CUET 2026 May 19 Shift 2 Chemistry

Question Paper (Memory-Based) with Solutions

Conducted by National Testing Agency (NTA)

General Instructions

(i) The examination will be conducted in Computer-Based Test (CBT) mode.

(ii) Each question carries +5 marks for correct answer and -1 mark for wrong answer.

(iii) The total number of questions are 50.

(iv) Duration of the exam is 1 hour (60 minutes).

1. Which has the lowest boiling point at 1 atm pressure?

(1) 0.1 M KCl

(2) 0.1 M urea

(3) 0.1 M $CaCl_2$

(4) 0.1 M $AlCl_3$

Correct Answer: (2) 0.1 M urea

Solution:

Concept: Boiling point elevation is a colligative property. It depends upon the number of solute particles present in the solution and is given by:

$$\Delta T_b = iK_b m$$

where:

- ΔT_b = elevation in boiling point
- i = van't Hoff factor
- K_b = molal elevation constant

- m = molality

Greater the number of particles formed in solution, greater is the boiling point elevation.

Step 1: Understanding the relation between boiling point and number of particles.

Pure solvents have the lowest boiling point. When a solute is added, the boiling point increases.
The increase depends upon the value of van't Hoff factor i.
More dissociation $\Rightarrow$ more particles $\Rightarrow$ higher boiling point.
Thus, the solution producing the least number of particles will have the lowest boiling point.

Step 2: Calculating relative number of particles for each solution.

- $KCl \rightarrow K^+ + Cl^-$

  Number of ions formed $= 2$

  Therefore, $i \approx 2$

- $CaCl_2 \rightarrow Ca^{2+} + 2Cl^-$

  Number of ions formed $= 3$

  Therefore, $i \approx 3$

- $AlCl_3 \rightarrow Al^{3+} + 3Cl^-$

  Number of ions formed $= 4$

  Therefore, $i \approx 4$

- Urea is a non-electrolyte and does not dissociate in water.

  Therefore,

$$i = 1$$

Step 3: Comparing boiling point elevations.

Since:

$$\Delta T_b \propto i$$

Relative boiling point elevation:

$$\text{urea} < KCl < CaCl_2 < AlCl_3$$

Thus, urea causes the minimum elevation in boiling point.

Hence, it has the lowest boiling point among the given solutions.

Quick Tip: For colligative properties, always compare the total number of particles formed in solution. Non-electrolytes like glucose and urea have $i = 1$, so they show minimum effect on boiling point and freezing point compared to ionic compounds of same concentration.

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2. Which of the following solutions has highest osmotic pressure?

(1) $1\,M$ $NaCl$

(2) $1\,M$ $MgCl_2$

(3) $1\,M$ urea

(4) $1\,M$ glucose

Correct Answer: (2) $1\,M$ $MgCl_2$

Solution:

Concept: Osmotic pressure is a colligative property and depends upon the total number of solute particles present in the solution.

It is given by the relation:

$$\pi = iCRT$$

where:

- π = osmotic pressure
- i = van't Hoff factor
- C = molar concentration
- R = gas constant
- T = absolute temperature

For solutions of equal concentration at the same temperature:

$$\pi \propto i$$

Hence, the solution producing maximum number of particles will have the highest osmotic pressure.

Step 1: Determining van't Hoff factor for each solution.

- $NaCl \rightarrow Na^{+} + Cl^{-}$

  Total particles formed $= 2$

  Therefore,

  $$i \approx 2$$

- $MgCl_2 \rightarrow Mg^{2+} + 2Cl^{-}$

  Total particles formed $= 3$

  Therefore,

  $$i \approx 3$$

- Urea is a non-electrolyte and does not dissociate.

  Therefore,

  $$i = 1$$

- Glucose is also a non-electrolyte.

  Therefore,

  $$i = 1$$

Step 2: Comparing osmotic pressures.

Since all solutions are $1\,M$ and temperature is same:

$$\pi \propto i$$

Comparing values:

$$MgCl_2 > NaCl > \text{urea} = \text{glucose}$$

Thus, $1\,M\ MgCl_2$ has the highest osmotic pressure.

