

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 **35 questions**. All questions are compulsory.
- (ii) Section A: Questions 1 to 18 are multiple choice questions, carrying 1 mark each.
- (iii) Section B: Questions 19 to 25 are very short answer questions, carrying 2 marks each.
- (iv) Section C: Questions 26 to 30 are short answer questions, carrying 3 marks each.
- (v) Section D: Questions 31 to 32 are case-based questions, carrying 4 marks each.
- (vi) Section E: Questions 33 to 35 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.

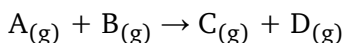
Section A

1. The magnetic moment of $[\text{NiCl}_4]^{2-}$ is

[Atomic number : Ni = 28]

- (A) 1.82 BM (B) 2.82 BM
(C) 4.42 BM (D) 5.46 BM

2. The following experimental rate data were obtained for a reaction carried out at 25 °C:

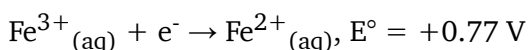
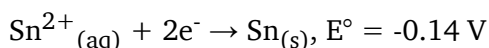


Initial $[\text{A}_{(\text{g})}]/\text{mol dm}^{-3}$	Initial $[\text{B}_{(\text{g})}]/\text{mol dm}^{-3}$	Initial rate/ $\text{mol dm}^{-3}\text{s}^{-1}$
3.0×10^{-2}	2.0×10^{-2}	1.89×10^{-4}
3.0×10^{-2}	4.0×10^{-2}	1.89×10^{-4}
6.0×10^{-2}	4.0×10^{-2}	7.56×10^{-4}

What are the orders with respect to $\text{A}_{(\text{g})}$ and $\text{B}_{(\text{g})}$?

- (A) Order w.r.t. A: Zero; Order w.r.t. B: Second
(B) Order w.r.t. A: First; Order w.r.t. B: Zero
(C) Order w.r.t. A: Second; Order w.r.t. B: Zero
(D) Order w.r.t. A: Second; Order w.r.t. B: First

3. Consider the following standard electrode potential values:



What is the cell reaction and potential for the spontaneous reaction that occurs ?

- (A) $2 \text{Fe}^{2+}_{(\text{aq})} + \text{Sn}^{2+}_{(\text{aq})} \rightarrow 2 \text{Fe}^{3+}_{(\text{aq})} + \text{Sn}_{(\text{s})}, E^\circ = -0.91 \text{ V}$
(B) $2 \text{Fe}^{3+}_{(\text{aq})} + \text{Sn}_{(\text{s})} \rightarrow 2 \text{Fe}^{2+}_{(\text{aq})} + \text{Sn}^{2+}_{(\text{aq})}, E^\circ = +0.91 \text{ V}$
(C) $2 \text{Fe}^{2+}_{(\text{aq})} + \text{Sn}^{2+}_{(\text{aq})} \rightarrow 2 \text{Fe}^{3+}_{(\text{aq})} + \text{Sn}_{(\text{s})}, E^\circ = +0.91 \text{ V}$
(D) $2 \text{Fe}^{3+}_{(\text{aq})} + \text{Sn}_{(\text{s})} \rightarrow 2 \text{Fe}^{2+}_{(\text{aq})} + \text{Sn}^{2+}_{(\text{aq})}, E^\circ = +1.68 \text{ V}$

4. Which of the following cell was used in Apollo space programme ?

- (A) Mercury cell (B) Daniel cell
(C) $\text{H}_2\text{-O}_2$ Fuel cell (D) Dry cell

5. Which of the following alcohols will not undergo oxidation ?

- (A) Butanol (B) Butan-2-ol
(C) 2-Methylbutan-2-ol (D) 3-Methylbutan-2-ol

6. The unit of molar conductivity is

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

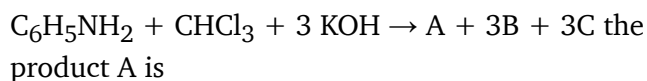
7. Out of the following 1.0 M aqueous solutions, which one will show largest freezing point depression ?

