

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. $\text{CH}_3\text{CH}_2\text{CHO}$ and $\text{CH}_3\text{CH}_2\text{COOH}$ can be distinguished by:

- (A) Sodium bicarbonate test (B) Hinsberg test
(C) Iodoform test (D) Lucas test

2. While doing qualitative analysis in chemistry lab, Abhishek added yellow coloured potassium chromate solution into a test tube. He was surprised to see the colour of the solution changing immediately to orange. He realised that the test tube was not clean and contained a few drops of some liquid. Which of the following substances will be the most likely liquid to be present in the test tube before adding potassium chromate solution?

- (A) Sodium hydrogen carbonate solution (B) Methyl orange solution
(C) Sodium hydroxide solution (D) HCl solution

3. The role of a catalyst is to change:

- (A) equilibrium constant (B) enthalpy of reaction
(C) Gibbs energy of reaction (D) activation energy of reaction

4. Which of the following molecules is chiral in nature?

- (A) 1-chloropropane (B) 2-chloropropane
(C) 1-chlorobutane (D) 2-chlorobutane

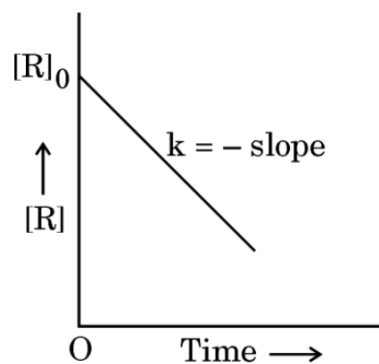
5. $\text{CH}_3\text{CH}_2\text{OH}$ can be converted to CH_3CHO by:

- (A) catalytic hydrogenation (B) treatment with LiAlH_4
(C) treatment with PCC (D) treatment with KMnO_4

6. The IUPAC name for $\text{CH}_3 - \text{CH}_2 - \text{N}(\text{CH}_3) - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ is:

- (A) N-methylpentan-2-amine (B) N-ethyl-N-methylpropan-1-amine
(C) N,N-diethylpropan-1-amine (D) N,N-dimethylpropan-1-amine

7. A plot between concentration of reactant $[\text{R}]$ and time 't' is shown below. Which of the given order of reaction is indicated by the graph?



- (A) Third order (B) Second order
(C) First order (D) Zero order

8. The treatment of ethyl bromide with alcoholic silver nitrite gives:

- (A) ethyl nitrite (B) nitroethane
(C) nitromethane (D) ethene

9. Which of the following aqueous solutions will have the highest freezing point?

- (A) 1.0 M KCl (B) 1.0 M Na_2SO_4
(C) 1.0 M Glucose (D) 1.0 M AlCl_3

10. Which of the following aldehydes will undergo Cannizzaro reaction?

- (A) $\text{CH}_3 - \text{CH}(\text{CH}_3) - \text{CHO}$ (B) $(\text{CH}_3)_3\text{C} - \text{CHO}$
(C) $\text{CH}_3 - \text{CH}_2 - \text{CHO}$ (D) $\text{CH}_3 - \text{CH}(\text{CH}_3) - \text{CH}(\text{CH}_3) - \text{CHO}$

11. In which of the following groups are both ions coloured in aqueous solution?

I. Cu^+ II. Ti^{4+} III. Co^{2+} IV. Fe^{2+}

[Atomic number: Cu = 29, Ti = 22, Co = 27, Fe = 26]

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

12. Match the type of cell given in Column I with their use given in Column II.

Column I **Column II**

- i. Lead storage cell a. Wall clock
ii. Mercury cell b. Apollo Space Programme
iii. Dry cell c. Wrist watch
iv. Fuel cell d. Inverter

- (A) i-a, ii-b, iii-c, iv-d (B) i-d, ii-c, iii-a, iv-b
(C) i-c, ii-d, iii-b, iv-a (D) i-b, ii-a, iii-d, iv-c

13. Given below are two statements labelled as Assertion (A) and Reason (R). Select the correct answer from the codes (A), (B), (C) and (D):

(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.

Assertion (A): The solubility of aldehydes and ketones in water decreases with increase in size of the alkyl group.

Reason (R): Aldehydes and ketones have dipole-dipole interaction.

- (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. Given below are two statements labelled as Assertion (A) and Reason (R). Select the correct answer from the codes (A), (B), (C) and (D):

(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.

Assertion (A): The boiling points of alkyl halides decrease in the order $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$.

Reason (R): The van der Waals forces of attraction decrease in the order $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$.

- (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. Given below are two statements labelled as Assertion (A) and Reason (R). Select the correct answer from the codes (A), (B), (C) and (D):

(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.

Assertion (A): For measuring resistance of an ionic solution an AC source is used.

Reason (R): Concentration of ionic solution will change if DC source is used.

(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. Given below are two statements labelled as Assertion (A) and Reason (R). Select the correct answer from the codes (A), (B), (C) and (D):

(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.

