowest pK_b value? 1
 (A) $C_6H_5-N(CH_3)_2$ (B) $C_6H_5-NH(CH_3)$
 (C) $C_6H_5-NH_2$ (D) p-nitroaniline ($O_2N-C_6H_4-NH_2$)
12. The deficiency of which of the following vitamins causes increased fragility of red blood cells and muscular weakness? 1
 (A) Vitamin A (B) Vitamin K
 (C) Vitamin E (D) Vitamin D
13. Assertion (A): It is not possible to separate the components of an azeotrope by fractional distillation. 1
 Reason (R): Components of an azeotrope have the same composition in liquid and vapour phase and boil at a constant temperature.
 (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
14. Assertion (A): The presence of $-OH$ group in phenols directs the incoming group to meta position in the ring. 1
 Reason (R): $-OH$ group in phenols activates the aromatic ring towards electrophilic substitution reaction.
 (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
15. Assertion (A): Actinoids show wide range of oxidation states. 1
 Reason (R): Actinoids are radioactive in nature.
 (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.
16. Assertion (A): The pentaacetate of glucose does not react with H_2N-OH . 1
 Reason (R): It indicates the presence of free $-CHO$ group in glucose.
 (A) Both A and R are true and R is the correct explanation of A. (B) Both A and R are true but R is not the correct explanation of A. (C) A is true but R is false. (D) A is false but R is true.

Section B · Very short answer (2 marks each)

17. What type of deviation from Raoult's law is shown by a mixture of phenol and aniline? Give reason. What will happen to the boiling point of the solution on mixing phenol and aniline? 2
18. Why are haloarenes less reactive towards nucleophilic substitution reaction? Give two reasons. 2
19. (a) Write IUPAC names of the following coordination compounds: (i) $[Ag(NH_3)_2][Ag(CN)_2]$ (ii) $K_3[Fe(C_2O_4)_3]$ 2

OR

- (b) (i) Give a chemical test to show that $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ and $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ are ionisation isomers. (ii) What is meant by the 'Chelate effect'? Give an example. 2
20. Differentiate between the following: (i) Peptide linkage and Glycosidic linkage (ii) Essential amino acids and Non-essential amino acids 2
21. Following reaction takes place in one step: $2\text{A} + \text{B} \longrightarrow 2\text{C}$. How will the rate of above reaction change if the volume of the reaction vessel is decreased to one third of its original volume? Will there be any change in the order of reaction with the reduced volume? 2

Section C · Short answer (3 marks each)

22. For the first order thermal decomposition reaction, following data was obtained: 3
 $\text{C}_2\text{H}_5\text{Cl}(\text{g}) \longrightarrow \text{C}_2\text{H}_4(\text{g}) + \text{HCl}(\text{g})$. At $t = 0$ s, total pressure = 0.30 atm; at $t = 30$ s, total pressure = 0.50 atm. Calculate rate constant. [Given: $\log 3 = 0.48$]
23. (a) (i) Why is the Equilibrium Constant (K_c) related to E_{cell}° and not to E_{cell} ? (ii) Two metals 'A' and 'B' have standard electrode potential values of -0.24 V and $+0.80$ V respectively. Which of these will liberate hydrogen gas from dil. H_2SO_4 ? (iii) Write the cell reaction which occurs in lead storage battery when it is in charging. 3
- OR**
- (b) What type of battery is Mercury cell? Why it is more advantageous than dry cell? Write overall reaction taking place in Mercury cell. 3
24. Calculate the boiling point of a solution containing 0.61 g of benzoic acid (Molar mass = 122 g mol^{-1}) in 5 g of CS_2 in which it dimerises to the extent of 88%. The boiling point and K_b of CS_2 are 46.2°C and 2.3 K kg mol^{-1} respectively. 3
25. Write the reactions of D-Glucose with the following: (a) HI (b) Br_2 water (c) Conc. HNO_3 3
26. Give reasons for the following: (a) Carboxylic acids have higher boiling point than alcohols of comparable molecular masses. (b) Alpha (α) hydrogens of aldehydes and ketones are acidic in nature. (c) Nucleophilic addition of ammonia and its derivatives does not occur with carbonyl group in strongly acidic medium. 3
27. Write the reaction involved in the following: (a) Reimer-Tiemann reaction (b) Kolbe's reaction (c) Friedel-Crafts acylation of anisole 3
28. Compound 'X' with molecular formula $\text{C}_4\text{H}_9\text{Br}$ reacts with aqueous KOH to give an alcohol. The rate of this reaction depends only on the concentration of the compound 'X'. When an optically active isomer 'Y' of the compound 'X' was treated with aqueous KOH solution, the rate of reaction was found to be dependent on concentration of compound 'Y' and aqueous KOH both. (a) Write down the structural formula of both 'X' and 'Y'. (b) Out of 'X' and 'Y', which one will undergo racemisation and why? (c) Out of 'X' and 'Y', which one will form product with inversion of configuration and why? 3