- (A) NaCl (B) Na_2SO_4
(C) $\text{C}_6\text{H}_{12}\text{O}_6$ (D) $\text{Al}_2(\text{SO}_4)_3$

8. Which of the following molecules has a chiral centre correctly labelled with an asterisk (*) ?

- (A) $\text{CH}_3\text{C}^*\text{HBrCH}_3$
(B) $\text{CH}_3\text{C}^*\text{HClCH}_2\text{Br}$
(C) $\text{HOCH}_2\text{C}^*\text{H}(\text{OH})\text{CH}_2\text{OH}$
(D) $\text{CH}_3\text{C}^*\text{Br}_2\text{CH}_3$

9. In the reaction

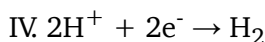
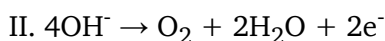
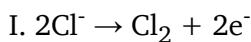


- (A) $\text{C}_6\text{H}_5\text{NC}$ (B) $\text{C}_6\text{H}_5\text{CN}$
(C) $\text{C}_6\text{H}_5\text{Cl}$ (D) $\text{C}_6\text{H}_5\text{NHCH}_3$

10. β -pleated sheet structure in proteins refers to

- (A) primary structure (B) secondary structure
(C) tertiary structure (D) quaternary structure

11. Four half reactions I to IV are shown below:



Which two of these reactions are most likely to occur when concentrated brine is electrolysed ?

- (A) I and III (B) I and IV
(C) II and III (D) II and IV

12. Which property of transition metals enables them to behave as catalysts ?

- (A) High melting point (B) High ionisation enthalpy
(C) Alloy formation (D) Variable oxidation states

13. Which of the following would not be a good choice for reducing nitrobenzene to aniline ?

- (A) LiAlH_4 (B) H_2/Ni
(C) Fe and HCl (D) Sn and HCl

14. Which one of the following has lowest pK_a value ?

- (A) $\text{CH}_3\text{—COOH}$ (B) $\text{O}_2\text{N—CH}_2\text{—COOH}$
(C) $\text{Cl—CH}_2\text{—COOH}$ (D) HCOOH

15. Assertion (A): The backbone of DNA and RNA molecules is a chain consisting of heterocyclic base, pentose sugar and phosphate group.

Reason (R): Nucleotides and nucleosides mainly differ from each other in presence of phosphate group.

- (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 applicable to elementary as well as complex reactions.

Reason (R): For a complex reaction molecularity has no meaning.

- (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.

17. Assertion (A): The final product in Aldol condensation is always α,β -unsaturated carbonyl compound.

Reason (R): α,β -unsaturated carbonyl compounds are stabilised due to conjugation.

- (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.

18. Assertion (A): $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$ gives a white precipitate with silver nitrate solution.

Reason (R): The complex dissociates to give Cl^- and SO_4^{2-} ions.

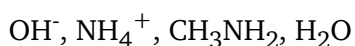
- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A). (B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false. (D) Assertion (A) is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

Section B

19. For the pair phenol and cyclohexanol, answer the following:

- (a) Why is phenol more acidic than cyclohexanol ?
(b) Give one chemical test to distinguish between the two.

20. (a) Which of the following species cannot act as a ligand ? Give reason.



(b) The complex $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$ is red in colour. Give IUPAC name of its linkage isomer.

21. What happens to the rate constant k and activation energy E_a as the temperature of a chemical reaction is increased ? Justify.

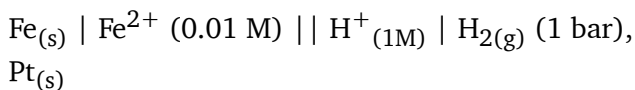
22. Why haloarenes are not reactive towards nucleophilic substitution reaction ? Give two reasons.

23. (a) (i) What should be the signs (positive/negative) for E°_{cell} and ΔG° for a spontaneous redox reaction occurring under standard conditions ?

(ii) State Faraday's first law of electrolysis.

OR

(b) Calculate the emf of the following cell at 298 K:



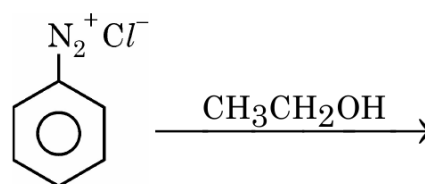
Given $E^\circ_{\text{cell}} = 0.44 \text{ V}$.

24. (a) (i) Draw the zwitter ion structure for sulphanilic acid.

(ii) How can the activating effect of $-\text{NH}_2$ group in aniline be controlled ?

