

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. Among the following outermost electronic configurations of transition metals, which one shows the highest oxidation state?

- (A) $3d^1 4s^2$ (B) $3d^5 4s^1$
(C) $3d^3 4s^2$ (D) $3d^2 4s^2$

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

- (A) 1% KCl (B) 1% glucose
(C) 1% urea (D) 1% CaCl_2

3. Kohlrausch gave the following relation for strong electrolytes:

$$\Lambda_m = \Lambda_m^\circ - A\sqrt{C}$$

Which of the following equality holds true?

- (A) $\Lambda_m = \Lambda_m^\circ$ as $C \rightarrow 1$ (B) $\Lambda_m = \Lambda_m^\circ$ as $C \rightarrow 0$
(C) $\Lambda_m = \Lambda_m^\circ$ as $C \rightarrow \infty$ (D) $\Lambda_m = \Lambda_m^\circ$ as $C \rightarrow \sqrt{A}$

4. Unit of rate constant 'k' for a second order reaction is:

- (A) s^{-1} (B) $\text{mol L}^{-1} \text{s}^{-1}$
(C) $\text{mol}^{-1} \text{L s}^{-1}$ (D) $\text{mol}^{-2} \text{L}^2 \text{s}^{-1}$

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

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

6. The number of moles of AgCl precipitated when excess AgNO_3 solution is mixed with one mole of $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]\text{Cl}$ is:

- (A) 1 (B) 0
(C) 2 (D) 3

7. The synthesis of alkyl fluoride is best carried out by:

- (A) Finkelstein reaction (B) Swarts reaction
(C) Sandmeyer reaction (D) Wurtz reaction

8. In the reaction $\text{R-OH} + \text{HCl} \xrightarrow{[\text{ZnCl}_2]} \text{RCl} + \text{H}_2\text{O}$, what is the correct order of reactivity of alcohols?

- (A) $1^\circ < 2^\circ < 3^\circ$ (B) $2^\circ < 1^\circ < 3^\circ$
(C) $3^\circ > 1^\circ < 2^\circ$ (D) $1^\circ > 2^\circ > 3^\circ$

9. Phenol reacts with Bromine (Br_2) water to form:

- (A) 2,4-dibromophenol (B) 2-bromophenol
(C) 2,4,6-tribromophenol (D) 4-bromophenol

10. When excess of alkyl iodide is treated with ammonia, the product obtained is:

- (A) Primary amine (B) Secondary amine
(C) Tertiary amine (D) A mixture of amines

11. An amine 'X' reacts with Hinsberg reagent and the product obtained is insoluble in alkali. The amine 'X' is:

- (A) $(\text{CH}_3)_2\text{NH}$ (B) $(\text{CH}_3)_3\text{N}$
(C) $\text{CH}_3\text{-CH}_2\text{-NH}_2$ (D) $\text{C}_6\text{H}_5\text{-NH}_2$

12. 'Scurvy' is caused due to the deficiency of:

- (A) Vitamin A (B) Vitamin B₂
(C) Vitamin C (D) Vitamin D
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13. Assertion (A): A mixture of o-nitrophenol and p-nitrophenol can be separated by steam distillation.

Reason (R): o-nitrophenol is steam volatile due to intramolecular hydrogen bonding.

- (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.
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14. Assertion (A): Cooking time is reduced in pressure cooker.

Reason (R): Boiling point of water inside the pressure cooker is lowered down.

- (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.
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15. Assertion (A): Actinoids show irregularities in their electronic configurations.

Reason (R): This is due to varying stability of f^0 , f^7 and f^{14} configurations.

- (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.
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16. Assertion (A): Maltose is a reducing sugar.

Reason (R): One of the two glucose units can open to expose free aldehydic group in solution.

- (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.
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Section B

17. What is meant by negative deviation from Raoult's law? Give an example. What type of azeotrope is formed by negative deviation?

18. (a) Write the IUPAC name of the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$. Draw the structure of geometrical isomer of this complex which is optically inactive.

OR

(b) (i) Write the formula of the following coordination compound:

Pentaamminecarbonatocobalt(III)chloride

(ii) Write the IUPAC name of the linkage isomer of the complex $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$.

19. State a condition under which a bimolecular reaction is kinetically first order reaction. Give an example. For which type of reactions, do order and molecularity have the same value?

20. Write two differences between Amylose and Amylopectin components of starch.

21. Why are haloarenes less reactive towards nucleophilic substitution reaction? How does the presence of nitro ($-\text{NO}_2$) group at ortho- and para-positions in haloarenes increase the reactivity towards nucleophilic substitution reaction?