Assertion (A): Henry's law constant (K_H) decreases with increase in temperature.

Reason (R): As the temperature increases, solubility of gases in liquids decreases.

(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. For KCl solution, the conductivity (κ , in S cm^{-1}) and molar conductivity (Λ_m , in $\text{S cm}^2 \text{mol}^{-1}$) at 298.15 K at different concentrations are given:

Concentration (mol/L)	Conductivity (S cm^{-1})	Molar Conductivity ($\text{S cm}^2 \text{mol}^{-1}$)
1.000	0.1113	111.3
0.100	0.0129	129.0
0.010	0.00141	141.0

Based on the data given above, give plausible reason for the variation of conductivity and molar conductivity with concentration.

18. (a) Calculate the elevation of boiling point of a solution when 3 g of CaCl_2 (Molar mass = 111 g mol^{-1}) was dissolved in 260 g of water, assuming that CaCl_2 undergoes complete dissociation. (K_b for water = $0.52 \text{ K kg mol}^{-1}$)

OR

(b) Liquids 'X' and 'Y' form an ideal solution. The vapour pressure of pure 'X' and pure 'Y' are 120 mm Hg and 160 mm Hg respectively. Calculate the vapour pressure of the solution containing equal moles of 'X' and 'Y'.

19. (a) Give any two differences between order and molecularity of a reaction.

(b) For a reaction $\text{X} + \text{Y} \rightarrow \text{Z}$, in which both X and Y follow first order kinetics; if the concentration of X is increased 2 times and concentration of Y is increased 3 times, how does it affect the rate of reaction?

20. Write the mechanism of dehydration of ethyl alcohol with conc. H_2SO_4 at 443 K.

21. (a) Carboxylic acid is more acidic than phenol. Give reason.

(b) Give a chemical test to distinguish between benzaldehyde and acetophenone.

Section C

22. (a) Shweta mixed two liquids A and B of 10 mL each. After mixing, the volume of the solution was found to be 20.2 mL.

(i) Why was there a volume change after mixing the liquids?

(ii) Will there be an increase or decrease of temperature after mixing?

(iii) Give one example for this type of solution.

OR

(b) (i) How does sprinkling of salt help in clearing the snow covered roads in hilly areas?

(ii) What happens when red blood cells are kept in 0.5% (mass/vol) NaCl solution? Justify your answer.

(iii) Write an application of reverse osmosis.

23. For the reaction $A + B \rightarrow \text{Products}$, the following initial rates were obtained at various initial concentrations of reactants:

Sl. No.	[A]/mol L ⁻¹	[B]/mol L ⁻¹	Initial rate/mol L ⁻¹ s ⁻¹
1	0.1	0.1	0.05
2	0.2	0.1	0.10
3	0.1	0.2	0.05

Determine the order of the reaction with respect to A and B and overall order of the reaction.

24. (a) Write the name and structure of a hexadentate ligand.

(b) Why is $[\text{Ni}(\text{CN})_4]^{2-}$ square planar while $[\text{Ni}(\text{CO})_4]$ is tetrahedral? [Atomic number: Ni = 28]

25. Account for the following:

(a) Haloarenes are less reactive towards nucleophilic substitution reactions.

(b) p-dichlorobenzene has higher melting point than ortho and meta isomers.

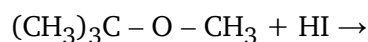
(c) Tertiary alkyl halides are least reactive towards $\text{S}_{\text{N}}2$ reaction.

26. (a) Write the chemical equation for the following:

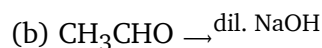
(i) Preparation of phenol from cumene

(ii) Nitration of anisole

(b) Complete the following:



27. Write the products formed in the following reactions:



28. (a) Name the vitamin which is responsible for coagulation of blood.

(b) What is meant by denaturation of protein? Give an example.

29. Carbohydrates are polyhydroxy aldehydes or ketones that represent enormous structural diversity in terms of the arrangement of atoms in space, resulting in hundreds of stereoisomers. Although the chemical properties of most stereoisomers may not be very different, their metabolic rate and utilization in biological systems is significantly different and known to influence the overall carbohydrate metabolism. Structural variants, which arise due to a different arrangement of atoms in three-dimensional space are known as stereoisomers. The number of stereoisomers can be theoretically estimated by using the formula 2^n , where 'n' is the number of stereocenters or asymmetric (chiral) carbon atoms in a molecule. Out of these stereoisomers, there are some structures, which are mirror images of each other, and they are referred to as enantiomers.

Answer the following questions:

- (a) Give chemical reactions to show the presence of an aldehydic group and straight chain in glucose.
- (b) (i) Define anomers.

OR

- (b) (ii) Draw the structure of β -D-Glucopyranose.
- (c) Sucrose is known as invert sugar. Explain.