OR

(b) (i) Complete the reaction with the main product formed:



(ii) Convert Bromoethane to Propanamine.

25. Give the reaction of heating glucose with hydroxylamine. Presence of which group is confirmed by this reaction ?

Section C

26. Give reasons for any 3 of the following observations:

- (a) Penta-acetate of glucose does not react with hydroxylamine.
- (b) Amino acids behave like salts.
- (c) Water soluble vitamins must be taken regularly in diet.
- (d) The two strands in DNA are complimentary to each other.

27. (a) On the basis of crystal field theory, write the electronic configuration for d^4 with a strong field ligand for which $\Delta_o > P$.

(b) A solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green but a solution of $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless. Explain.

[Atomic number : Ni = 28]

28. (a) (i) Why is the C—O bond length in phenols less than that in methanol ?

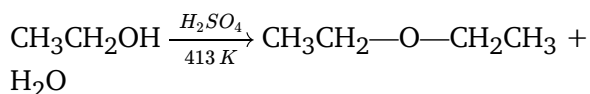
(ii) Arrange the following in order of increasing boiling point:

Ethoxyethane, Butanal, Butanol, n-butane

(iii) How can phenol be prepared from anisole ? Give reaction.

OR

(b) (i) Give mechanism of the following reaction:

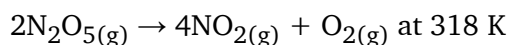


(ii) Illustrate hydroboration–oxidation reaction with an example.

29. (a) Illustrate Sandmeyer's reaction with an equation.

(b) Explain, why $(\text{CH}_3)_2\text{NH}$ is more basic than $(\text{CH}_3)_3\text{N}$ in aqueous solution.

30. (a) For the reaction



calculate the rate of reaction if rate of disappearance of $\text{N}_2\text{O}_{5(\text{g})}$ is $1.4 \times 10^{-3} \text{ mol L}^{-1} \text{ s}^{-1}$.

(b) For a first order reaction derive the relationship $t_{99\%} = 2 t_{90\%}$.

31. Nucleophilic Substitution

Nucleophilic Substitution reaction of haloalkane can be conducted according to both S_N1 and S_N2 mechanisms. S_N1 is a two step reaction while S_N2 is a single step reaction. For any haloalkane which mechanism is followed depends on factors such as structure of haloalkane, properties of leaving group, nucleophilic reagent and solvent.

Influences of solvent polarity: In S_N1 reaction, the polarity of the system increases from the reactant to the transition state, because a polar solvent has a greater effect on the transition state than the reactant, thereby reducing activation energy and accelerating the reaction. In S_N2 reaction, the polarity of the system generally does not change from the reactant to the transition state and only charge dispersion occurs. At this time, polar solvent has a great stabilizing effect on Nu than the transition state, thereby increasing activation energy and slow down the reaction rate. For example, the decomposition rate (S_N1) of tertiary chlorobutane at 25 °C in water (dielectric constant 79) is 300000 times faster than in ethanol (dielectric constant 24). The reaction rate (S_N2) of 2-Bromopropane and NaOH in ethanol containing 40% water is twice slower than in absolute ethanol. Hence the level of solvent polarity has influence on both S_N1 and S_N2 reaction, but with different results. Generally speaking weak polar solvent is favourable for S_N2 reaction, while strong polar solvent is favourable for S_N1 . Generally speaking the substitution reaction of tertiary haloalkane is based on S_N1 mechanism in solvents with a strong polarity (for example ethanol containing water).

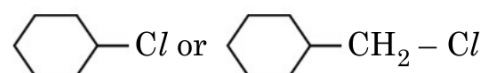
31a. (a) Why racemisation occurs in S_N1 ?

31b. (b) Why is ethanol less polar than water ?

31c. (c) Which one of the following in each pair is more reactive towards S_N2 reaction ?

(i) $\text{CH}_3\text{—CH}_2\text{—I}$ or $\text{CH}_3\text{CH}_2\text{—Cl}$

(ii)



OR

(c) Arrange the following in the increasing order of their reactivity towards S_N1 reactions:

(i) 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane

(ii) 1-Bromo-3-methylbutane, 2-Bromo-2-methylbutane, 2-Bromo-3-methylbutane

32. Rahul set-up an experiment to find resistance of aqueous KCl solution for different concentrations at 298 K using a conductivity cell connected to a Wheatstone bridge. He fed the Wheatstone bridge with a.c. power in the audio frequency range 550 to 5000 cycles per second. Once the resistance was calculated from null point he also calculated the conductivity κ and molar conductivity Λ_m and recorded his readings in tabular form.

