

Question Paper

Conducted by the Central Board of Secondary Education (CBSE)



Time Allowed: 3 Hours

Maximum Marks: 70

General Instructions

- (i) This question paper contains **33 questions**. All questions are compulsory.
- (ii) Section A: Questions 1 to 16 are multiple choice questions, carrying 1 mark each.
- (iii) Section B: Questions 17 to 21 are very short answer questions, carrying 2 marks each.
- (iv) Section C: Questions 22 to 28 are short answer questions, carrying 3 marks each.
- (v) Section D: Questions 29 to 30 are case-based questions, carrying 4 marks each.
- (vi) Section E: Questions 31 to 33 are long answer questions, carrying 5 marks each.
- (vii) Attempt one alternative where an internal choice is provided. Follow the instructions within each question.
- (viii) Use of calculators is not allowed.

Section A

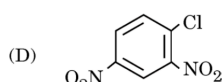
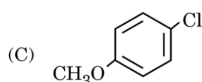
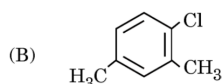
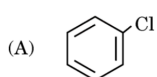
1. The mole fraction of a solute in 2.0 molal aqueous solution is:

- (A) 1.87 (B) 0.347
(C) 0.0347 (D) 0.00347

2. On electrolysis of very dilute aqueous solution of NaCl using platinum electrodes:

- (A) H₂ gas is evolved at anode. (B) Na is produced at cathode.
(C) O₂ gas is evolved at anode. (D) H₂ gas is evolved at cathode.

3. Which of the following compounds is most reactive towards nucleophilic substitution reaction with aqueous NaOH?



- (A) Structure (A) (B) Structure (B)
(C) Structure (C) (D) Structure (D)

4. The dehydration of 1°, 2° and 3° alcohols follows the order:

- (A) 2° > 1° > 3° (B) 3° > 2° > 1°
(C) 1° > 2° > 3° (D) 1° > 3° > 2°

5. The oxidation number of Co in [Co(NH₃)₅(ONO)]SO₄ is:

- (A) +3 (B) +2
(C) +4 (D) +6

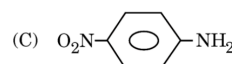
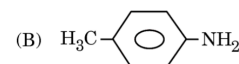
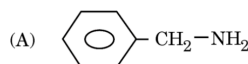
6. According to Werner's theory, the primary valencies of the central metal atom:

- (A) are satisfied by neutral molecules or negative ions. (B) are equal to its coordination number.
(C) are satisfied by negative ions. (D) are non-ionisable.

7. Which reagent is used to distinguish between C₆H₅NH₂ and (C₆H₅)₂NH?

- (A) KMnO₄ (B) CHCl₃ + KOH (ethanolic)
(C) NaOH + I₂ (D) Neutral FeCl₃

8. Among the following, which one has the lowest value of pK_b?



- (A) Structure (A) (B) Structure (B)
(C) Structure (C) (D) Structure (D)

9. In aqueous acidified solution, CrO₄²⁻ ion converts to which of the following?

- (A) CrO₃ (B) Cr³⁺
(C) Cr₂O₇²⁻ (D) CrO

10. The boiling point of an azeotropic mixture of water and nitric acid is more than that of pure water and nitric acid. The mixture shows:

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|--|--|
| (A) no deviation from Raoult's law | (B) that solution is an ideal solution |
| (C) positive deviation from Raoult's law | (D) negative deviation from Raoult's law |

11. On hydrolysis, which of the following carbohydrates gives only glucose?

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|-------------|---------------|
| (A) Starch | (B) Sucrose |
| (C) Lactose | (D) Galactose |

12. For the reaction $2A \rightarrow 3B$, the rate of reaction $+d[B]/dt$ is equal to:

- | | |
|----------------------|----------------------|
| (A) $-(3/2) d[A]/dt$ | (B) $-(2/3) d[A]/dt$ |
| (C) $-(1/2) d[A]/dt$ | (D) $+3 d[A]/dt$ |

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

Reason (R): Zr and Hf have almost identical atomic and ionic radii due to lanthanoid contraction.

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

14. **Assertion (A):** Phenol is more acidic than 4-methylphenol.

Reason (R): The presence of an electron releasing group in phenol makes it more acidic.

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

15. **Assertion (A):** Aromatic primary amines can easily be prepared by Gabriel phthalimide synthesis.

Reason (R): Gabriel phthalimide synthesis is used to prepare only aliphatic primary amines.

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

16. **Assertion (A):** Order of reaction is not applicable for elementary reaction but applicable for complex reaction.