Section C

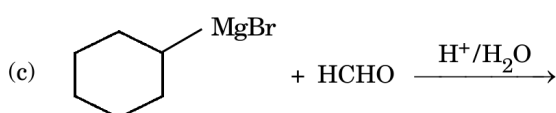
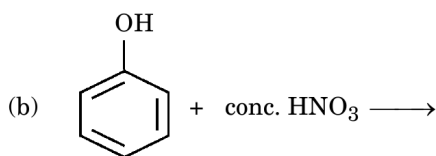
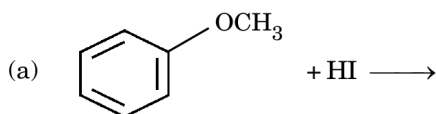
22. Differentiate between:

- (a) Essential amino acids and Non-essential amino acids
- (b) Peptide linkage and Glycosidic linkage
- (c) Fibrous protein and Globular protein

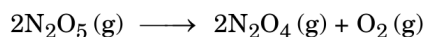
23. Give reasons for the following:

- (a) Benzoic acid does not undergo Friedel-Crafts reaction.
- (b) HCHO is more reactive than CH_3CHO towards addition of HCN.
- (c) Vinyl group directly attached with carboxylic acid should decrease the acidity of corresponding carboxylic acid due to resonance, but on the contrary it increases the acidity.

24. Write structure of the products of the following reactions:



25. The following data were obtained during the first order thermal decomposition of $\text{N}_2\text{O}_5(\text{g})$ at constant volume:



S.No.	Time/s	Total Pressure/atm
1	0	0.5
2	100	0.625

Calculate rate constant.

[Given: $\log 2 = 0.3010$, $\log 10 = 1$]

26. A compound (A) with molecular formula $\text{C}_4\text{H}_9\text{I}$ which is a primary alkyl halide, reacts with alcoholic KOH to give compound (B). Compound (B) reacts with HI to give (C) which is an isomer of (A). When (A) reacts with Na metal in the presence of dry ether, it gives a compound (D), C_8H_{18} , which is different from the compound formed when n-butyl iodide reacts with sodium. Write the structures of (A), (B), (C) and (D). Write the chemical equation when compound (A) is reacted with alcoholic KOH.

27. (a) Write the name of the cell which is generally used in inverters. Write the reactions taking place at anode and cathode of this cell, when it is in use.

OR

(b) Explain why electrolysis of an aqueous solution of NaCl gives H_2 gas at cathode and Cl_2 gas at anode? Write overall reaction.

(Given: $E^\circ_{\text{Na}^+/\text{Na}} = -2.71 \text{ V}$, $E^\circ_{\text{H}_2\text{O}/\text{H}_2} = -0.83 \text{ V}$, $E^\circ_{\text{Cl}_2/2\text{Cl}^-} = +1.36 \text{ V}$, $E^\circ_{\text{H}^+/\text{O}_2/\text{H}_2\text{O}} = +1.23 \text{ V}$)

28. 0.3 g of acetic acid (Molar mass = 60 g mol^{-1}) dissolved in 30 g of benzene shows a depression in freezing point equal to 0.45°C . Calculate the percentage association of acid if it forms a dimer in the solution.

(Given: K_f for benzene = $5.12 \text{ K kg mol}^{-1}$)

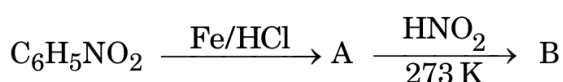
29. Amines are usually formed from amides, imides, halides, nitro compounds, etc. They exhibit hydrogen bonding which influences their physical properties. In alkyl amines, a combination of electron releasing, steric and H-bonding factors influence the stability of the substituted ammonium cations in protic polar solvents and thus affect the basic nature of amines. Alkyl amines are found to be stronger bases than ammonia. Amines being basic in nature, react with acids to form salts. Aryldiazonium salts, undergo replacement of the diazonium group with a variety of nucleophiles to produce aryl halides, cyanides, phenols and arenes.

Answer the following questions:

- (a) How can you convert the following?
- (i) Ethanoic acid to methanamine
- (ii) Propanenitrile to 1-aminopropane
- (b) Why is pK_b value of aniline more than that of methylamine?
- (c) (i) Arrange the following in increasing order of their basic strength in aqueous solution:
 $\text{CH}_3\text{-NH}_2$, $(\text{CH}_3)_2\text{NH}$, $(\text{CH}_3)_3\text{N}$

OR

- (c) (ii) Give the structures of A and B in the following reaction:



30. 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. In tetrahedral coordination entity formation, the d-orbital splitting is smaller as compared to the octahedral entity.