S.No.	Conc.(M)	$\kappa \text{ S cm}^{-1}$	$\Lambda_m \text{ S cm}^2 \text{ mol}^{-1}$
1.	1.00	111.3×10^{-3}	111.3
2.	0.10	12.9×10^{-3}	129.0
3.	0.01	1.41×10^{-3}	141.0

32a. (a) Why does conductivity decrease with dilution ?

32b. (b) If Λ_m° of KCl is $150.0 \text{ S cm}^2 \text{ mol}^{-1}$, calculate the degree of dissociation of 0.01 M KCl.

32c. (c) If Rahul had used HCl instead to KCl then would you expect the Λ_m values to be more or less than those per KCl for a given concentration. Justify.

OR

(c) Amit, a classmate of Rahul repeated the same experiment with CH_3COOH solution instead of KCl solution. Give one point that would be similar and one that would be different in his observations as compared to Rahul.

33. (a) (i) Write the reaction involved in Cannizzaro's reaction.

(ii) Why are the boiling point of aldehydes and ketones lower than that of corresponding carboxylic acids ?

(iii) An organic compound 'A' with molecular formula $C_5H_8O_2$ is reduced to n-pentane with hydrazine followed by heating with NaOH and Glycol. 'A' forms a dioxime with hydroxylamine and gives a positive Iodoform and Tollen's test. Identify 'A' and give its reaction for Iodoform and Tollen's test.

OR

(b) (i) Give a chemical test to distinguish between ethanal and ethanoic acid.

(ii) Why is the α -hydrogens of aldehydes and ketones are acidic in nature ?

(iii) An organic compound 'A' with molecular formula $C_4H_8O_2$ undergoes acid hydrolysis to form two compounds 'B' and 'C'. Oxidation of 'C' with acidified potassium permanganate also produces 'B'. Sodium salt of 'B' on heating with soda lime gives methane.

(1) Identify 'A', 'B' and 'C'.

(2) Out of 'B' and 'C', which will have higher boiling point ? Give reason.

34. (a) (i) Why is boiling point of 1M NaCl solution more than that of 1M glucose solution ?

(ii) A non-volatile solute 'X' (molar mass = 50 g mol^{-1}) when dissolved in 78 g of benzene reduced its vapour pressure to 90%. Calculate the mass of X dissolved in the solution.

(iii) Calculate the boiling point elevation for a solution prepared by adding 10 g of $MgCl_2$ to 200 g of water assuming $MgCl_2$ is completely dissociated.

(K_b for Water = 0.512 K kg mol^{-1} , Molar mass $MgCl_2$ = 95 g mol^{-1})

OR

(b) (i) Why is the value of Van't Hoff factor for ethanoic acid in benzene close to 0.5 ?

(ii) Determine the osmotic pressure of a solution prepared by dissolving 2.32×10^{-2} g of K_2SO_4 in 2 L of solution at 25 °C, assuming that K_2SO_4 is completely dissociated.

(R = 0.082 L atm $K^{-1} mol^{-1}$, Molar mass K_2SO_4 = 174 g mol^{-1})

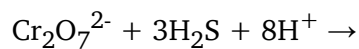
(iii) When 25.6 g of Sulphur was dissolved in 1000 g of benzene, the freezing point lowered by 0.512 K. Calculate the formula of Sulphur (S_x).

(K_f for benzene = 5.12 K kg mol^{-1} , Atomic mass of Sulphur = 32 g mol^{-1})

35. (a) Write the number of unpaired electrons in Cr^{2+} .

(Atomic number of Cr = 24)

(b) Complete the reaction mentioning all the products formed:



(c) Account for the following:

(i) Mn^{2+} is more stable than Fe^{2+} towards oxidation to +3 state.

(ii) Copper has exceptionally positive $E^\circ_{\text{Cu}^{2+}/\text{Cu}}$ value.

(iii) Eu^{2+} with electronic configuration $[\text{Xe}] 4f^7 6s^2$ is a strong reducing agent.

- End of Question Paper -