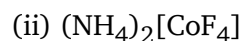
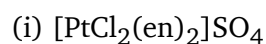
Reason (R): Order of reaction is an experimental quantity.

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

Section B

17. Explain why, on addition of 1 mol of KCl to 1 litre of water, the boiling point of water increases, while the addition of 1 mol of methyl alcohol to 1 litre of water decreases the boiling point.

18(a). Write IUPAC names of the following compounds:



OR

18(b). Define the following terms with a suitable example in each case:

(i) Ambidentate ligand

(ii) Double salt

19. For the compound having molecular formula $\text{C}_4\text{H}_9\text{Br}$, write:

(a) the isomer which is most reactive towards $\text{S}_{\text{N}}1$ displacement.

(b) the isomer which, on reacting with Na metal in the presence of dry ether, gives 2,5-Dimethylhexane.

20. For a reaction $\text{A} + \text{B} \rightarrow \text{Products}$, the rate law is:

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

Write the overall order of the reaction. Can this reaction be an elementary reaction? Give reason in support of your answer.

21. How do you explain the following?

(a) Presence of a carbonyl group in glucose.

(b) Presence of five -OH groups in glucose which are attached to different carbon atoms.

Section C

22. Give reasons for the following:

- (a) Alkyl halides, though polar, yet their solubility in water is very low.
- (b) p-Dichlorobenzene has higher melting point than those of o- and m-isomers.
- (c) $\text{CH}_3\text{-I}$ is more reactive than $\text{CH}_3\text{-Br}$ towards $\text{S}_{\text{N}}2$ reactions.

23. How will you obtain the following from benzene diazonium chloride? Write chemical equations involved:

- (a) Phenol
- (b) Iodobenzene
- (c) p-Aminoazobenzene

24. An organic compound (A) with molecular formula $\text{C}_3\text{H}_5\text{N}$ on reaction with $\text{C}_6\text{H}_5\text{MgBr}$ followed by hydrolysis, gives a compound (B). Compound (B) forms an orange-red precipitate with 2,4-DNP reagent and does not give iodoform test. It neither reduces Tollens' or Fehling's reagent nor does it decolourise bromine water. On drastic oxidation with chromic acid it gives a carboxylic acid (C) having molecular formula $\text{C}_7\text{H}_6\text{O}_2$. Identify the compounds (A), (B) and (C). Write the reactions of compound (A) with $\text{C}_6\text{H}_5\text{MgBr}$ followed by hydrolysis to give compound (B).

25. 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 = $1.86 \text{ K kg mol}^{-1}$)

26(a). Answer the following questions about the complexes $[\text{NiCl}_4]^{2-}$ and $[\text{Ni}(\text{CN})_4]^{2-}$:

- (i) Write the hybridization involved in each case.
- (ii) Which of them is the inner orbital complex and which one is the outer orbital complex?
- (iii) Compare their magnetic behaviour.

[Atomic number: Ni = 28]

OR

26(b). (i) Name two coordination compounds which are important in biological systems.

(ii) What is meant by chelate effect? Give an example.

(iii) Why are low spin tetrahedral complexes rarely formed?

27. State Kohlrausch's law of independent migration of ions. With the help of a curve, explain why it is not easy to determine Λ_{m}^0 for weak electrolytes by extrapolating the concentration - molar conductivity curve, as it is for strong electrolytes.

28. The half-life period of a radioactive element is 1.5×10^{10} years. Calculate the time in which the activity of the element is reduced to 75% of its original value.

[Given: $\log 2 = 0.30$, $\log 3 = 0.48$, $\log 4 = 0.60$]

29a. Case study (Biomolecules): Living systems are made up of various complex biomolecules like carbohydrates, proteins, nucleic acids, lipids, etc. Proteins and carbohydrates are essential constituents of our food. In addition, some simple molecules like vitamins and mineral salts also play an important role in the functions of organisms. All proteins are polymers of α -amino acids. Proteins can be classified into two types on the basis of their molecular shape - Fibrous and Globular proteins. Vitamins are accessory food factors required in the diet. They are classified as fat-soluble and water-soluble. Deficiency of vitamins leads to many diseases. Nucleic acids are the polymers of nucleotides which in turn consist of a base, a pentose sugar and phosphate moiety. There are two types of nucleic acids - DNA and RNA. Nucleic acids are responsible for the transfer of characters from parents to offsprings.

(a) Write the name of basic building units of proteins and nucleic acids. How can you differentiate between Fibrous and Globular proteins on the basis of their structures?