Section D · Case-based (4 marks each)

29. The reaction of amines with mineral acids to form ammonium salts shows that these are basic in nature. Aliphatic amines are stronger bases than ammonia whereas aromatic amines are weaker bases than ammonia. Aliphatic and aromatic primary and secondary amines react with acid chlorides, anhydrides and esters by nucleophilic substitution reaction. The main problem encountered during electrophilic substitution reactions of aromatic amines is that of their high reactivity. Substitution tends to occur at ortho- and para-positions. Hinsberg reagent is used for the identification and distinction between primary, secondary and tertiary amines. Aryldiazonium salts, usually obtained from arylamines, undergo replacement of the diazonium group with a variety of nucleophiles to provide advantageous methods for producing aryl halides, cyanides, phenols and arenes.

(a) (i) Why $\text{CH}_3\text{—NH}_2$ is a stronger base than $(\text{CH}_3)_3\text{N}$ in aqueous solution? (ii) Write structural formulae of the compound A and B: $\text{CH}_3\text{CONH}_2 \xrightarrow{\text{NaOBr}} \text{A} \xrightarrow[\text{Base}]{\text{C}_6\text{H}_5\text{COCl}} \text{B}$ (2)

(b) A compound 'X' with molecular formula $\text{C}_3\text{H}_9\text{N}$ reacts with Hinsberg reagent to give a product insoluble in alkali. Identify 'X'. (1)

OR

(b) How can you convert aniline to benzonitrile? (1)

(c) Why is —NH_2 group of aniline acetylated before carrying out nitration? (1)

30. The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometry of coordination compounds. The Crystal Field Theory (CFT) of coordination compounds is based on the effect of different crystal fields (provided by the ligands taken as point charges), on the degeneracy of d-orbital energies of the central metal atom/ion. The splitting of the d-orbitals provides different electronic arrangements in strong and weak crystal fields.

(a) In octahedral crystal field, energies of which d-orbitals will be raised when ligands approach the central metal atom/ion? Give reason in support of your answer. (2)

(b) Using crystal field theory, write the electronic configuration of central metal atom/ion of the following: (i) $[\text{CoF}_6]^{3-}$ (ii) $[\text{Co}(\text{NH}_3)_6]^{3+}$ [At. No.: Co = 27] (1)

(c) $[\text{NiCl}_4]^{2-}$ is paramagnetic while $[\text{Ni}(\text{CO})_4]$ is diamagnetic though both are tetrahedral. Why? [Atomic No.: Ni = 28] (1)

OR

(c) Write hybridization and magnetic behaviour of the complex $[\text{Fe}(\text{CN})_6]^{3-}$. [Atomic No.: Fe = 26] (1)

Section E · Long answer (5 marks each)

31. (a) (i) An organic compound (X) has the molecular formula $\text{C}_5\text{H}_{10}\text{O}$. Draw structures for (X) if it: (I) does not give Tollen's test but gives a positive iodoform test. (II) does not give Tollen's test and iodoform test but undergoes Aldol condensation. (III) undergoes Cannizzaro's reaction. (ii) Show how each of the following compounds can be converted to benzoic acid: (I) Acetophenone (II) Ethyl benzene

OR

(b) (i) Draw structure of the 2, 4-dinitrophenyl hydrazone derivative of benzaldehyde. (ii) Arrange the following in increasing order of their reactivity towards HCN: Di-tert. butyl ketone, Acetaldehyde, Acetone (iii) Give a simple chemical test to distinguish between benzoic acid and ethyl benzoate. (iv) Write the name of the reagent to convert Ethanenitrile to Ethanal. (v) Draw the structure of 'X' in the following reaction: cyclohexanol $\xrightarrow{\text{CrO}_3}$ 'X'

32. (a) (i) From the given data of $E_{M^{2+}/M}^\circ$ values (V –1.18, Cr –0.91, Mn –1.18, Fe –0.44, Co –0.28, Ni –0.25, Cu +0.34), answer: (I) Why $E_{M^{2+}/M}^\circ$ show irregular trend? (II) Why is $E_{Cu^{2+}/Cu}^\circ$ value exceptionally positive? (III) Why $E_{Mn^{2+}/Mn}^\circ$ value is highly negative? (ii) Write the ionic equations for the oxidising action of potassium permanganate for its reaction with I^- in both acidic and alkaline solutions.