Quick Tip: For colligative properties, ionic compounds show greater effect than non-electrolytes because they dissociate into multiple ions.
Always compare the van't Hoff factor i:

$$\text{Higher } i \Rightarrow \text{Higher osmotic pressure}$$

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3. The molal freezing point constant for water is $1.86^\circ C$. The freezing point of $0.1\,m\ NaCl$ solution is expected to be:

(1) $-1.86^\circ C$

(2) $-0.372^\circ C$

(3) $-0.186^\circ C$

(4) $0.372^\circ C$

Correct Answer: (2) $-0.372^\circ C$

Solution:

Concept: Depression in freezing point is a colligative property and is given by:

$$\Delta T_f = iK_f m$$

where:

- ΔT_f = depression in freezing point
- i = van't Hoff factor
- K_f = molal freezing point constant
- m = molality

The freezing point of solution is:

$$T_f = T_f^\circ - \Delta T_f$$

where T_f° is the freezing point of pure solvent.

Step 1: Finding van't Hoff factor for $NaCl$.

Sodium chloride dissociates as:

$$NaCl \rightarrow Na^{+} + Cl^{-}$$

Thus, total ions formed $= 2$.

Therefore,

$$i = 2$$

Step 2: Calculating depression in freezing point.

Given:

$$K_f = 1.86^{\circ}C$$

$$m = 0.1$$

$$i = 2$$

Using formula:

$$\Delta T_f = iK_f m$$

Substituting values:

$$\Delta T_f = 2 \times 1.86 \times 0.1$$

$$\Delta T_f = 0.372^{\circ}C$$

Step 3: Calculating freezing point of solution.

Freezing point of pure water:

$$0^{\circ}C$$

Hence,

$$T_f = 0 - 0.372$$

$$T_f = -0.372^{\circ}C$$

Therefore, the freezing point of the solution is:

$$-0.372^{\circ}C$$

Quick Tip: Electrolytes produce more particles in solution, so freezing point depression becomes larger. For $NaCl$, always remember:

$$i \approx 2$$

because it dissociates into two ions.

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4. The average osmotic pressure of human body is 7.8 bar at $37^{\circ}C$. What is the concentration of an aqueous solution of $NaCl$ that could be used in bloodstream?

(1) 0.15 $mol\,L^{-1}$

(2) 0.30 $mol\,L^{-1}$

(3) 0.60 $mol\,L^{-1}$

(4) 0.45 $mol\,L^{-1}$

Correct Answer: (1) 0.15 $mol\,L^{-1}$

Solution:

Concept: Osmotic pressure is given by the relation:

$$\pi = iCRT$$

where:

- π = osmotic pressure
- i = van't Hoff factor
- C = molar concentration
- R = gas constant
- T = temperature in Kelvin

For electrolytes like $NaCl$, dissociation must be considered using van't Hoff factor.

Step 1: Writing the given data.

$$\pi = 7.8\ bar$$

$$T = 37^{\circ}C = 310\,K$$

For $NaCl$:

$$NaCl \rightarrow Na^{+} + Cl^{-}$$

Therefore,

$$i = 2$$

Gas constant:

$$R = 0.083\ L\ bar\ mol^{-1}K^{-1}$$

Step 2: Substituting values in osmotic pressure equation.

$$\pi = iCRT$$

$$7.8 = 2 \times C \times 0.083 \times 310$$

$$7.8 = 51.46\,C$$

Step 3: Calculating concentration.

$$C = \frac{7.8}{51.46}$$

$$C \approx 0.15\ mol\ L^{-1}$$

Therefore, the concentration of $NaCl$ solution suitable for bloodstream is:

$$0.15\ mol\ L^{-1}$$

Quick Tip: Physiological saline used in medical applications is approximately $0.15\,M\ NaCl$, which corresponds to nearly 0.9% saline solution.
Always include van't Hoff factor for ionic compounds while calculating osmotic pressure.

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5. The vapor pressures of two liquids P and Q are 80 torr and 60 torr respectively. The total vapor pressure of the solution obtained by mixing 3 mol of P and 2 mol of Q would be:

(1) 68 torr

(2) 140 torr

(3) 72 torr

(4) 20 torr

Correct Answer: (3) 72 torr

Solution:

Concept: For an ideal liquid solution, Raoult's law states:

$$P_{total} = P_P + P_Q$$

where:

$$P_P = X_P P_P^\circ$$

$$P_Q = X_Q P_Q^\circ$$

Here:

- X_P, X_Q are mole fractions
- P_P°, P_Q° are vapor pressures of pure liquids

Thus,

$$P_{total} = X_P P_P^\circ + X_Q P_Q^\circ$$

Step 1: Calculating mole fractions.