29b-i. (b)(i) What products would be formed when a nucleotide from DNA containing thymine is hydrolyzed?

29b-ii. (b)(ii) Write one structural difference between DNA and RNA.

29c. (c) Give one example each of a fat-soluble vitamin and a water-soluble vitamin.

30a. Case study (Alcohols, Phenols and Ethers): Alcohols have higher boiling points than other compounds, namely hydrocarbons, ethers and haloalkanes of comparable molecular masses. On oxidation, primary alcohols yield aldehydes with mild oxidizing agents and carboxylic acids with strong oxidizing agents. Secondary alcohols yield ketones on oxidation while tertiary alcohols are resistant to oxidation. Ethers may be prepared by dehydration of alcohols and Williamson synthesis. The C-O bond in ethers can be cleaved by hydrogen halides. The presence of -OH group in phenols activates the aromatic ring towards electrophilic substitution and directs the incoming group to ortho and para positions due to resonance effect. In presence of NaOH, phenol generates phenoxide ion which is even more reactive than phenol. Thus, in alkaline medium, phenol undergoes Kolbe's reaction.

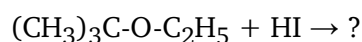
(a) Name the reagents used in the following reactions:

- (i) Oxidation of a primary alcohol to aldehyde
- (ii) Oxidation of a primary alcohol to carboxylic acid

30b. (b) Write the reaction involved in Kolbe's reaction.

30c-i. (c)(i) Why are tertiary alcohols resistant to oxidation?

30c-ii. (c)(ii) Write the products of the following reaction:



Section E

31a. (a)(i) Calculate the electrode potential of a half-cell for zinc electrode dipping in 0.01 M ZnSO_4 solution at 25°C .

Given: $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$; $[\log 10 = 1]$

(ii) Write anode, cathode and overall reaction involved in dry cell.

(iii) Equilibrium constant (K_c) is related to E°_{cell} , but not to E_{cell} . Why?

31b. (b)(i) The conductivity of 0.001 M solution of acetic acid is $3.905 \times 10^{-5} \text{ S cm}^{-1}$. Calculate its molar conductivity and degree of dissociation (α).

Given: $\lambda^\circ_{\text{CH}_3\text{COO}^-} = 40.9 \text{ S cm}^2 \text{ mol}^{-1}$, $\lambda^\circ_{\text{H}^+} = 349.6 \text{ S cm}^2 \text{ mol}^{-1}$.

(ii) Give reasons for the following:

(I) Why does a mercury cell deliver a constant voltage for its entire life?

(II) Why is it necessary to use salt bridge in a galvanic cell?

32a. (a)(i) Describe giving reason which one of the following pairs has the property indicated:

(I) Fe or Cu - higher melting point

(II) Ti^{3+} or Sc^{3+} - coloured in aqueous solution

(III) Cr or Zn - higher third ionisation enthalpy

(ii) Write the ionic equations for the oxidizing action of MnO_4^- in acidic medium with:

(I) Fe^{2+} ion

(II) I^- ion

32b. (b)(i) A black-brown coloured solid (A) when fused with KOH in the presence of air, produces a dark green coloured compound (B) which on electrolytic oxidation in alkaline medium gives a dark purple coloured compound (C). Identify (A), (B) and (C). Write the reactions involved.

(ii) What happens when an acidic solution of the green compound (B) is allowed to stand for some time? Also write the equation involved. What is this type of reaction called?

33a. (a)(i) Write the product(s) when:

(I) One mol of ethanal is treated with 1 mol of CH_3OH in the presence of dry HCl gas.

(II) Benzaldehyde is treated with conc. NaOH.

(III) Ethanoic acid is heated in the presence of P_2O_5 .

(ii) Write a simple chemical test to distinguish between Ethanal and Propanal.

(iii) Write the name of the reagent to transform Allyl alcohol to Propenal.

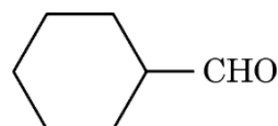
33b. (b)(i) Draw the structure of the semicarbazone of acetone.

(ii) Why are α -hydrogen atoms of aldehydes and ketones acidic in nature?

(iii) Arrange the following compounds in increasing order of their reactivity towards HCN: CH_3COCH_3 , CH_3CHO , $(\text{CH}_3)_3\text{C-CO-CH}_3$

(iv) Write the reaction involved in Etard reaction.

(v) Write the product when



reacts with Zn(Hg)/conc. HCl .

- End of Question Paper -