OR

- (b) (i) Name a member of the lanthanoid series (I) which exhibits +4 oxidation state (II) which exhibits +2 oxidation state. (ii) Why transition metals act as good catalyst? (iii) Why Cr has higher melting point than Mn? (iv) What happens when acidic solution of potassium permanganate is allowed to stand for sometime? Give the equation involved. What is this type of reaction called?

33. (a) Calculate emf and ΔG for the following cell at 298 K:
 $Mg(s) | Mg^{2+}(0.01 M) || Ag^+(0.001 M) | Ag(s)$. Given: $E_{Mg^{2+}/Mg}^\circ = -2.37 V$, $E_{Ag^+/Ag}^\circ = +0.80 V$ [1 F = 96500 C mol⁻¹, log 10 = 1]

OR

- (b) For the reaction: $2 AgCl(s) + H_2(g)(0.4 atm) \longrightarrow 2 Ag(s) + 2 H^+(0.1 M) + 2 Cl^-(0.2 M)$. Calculate emf of the cell at 25 °C. Given: $\Delta G^\circ = -43500 J mol^{-1}$ [log 10 = 1, 1 F = 96500 C mol⁻¹]

Solutions · CBSE 2026 · 56/11

- Q1 Answer: (B)

For a first-order reaction $t_{1/2} = \frac{0.693}{k}$, which does not depend on the initial concentration $[R]_0$: a horizontal line. (Graph A is zero order, $t_{1/2} \propto [R]_0$; a horizontal rate-concentration line, C, is also zero order.)

- Q2 Answer: (B) 0.1 M CaCl₂

$\Delta T_f = iK_f m$. At the same molality, CaCl₂ gives 3 ions (i = 3), KCl gives 2 and glucose and urea do not dissociate (i = 1). The largest depression, hence the lowest freezing point, is for CaCl₂.

- Q3 Answer: (C) Hg

A transition element has an incompletely filled d subshell in the atom or in a common ion. Hg (5d¹⁰6s²) has a full d subshell in the atom and in Hg²⁺, so it is not regarded as a transition metal. (Ag and Cu have partly filled d orbitals in Ag²⁺ and Cu²⁺.)

- Q4 Answer: (B) $e^{-E_a/RT}$

In the Arrhenius equation $k = Ae^{-E_a/RT}$, the factor $e^{-E_a/RT}$ is the fraction of molecules having kinetic energy equal to or greater than E_a .

- Q5 Answer: (D) Cl₂ gas will be released at anode

Cathode: $Cu^{2+} + 2e^- \longrightarrow Cu$ (copper deposits). Anode: $2Cl^- \longrightarrow Cl_2 + 2e^-$; although oxidation of water has a lower E° , chloride is oxidised because of the overpotential for oxygen.

- Q6 Answer: (C) 2-Hydroxybenzoic acid (salicylic acid). Acetylation with acetic anhydride gives acetylsalicylic acid (aspirin).

Q7 Answer: (D) 6

Secondary valency = coordination number = number of ligand donor atoms: $5 \text{NH}_3 + 1 \text{NO}_2^- = 6$.

Q8 Answer: (D) ortho- and para-nitrophenol

The $-\text{OH}$ group activates the ring and directs to o- and p-positions; with dilute nitric acid at low temperature a mixture of o- and p-nitrophenols is formed. (Conc. HNO_3 gives picric acid.)

Q9 Answer: (B)

Enantiomers rotate plane-polarised light by equal amounts but in **opposite** directions, so their specific rotations are equal in magnitude and opposite in sign. Their physical properties and reactivity (with achiral reagents) are identical.

Q10 Answer: (C) 51% para, 47% meta, 2% ortho

In the strongly acidic nitrating mixture, aniline is protonated to the anilinium ion ($-\text{NH}_3^+$), which is meta-directing, so a large amount of the meta product forms along with para.