30. Werner's coordination theory in 1893 was the first attempt to explain the bonding in coordination complexes. It must be remembered that this theory was put forward before the electron had been discovered by J.J. Thomson in 1897, and before the electronic theory of valency. Werner did not have any of the modern instrumental techniques and all his studies were made using simple experimental techniques. Werner was able to explain the nature of bonding in complexes and he concluded that in complexes, the metal shows two different sorts of valency: primary and secondary. Primary valences are normally ionisable whereas secondary valences are non ionisable.

Answer the following questions:

- (a) One mole of $\text{CrCl}_3 \cdot 4\text{H}_2\text{O}$ precipitates one mole of AgCl when treated with excess of AgNO_3 solution. Write (i) the structural formula of the complex, and (ii) the secondary valency of Cr.
- (b) What is the difference between a complex and a double salt?
- (c) (i) Arrange the following complexes in the increasing order of conductivity of their solution: $[\text{Cr}(\text{NH}_3)_3\text{Cl}_3]$, $[\text{Cr}(\text{NH}_3)_6]\text{Cl}_3$, $[\text{Cr}(\text{NH}_3)_5\text{Cl}]\text{Cl}_2$

OR

- (c) (ii) Write two differences between primary and secondary valences in coordination compounds.

31. (a) (i) When pyrolusite ore is fused with KOH, in presence of air, a dark green coloured product 'A' is obtained which changes to purple coloured compound 'B' in acidic medium.

(I) Write the formulae of 'A' and 'B'.

(II) Write the ionic equation for the reaction when compound 'B' reacts with Fe^{2+} in acidic medium.

(ii) Give reasons:

(I) Ce^{4+} in aqueous solution is a good oxidising agent.

(II) The actinoid contraction is greater from element to element than lanthanoid contraction.

(III) $E^\circ_{\text{Zn}^{2+}/\text{Zn}}$ value is more negative than expected, whereas $E^\circ_{\text{Cu}^{2+}/\text{Cu}}$ is positive.

OR

(b) (i) While studying the periodic properties, Arti came across an abnormal behaviour in the atomic size of Hf. She found that, even though Hf is placed below Zr in the same group, both have almost similar atomic sizes.

(I) Which phenomenon is responsible for the above behaviour? Define it.

(II) Mention any other consequence of the above phenomenon.

(ii) Give reasons for the following:

(I) Transition metals exhibit catalytic properties.

(II) Transition metals have high enthalpy of atomisation.

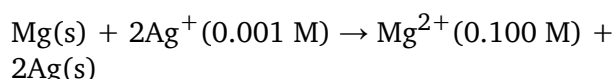
(III) Sc is a transition element, while Zn is not.

32. (a) (i) For a galvanic cell, the following half reactions are given. Decide, which will remain as reduction reaction and which will be reversed to become an oxidation reaction. Give reason for your answer.

(I) $\text{Cr}^{3+} + 3\text{e}^- \rightarrow \text{Cr(s)}$; $E^\circ = -0.74 \text{ V}$

(II) $\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe(s)}$; $E^\circ = -0.44 \text{ V}$

(ii) Represent the cell in which the following reaction takes place:



Calculate E_{cell} if $E^\circ_{\text{cell}} = 3.17 \text{ V}$. ($\log 10 = 1$)

OR

(b) (i) State Kohlrausch's law. Give any two applications of it.

(ii) $\Lambda_m^\infty \text{NH}_4\text{Cl}$, $\Lambda_m^\infty \text{NaOH}$ and $\Lambda_m^\infty \text{NaCl}$ are 129.8, 217.4, and 108.9 $\text{S cm}^2 \text{mol}^{-1}$ respectively. Molar conductivity of $1 \times 10^{-2} \text{ M}$ solution of NH_4OH is 9.33 $\text{S cm}^2 \text{mol}^{-1}$. Calculate the degree of dissociation (α) of NH_4OH solution at this concentration.

33. (a) (i) In a chemistry practical class, the teacher gave his students an amine 'X' having molecular formula C_2H_7N , and asked the students to identify the type of amine. One of the students, Neeta, observed that it reacts with $C_6H_5SO_2Cl$, to give a compound which dissolves in NaOH solution. Can you help Neeta to identify the compound 'X'?

(ii) Arrange the following in the increasing order of their pK_b value in aqueous phase:



(iii) Aniline on nitration gives considerable amount of meta product along with ortho and para products. Why?

(iv) Convert aniline to:

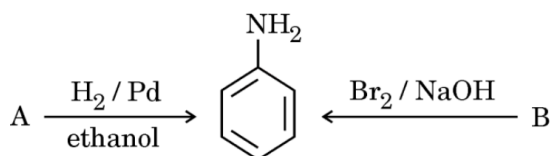
(I) p-bromoaniline

(II) phenol

OR

(b) (i) Arun heated a mixture of ethylamine and $CHCl_3$ with ethanolic KOH, which forms a foul smelling gas. Write the chemical equation involved.

(ii) Identify A and B in the following reactions:



(iii) Convert aniline to:

(I) benzene

(II) sulphanilic acid