Answer the following questions:

- (a) On the basis of CFT, explain why $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$ complex is coloured? What happens on heating the complex $[\text{Ti}(\text{H}_2\text{O})_6]\text{Cl}_3$? Give reason.

[Atomic no.: Ti = 22]

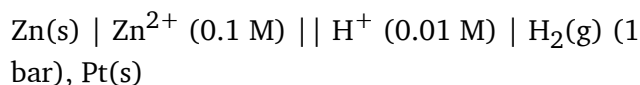
- (b) (i) What is crystal field splitting energy?

OR

- (b) (ii) On the basis of Δ_o and P (pairing energy), how can you differentiate between a strong field ligand and a weak field ligand?
- (c) Why are low spin tetrahedral complexes rarely observed?

Section E

31. (a) (i) Calculate the emf of the following cell at 25°C:



[Given: $E^\circ_{\text{Zn}^{2+}/\text{Zn}} = -0.76 \text{ V}$, $E^\circ_{2\text{H}^+/\text{H}_2} = 0.00 \text{ V}$, $\log 10 = 1$]

(ii) State Faraday's second law of electrolysis. How much electricity is required in terms of Faraday for the reduction of 1 mol of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} ?

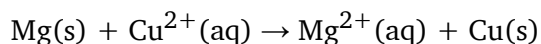
OR

(b) Answer the following questions:

(i) The conductivity of 0.20 M solution of KCl is $2.48 \times 10^{-2} \text{ S cm}^{-1}$. Calculate its molar conductivity and degree of dissociation (α).

[Given: $\lambda^\circ_{(\text{K}^+)} = 73.5 \text{ S cm}^2 \text{ mol}^{-1}$, $\lambda^\circ_{(\text{Cl}^-)} = 76.5 \text{ S cm}^2 \text{ mol}^{-1}$]

(ii) Calculate $\Delta_r G^\circ$ of the following cell:



[Given: $E^\circ_{\text{Mg}^{2+}/\text{Mg}} = -2.37 \text{ V}$, $E^\circ_{\text{Cu}^{2+}/\text{Cu}} = +0.34 \text{ V}$, $1 \text{ F} = 96500 \text{ C mol}^{-1}$]

(iii) What type of cell is mercury cell? Why is it more advantageous than dry cell?

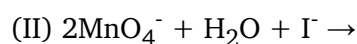
32. (a) (i) Account for the following:

(I) The $E^\circ_{\text{Mn}^{2+}/\text{Mn}}$ value for manganese is highly negative, whereas $E^\circ_{\text{Mn}^{3+}/\text{Mn}^{2+}}$ is highly positive.

(II) Actinoids show wide range of oxidation states.

(III) Transition metals have high melting points.

(ii) Complete the following ionic equations:



OR

(b) Answer the following questions:

(i) Name two elements of 3d series for which the third ionisation enthalpies are quite high.

(ii) Out of KMnO_4 and K_2MnO_4 , which one is paramagnetic and why?

(iii) Write any one consequence of lanthanoid contraction.

(iv) How do you prepare potassium manganate from pyrolusite ore?

(v) Why is the ability of oxygen more than fluorine to stabilise higher oxidation states of transition metals?

33. (a) (i) An organic compound (X) having molecular formula $C_5H_{10}O$ can show various properties depending on its structures. Draw each of the structures if it:

(I) shows Cannizzaro reaction.

(II) reduces Tollens' reagent and has a chiral carbon.

(III) gives positive iodoform test.

(ii) Write the reaction involved in the following:

(I) Clemmensen reduction

(II) Etard reaction

OR

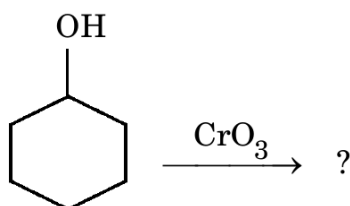
(b) Answer the following questions:

(i) Draw structure of the methyl hemiacetal of methanal.

(ii) There are two $-NH_2$ groups in semicarbazide. However only one is involved in the formation of semicarbazones. Give reason.

(iii) How will you convert ethanol to 3-hydroxybutanal?

(iv) Complete the following equation:



(v) Write the final product formed when phthalic acid is treated with NH_3 followed by strong heating.