Q11 Answer: (A) $\text{C}_6\text{H}_5-\text{N}(\text{CH}_3)_2$

Lowest pK_b means strongest base. The electron-releasing methyl groups increase the electron density on N; N,N-dimethylaniline is the strongest base here, while the electron-withdrawing $-\text{NO}_2$ makes p-nitroaniline the weakest.

Q12 Answer: (C) Vitamin E

Q13 Answer: (A) Both A and R are true and R is the correct explanation of A.

Since the vapour has the same composition as the liquid, distillation cannot change the composition.

Q14 Answer: (D) A is false, but R is true.

$-\text{OH}$ activates the ring by resonance (+R effect) and increases electron density at the ortho and para positions, so it is an o/p-director, not a meta-director.

Q15 Answer: (B) Both A and R are true, but R is not the correct explanation of A.

The wide range of oxidation states arises because the 5f, 6d and 7s orbitals have comparable energies, not because of radioactivity.

Q16 Answer: (C) A is true, but R is false.

Glucose pentaacetate does not react with hydroxylamine; this shows the **absence** of a free $-\text{CHO}$ group in it (glucose exists in a cyclic hemiacetal form).

Q17 Negative deviation. The hydrogen bonding between the phenolic $-\text{OH}$ and the lone pair on the nitrogen of aniline (solute-solvent interaction) is stronger than the interactions in the pure components. So the vapour pressure is lower than expected by Raoult's law.
The boiling point of the solution **increases** (a maximum-boiling azeotrope can form).

Q18 Any two:

1. **Resonance:** the lone pair on the halogen is delocalised into the ring, giving the C-X bond partial double-bond character, so it is harder to break.
2. **Hybridisation:** the C of C-X is sp^2 (more s-character, more electronegative), so the bond is shorter and stronger.

3. **Instability of the phenyl cation** (no resonance stabilisation), so S_N1 does not occur.

4. **Repulsion** between the electron-rich ring and the approaching nucleophile.

- Q19(a)** (i) Diamminesilver(I) dicyanidoargentate(I)
(ii) Potassium trioxalatoferate(III)

- Q19(b)** (i) Add AgNO_3 solution: $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ gives a white precipitate of AgCl (free Cl^-), the other does not. Or add BaCl_2 : $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ gives a white precipitate of BaSO_4 (free SO_4^{2-}), the other does not.
(ii) Chelate effect: complexes formed by di- or polydentate ligands (chelates) are more stable than similar complexes with monodentate ligands. Example: $[\text{Co}(\text{en})_3]^{3+}$ or $[\text{Ni}(\text{en})_3]^{2+}$ is more stable than the corresponding ammine complex.

- Q20** (i) A **peptide linkage** is the amide bond ($-\text{CO}-\text{NH}-$) formed between the $-\text{COOH}$ of one amino acid and the $-\text{NH}_2$ of another. A **glycosidic linkage** is the oxide ($-\text{O}-$) linkage joining two monosaccharide units.
(ii) **Essential amino acids** cannot be synthesised in the body and must be obtained through the diet (e.g. valine, leucine). **Non-essential amino acids** can be synthesised in the body (e.g. glycine, alanine).

- Q21** For an elementary (one-step) reaction, $\text{rate} = k[\text{A}]^2[\text{B}]$.
Reducing the volume to one-third triples every concentration:

$$\text{Rate}' = k(3[\text{A}])^2(3[\text{B}]) = 27k[\text{A}]^2[\text{B}]$$

The rate becomes **27 times**. The **order does not change** (it stays 3); it depends on the rate law, not on the volume.

- Q22** Let x atm of $\text{C}_2\text{H}_5\text{Cl}$ decompose: $p_t = (p_0 - x) + x + x = p_0 + x$, so $x = 0.50 - 0.30 = 0.20$ atm.
Pressure of reactant at 30 s: $p_0 - x = 0.30 - 0.20 = 0.10$ atm.

$$k = \frac{2.303}{t} \log \frac{p_0}{p_0 - x} = \frac{2.303}{30} \log \frac{0.30}{0.10} = \frac{2.303 \times 0.48}{30} \approx 3.68 \times 10^{-2} \text{ s}^{-1}$$