Number of moles:

$$n_P = 3$$

$$n_Q = 2$$

Total moles:

$$n_{total} = 3 + 2 = 5$$

Mole fraction of P:

$$X_P = \frac{3}{5}$$

Mole fraction of Q:

$$X_Q = \frac{2}{5}$$

Step 2: Applying Raoult's law.

Given:

$$P_P^\circ = 80 \text{ torr}$$

$$P_Q^\circ = 60 \text{ torr}$$

Using:

$$P_{total} = X_P P_P^\circ + X_Q P_Q^\circ$$

$$P_{total} = \frac{3}{5} \times 80 + \frac{2}{5} \times 60$$

$$P_{total} = 48 + 24$$

$$P_{total} = 72 \text{ torr}$$

Therefore, the total vapor pressure of the solution is:

$$72 \text{ torr}$$

Quick Tip: For binary ideal solutions:

$$P_{total} = X_A P_A^\circ + X_B P_B^\circ$$

Always calculate mole fractions first before applying Raoult's law.

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6. The 5% solution of cane sugar (molecular weight = 342) is isotonic with 1% solution of substance X. The molecular weight of X is:

(1) 342

(2) 171.2

(3) 68.4

(4) 136.8

Correct Answer: (3) 68.4

Solution:

Concept: Two solutions are said to be isotonic when they have the same osmotic pressure at the same temperature.

For dilute solutions:

$$\pi = CRT$$

For isotonic solutions:

$$C_1 = C_2$$

Since concentration in percentage is given, we use:

$$\frac{w_1}{M_1} = \frac{w_2}{M_2}$$

where:

- w = mass of solute in same volume of solution
- M = molecular weight

Step 1: Writing the given data.

For cane sugar:

$$w_1 = 5\,g$$

$$M_1 = 342$$

For substance X:

$$w_2 = 1\,g$$

$$M_2 = ?$$

Step 2: Applying isotonic condition.

$$\frac{w_1}{M_1} = \frac{w_2}{M_2}$$

Substituting values:

$$\frac{5}{342} = \frac{1}{M_2}$$

Cross multiplying:

$$M_2 = \frac{342}{5}$$

$$M_2 = 68.4$$

Therefore, the molecular weight of substance X is:

68.4

Quick Tip: For isotonic non-electrolyte solutions:

$$\frac{w_1}{M_1} = \frac{w_2}{M_2}$$

Lower molecular weight means larger number of solute particles for same mass percentage.

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7. Which of the following solutions shows positive deviation from Raoult's law?

(1) Acetone + Aniline

(2) Acetone + Ethanol

(3) Water + Nitric acid

(4) Chloroform + Benzene

Correct Answer: (2) Acetone + Ethanol

Solution:

Concept: A solution shows:

- **Positive deviation** from Raoult's law when intermolecular forces between unlike molecules are weaker than those between like molecules.
- **Negative deviation** when intermolecular attractions between unlike molecules are stronger.

For positive deviation:

$$A-B < A-A \text{ and } B-B$$

As a result:

- Vapor pressure increases
- Boiling point decreases

Step 1: Analyzing Acetone + Aniline.

Acetone and aniline interact strongly through hydrogen bonding between:

$$\text{C=O of acetone and } -NH_2 \text{ of aniline}$$

Thus, intermolecular attraction becomes stronger.
Therefore, this mixture shows **negative deviation**.

Step 2: Analyzing Acetone + Ethanol.

Pure ethanol molecules are strongly associated through hydrogen bonding.
When acetone is added, the strong ethanol-ethanol hydrogen bonding gets weakened.
The new acetone-ethanol interactions are comparatively weaker.
Hence:

$$A-B < A-A$$

Thus, vapor pressure increases above ideal value.

Therefore, the mixture shows:

Positive deviation from Raoult's law

Step 3: Analyzing remaining options.

- Water + Nitric acid shows strong ion-dipole interactions and hydrogen bonding.

  Hence, it shows negative deviation.

- Chloroform + Benzene forms stronger intermolecular interactions than ideal case.

  Hence, it also shows negative deviation.

Thus, only Acetone + Ethanol shows positive deviation.

Quick Tip: Positive deviation occurs when mixing causes weakening of intermolecular attractions.

Weaker attractions $\Rightarrow$ Higher vapor pressure

Common examples:

- Ethanol + Acetone
- Ethanol + Cyclohexane

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8. How many coulombs are required for the oxidation of 1 mole of H_2O to O_2?