- Q23(a)** (i) At equilibrium $E_{\text{cell}} = 0$; then the Nernst equation gives $E_{\text{cell}}^\circ = \frac{2.303RT}{nF} \log K_c$. So K_c is related to E_{cell}° ; E_{cell} (being zero at equilibrium) cannot give it.
(ii) **Metal A** ($E^\circ = -0.24$ V, below hydrogen) can reduce H^+ and liberate H_2 .
(iii) Charging: $2\text{PbSO}_4(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \longrightarrow \text{Pb}(\text{s}) + \text{PbO}_2(\text{s}) + 2\text{H}_2\text{SO}_4(\text{aq})$

- Q23(b)** It is a **primary** battery. Its cell potential stays constant (about 1.35 V) during its life because the overall reaction involves no ions in solution whose concentration changes; a dry cell's voltage falls with use.
Overall reaction: $\text{Zn}(\text{Hg}) + \text{HgO}(\text{s}) \longrightarrow \text{ZnO}(\text{s}) + \text{Hg}(\text{l})$

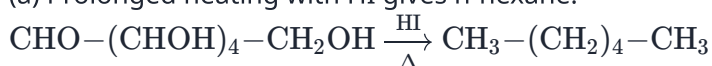
- Q24** Dimerisation $2\text{A} \rightleftharpoons \text{A}_2$ with degree $\alpha = 0.88$: $i = 1 - \frac{\alpha}{2} = 1 - 0.44 = 0.56$.
Molality $m = \frac{0.61/122}{5/1000} = \frac{0.005}{0.005} = 1 \text{ mol kg}^{-1}$.

$$\Delta T_b = iK_b m = 0.56 \times 2.3 \times 1 = 1.288 \text{ K}$$

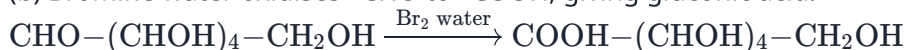
Boiling point = $46.2 + 1.29 \approx 47.49^\circ\text{C}$.

Q25

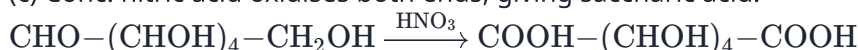
(a) Prolonged heating with HI gives n-hexane:



(b) Bromine water oxidises $-\text{CHO}$ to $-\text{COOH}$, giving gluconic acid:



(c) Conc. nitric acid oxidises both ends, giving saccharic acid:

**Q26**

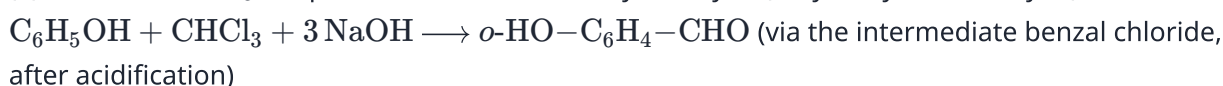
(a) Carboxylic acids form stronger and more extensive intermolecular hydrogen bonds; they exist as dimers, which effectively doubles the molecular size.

(b) The strongly electron-withdrawing carbonyl group pulls electron density from the α C-H bond, and the carbanion (enolate) formed after losing H^+ is stabilised by resonance.

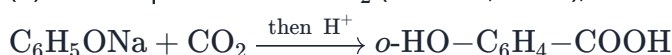
(c) In strongly acidic medium, ammonia and its derivatives (nucleophiles with a lone pair on N) get protonated to ammonium ions, which have no lone pair and cannot attack the carbonyl carbon.

Q27

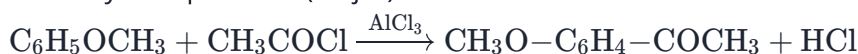
(a) Phenol + CHCl_3 + aq. NaOH, then H^+ $\rightarrow$ salicylaldehyde (2-hydroxybenzaldehyde):



(b) Sodium phenoxide + CO_2 (4–7 atm, 400 K), then H^+ $\rightarrow$ salicylic acid (2-hydroxybenzoic acid):



(c) Anisole + CH_3COCl / anhydrous AlCl_3 $\rightarrow$ 2-methoxyacetophenone (minor) + 4-methoxyacetophenone (major):

**Q28**

(a) X reacts by S_N1 (rate depends only on [X]): a tertiary halide, **2-bromo-2-methylpropane**, $(\text{CH}_3)_3\text{C}-\text{Br}$.

Y is optically active and reacts by S_N2 : **2-bromobutane**, $\text{CH}_3-\text{CHBr}-\text{CH}_2-\text{CH}_3$ (chiral).

(b) **Racemisation** occurs in an S_N1 reaction: the planar carbocation is attacked equally from both sides. Note that X has no chiral centre, so for an optically active substrate this applies to an S_N1 path; between X and Y, the S_N1 substrate X is the one reacting through a carbocation (racemisation is the characteristic outcome of this path).

(c) **Y** gives inversion of configuration: in S_N2 the nucleophile attacks from the side opposite to the leaving group (backside attack), giving Walden inversion.

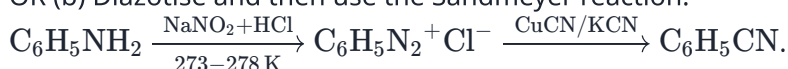
Q29

(a) (i) In water, basicity depends on the inductive effect, solvation (H-bonding of the ammonium ion) and steric hindrance together. The methylammonium ion (CH_3NH_3^+ , three N-H) is well stabilised by hydration, while the trimethylammonium ion has only one N-H and is poorly solvated; the bulky methyl groups also hinder solvation. So CH_3NH_2 is more basic.

(ii) Hoffmann bromamide degradation: A = CH_3NH_2 (methanamine). Benzoylation: B = $\text{C}_6\text{H}_5\text{CONHCH}_3$ (N-methylbenzamide).

(b) It forms a sulphonamide insoluble in alkali, so it is a secondary amine: **N-methylethanamine**, $\text{CH}_3-\text{NH}-\text{C}_2\text{H}_5$.

OR (b) Diazotise and then use the Sandmeyer reaction:



(c) The $-\text{NH}_2$ group is strongly activating, so direct nitration gives oxidation products and a mixture (including much meta product from the anilinium ion). Acetylation converts it to $-\text{NHCOCH}_3$, which is less activating, protects it from oxidation and gives mainly the para-nitro product; hydrolysis then regenerates the amine.

Q30

(a) The e_g orbitals, $d_{x^2-y^2}$ and d_{z^2} , are raised. In an octahedral field the six ligands approach along the x, y and z axes; these two orbitals point directly along the axes, towards the ligands, so their electrons are repelled more. The t_{2g} orbitals (d_{xy} , d_{yz} , d_{zx}) lie between the axes and are lowered.

(b) Both have Co^{3+} , $3d^6$.

(i) F^- is a weak-field ligand: $t_{2g}^4 e_g^2$ (4 unpaired electrons, high spin).

(ii) NH_3 is a strong-field ligand here: $t_{2g}^6 e_g^0$ (diamagnetic, low spin).

(c) In $[\text{NiCl}_4]^{2-}$, Ni is +2 ($3d^8$) and Cl^- is a weak ligand: two unpaired electrons remain (sp^3), so it is paramagnetic. In $[\text{Ni}(\text{CO})_4]$, Ni is 0 ($3d^8 4s^2$); CO is a strong ligand and the 4s electrons are pushed into 3d, giving $3d^{10}$ with no unpaired electrons (sp^3): diamagnetic.

OR (c) Fe^{3+} , $3d^5$; CN^- is strong-field: pairing gives one unpaired electron. Hybridisation $d^2 sp^3$ (inner orbital, octahedral); **paramagnetic** (one unpaired electron).

Q31(a)

(i) (I) A methyl ketone: **pentan-2-one**, $\text{CH}_3-\text{CO}-\text{CH}_2-\text{CH}_2-\text{CH}_3$ (or 3-methylbutan-2-one, $\text{CH}_3\text{COCH}(\text{CH}_3)_2$).

(II) A ketone without a CH_3CO^- group but with α -hydrogens: **pentan-3-one**, $\text{CH}_3\text{CH}_2-\text{CO}-\text{CH}_2\text{CH}_3$.

(III) An aldehyde with no α -hydrogen: **2,2-dimethylpropanal**, $(\text{CH}_3)_3\text{C}-\text{CHO}$.

(ii) (I) Haloform reaction:

$\text{C}_6\text{H}_5\text{COCH}_3 \xrightarrow{\text{NaOI (I}_2/\text{NaOH)}} \text{C}_6\text{H}_5\text{COONa} + \text{CHI}_3 \xrightarrow{\text{H}_3\text{O}^+} \text{C}_6\text{H}_5\text{COOH}$ (or oxidation with alkaline KMnO_4).