(1) $1.93 \times 10^5\ C$

(2) $9.65 \times 10^4\ C$

(3) $3.86 \times 10^5\ C$

(4) $4.825 \times 10^5\ C$

Correct Answer: (1) $1.93 \times 10^5\ C$

Solution:

Concept: The quantity of electricity required in electrochemical reactions is calculated using Faraday's law:

$$Q = nF$$

where:

- Q = charge in coulombs
- n = number of moles of electrons transferred
- F = Faraday constant

$$1F = 96500\ C$$

During oxidation of water, electrons are released.

Step 1: Writing oxidation half-reaction of water.

Oxidation of water is:

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$

From the equation:

2 moles of H_2O release 4 moles of electrons

Therefore:

1 mole of H_2O releases 2 moles of electrons

Step 2: Calculating charge required.

Using:

$$Q = nF$$

Here:

$$n = 2$$

Thus,

$$Q = 2 \times 96500$$

$$Q = 193000\ C$$

$$Q = 1.93 \times 10^5\ C$$

Therefore, the required charge is:

$$1.93 \times 10^5\ C$$

Quick Tip: Always balance electrochemical half-reactions first.

Then calculate:

$$\text{Charge} = (\text{moles of electrons}) \times 96500$$

Remember:

$$1F = 96500\ C$$

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9. Which of the following is a secondary cell?

(1) Leclanche cell

(2) Lead storage battery

(3) Concentration cell

(4) All of these

Correct Answer: (2) Lead storage battery

Solution:

Concept: Electrochemical cells are classified into:

- **Primary cells** — cannot be recharged once discharged.
- **Secondary cells** — rechargeable cells in which chemical reactions are reversible.

Secondary cells can be used repeatedly by passing electric current through them after discharge.

Step 1: Analyzing Leclanche cell.

Leclanche cell is a dry cell commonly used in torches and clocks.

The chemical reactions occurring in it are irreversible.

Hence, it is a:

Primary cell

Therefore, it is not a secondary cell.

Step 2: Analyzing Lead storage battery.

Lead storage battery is rechargeable.
During charging, the discharge reaction gets reversed by supplying electrical energy.
Thus, it is a:

Secondary cell

Step 3: Analyzing Concentration cell.

A concentration cell is a galvanic cell based on concentration difference between two electrodes or electrolytes.
It is not classified as a secondary rechargeable battery.
Therefore, it is not a secondary cell.

Step 4: Conclusion.

Only lead storage battery is a rechargeable electrochemical cell.
Hence, the correct answer is:

Lead storage battery

Quick Tip: Remember:

- Dry cell → Primary cell
- Lead-acid battery → Secondary cell

Secondary cells are rechargeable because their reactions are reversible.

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10. Cell reaction is spontaneous when:

(1) E°_{red} is negative
(2) ΔG° is negative

(3) $E^\circ_{\text{oxidation}}$ is positive

(4) ΔG° is positive

Correct Answer: (2) ΔG° is negative

Solution:

Concept: A chemical or electrochemical reaction is said to be spontaneous if it can proceed on its own under given conditions. In electrochemistry, spontaneity is related to Gibbs free energy change and cell potential by the relation:

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

where:

- ΔG° = standard Gibbs free energy change
- n = number of electrons transferred
- F = Faraday constant
- E°_{cell} = standard cell potential

For a spontaneous reaction:

$$\Delta G^\circ < 0 \quad \text{and} \quad E^\circ_{\text{cell}} > 0$$

Step 1: Understanding the condition for spontaneity.

If a reaction occurs spontaneously, the Gibbs free energy of the system decreases. Therefore:

$$\Delta G^\circ < 0$$

This is the fundamental thermodynamic condition for spontaneity.

Step 2: Relating Gibbs free energy with cell potential.

From the equation:

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

we observe that:

- If $E^\circ_{\text{cell}} > 0$, then $\Delta G^\circ < 0$
- If $E^\circ_{\text{cell}} < 0$, then $\Delta G^\circ > 0$

Thus, spontaneous reactions always have negative Gibbs free energy.

Step 3: Checking the given options.

- E°_{red} is negative: Not necessarily true for spontaneity.
- ΔG° is negative: Correct condition for spontaneous reaction.
- $E^\circ_{\text{oxidation}}$ is positive: Alone this does not determine spontaneity.
- ΔG° is positive: Indicates non-spontaneous reaction.

Therefore, the correct answer is:

$$\boxed{\Delta G^\circ < 0}$$

Quick Tip: Remember the relation:

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

$$E^\circ_{\text{cell}} > 0 \Rightarrow \Delta G^\circ < 0$$

Positive cell potential always indicates a spontaneous electrochemical reaction.