(II) Side-chain oxidation: $\text{C}_6\text{H}_5\text{CH}_2\text{CH}_3 \xrightarrow[\Delta]{\text{KMnO}_4/\text{KOH}} \text{C}_6\text{H}_5\text{COOK} \xrightarrow{\text{H}_3\text{O}^+} \text{C}_6\text{H}_5\text{COOH}$

Q31(b)

(i) $\text{C}_6\text{H}_5-\text{CH}=\text{N}-\text{NH}-\text{C}_6\text{H}_3(\text{NO}_2)_2$ (the NO_2 groups at positions 2 and 4 of the phenyl ring attached to NH).

(ii) Di-tert-butyl ketone < Acetone < Acetaldehyde (more alkyl groups and bulk lower reactivity).

(iii) **Sodium bicarbonate test:** benzoic acid gives brisk effervescence of CO_2 with NaHCO_3 solution; ethyl benzoate does not.

(iv) SnCl_2 / HCl followed by hydrolysis (Stephen reduction); or DIBAL-H followed by H_2O .

(v) X = **cyclohexanone** (the secondary alcohol is oxidised to a ketone).

Q32(a)

(i) (I) Because of irregular variation of the ionisation enthalpies ($\Delta_i H_1 + \Delta_i H_2$) and the sublimation (atomisation) enthalpies across the series.

(II) Cu has a high enthalpy of atomisation and a high ionisation enthalpy, and the hydration enthalpy of Cu^{2+} is not enough to compensate.

(III) Mn^{2+} has a stable half-filled $3d^5$ configuration, so Mn is readily oxidised to Mn^{2+} .

(ii) Acidic: $2 \text{MnO}_4^- + 10 \text{I}^- + 16 \text{H}^+ \longrightarrow 2 \text{Mn}^{2+} + 5 \text{I}_2 + 8 \text{H}_2\text{O}$

Alkaline/neutral: $2 \text{MnO}_4^- + \text{I}^- + \text{H}_2\text{O} \longrightarrow 2 \text{MnO}_2 + \text{IO}_3^- + 2 \text{OH}^-$

Q32(b)

(i) (I) Cerium (Ce^{4+}). (II) Europium (Eu^{2+}) or ytterbium.

(ii) Because they can show variable oxidation states and form complexes, and provide a large surface area for adsorption of reactants (forming unstable intermediates of lower activation energy).

(iii) Cr ($3d^5 4s^1$) uses more unpaired d and s electrons in metallic bonding, giving stronger bonds; Mn ($3d^5 4s^2$) has a stable half-filled configuration and its electrons are less available for bonding.

(iv) It slowly decomposes, depositing brown MnO_2 and releasing oxygen:



It is a **redox reaction** (Mn is reduced from +7 to +4 while oxygen is oxidised).

Q33(a) Cell reaction: $\text{Mg} + 2 \text{Ag}^+ \longrightarrow \text{Mg}^{2+} + 2 \text{Ag}$, $n = 2$.

$$E_{\text{cell}}^{\circ} = 0.80 - (-2.37) = 3.17 \text{ V.}$$

$$E_{\text{cell}} = E^{\circ} - \frac{0.059}{2} \log \frac{[\text{Mg}^{2+}]}{[\text{Ag}^+]^2} = 3.17 - 0.0295 \log \frac{10^{-2}}{(10^{-3})^2} = 3.17 - 0.0295 \times 4 = \mathbf{3.052 \text{ V}}$$

$$\Delta G = -nFE_{\text{cell}} = -2 \times 96500 \times 3.052 \approx \mathbf{-5.89 \times 10^5 \text{ J mol}^{-1}} \quad (-589 \text{ kJ mol}^{-1})$$

Q33(b) $n = 2$. $E^{\circ} = -\frac{\Delta G^{\circ}}{nF} = \frac{43500}{2 \times 96500} = 0.225 \text{ V.}$

$$E = E^{\circ} - \frac{0.059}{2} \log \frac{[\text{H}^+]^2 [\text{Cl}^-]^2}{p_{\text{H}_2}} = 0.225 - 0.0295 \log \frac{(0.1)^2 (0.2)^2}{0.4}$$

$$\frac{0.01 \times 0.04}{0.4} = 10^{-3}, \text{ so } \log = -3:$$

$$E = 0.225 + 0.0885 = \mathbf{0.314 \text{ V}}$$



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