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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 2 · Session 2026-27

Time allowed: 3 hours (plus 15 minutes reading time) **Maximum marks: 70**

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This is an original practice paper written to the CISCE 2027 specimen paper format; it is not issued by CISCE.

General instructions:

1. You are allowed an additional fifteen minutes for only reading the question paper. You must NOT start writing during the reading time.
2. The paper is divided into four sections and has twenty-one questions in all. Answer all questions.
3. Section A has fourteen subparts. Each subpart carries 1 mark.
4. While attempting Multiple Choice Questions in Section A, you are required to write only ONE option as the answer.
5. Section B has ten questions of 2 marks each. Section C has seven questions of 3 marks each. Section D has three questions of 5 marks each.
6. Internal choices have been provided in two questions each in Sections B, C and D.
7. The intended marks for questions are given in brackets [ ].
8. Balanced equations must be given wherever possible and diagrams where they are helpful. When solving numerical problems, all essential working must be shown.
9. Use: R = 1.987 cal K^{-1} mol^{-1} = 8.314 J K^{-1} mol^{-1} = 0.0821 dm^3 atm K^{-1} mol^{-1}; 1 L atm = 101.3 J; 1 faraday = 96500 C; Avogadro's number = 6.023×10^{23}.

Section A (14 marks)

1.	**(i)** *(A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets:* [Finkelstein, Swarts, Wurtz, positive, negative, maximum, minimum, one, three, galvanic, electrolytic, salicylaldehyde, salicylic acid, Reimer–Tiemann, Kolbe's] Ethyl iodide is made from ethyl chloride and NaI in dry acetone by the _____ reaction, while heating an alkyl chloride with AgF gives an alkyl fluoride by the _____ reaction.	1
	(ii) A mixture of chloroform and acetone shows _____ deviation from Raoult's law and forms a _____-boiling azeotrope.	1
	(iii) Depositing one mole of aluminium from Al^{3+} ions needs _____ faraday(s); a cell in which electrical energy drives a non-spontaneous reaction is called a(n) _____ cell.	1
	(iv) Phenol heated with chloroform and aqueous NaOH, followed by acidification, gives _____. This is the _____ reaction.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* NaCl is 90% dissociated in a dilute aqueous solution. Its van't Hoff factor is: (a) 2.0 (b) 1.8 (c) 1.9 (d) 0.9	1
	(vi) The oxidation state of iron in $[Fe(CN)_6]^{4-}$ is: (a) +3 (b) +2 (c) +6 (d) +4	1
	(vii) A reaction has a rate constant of 3×10^{-3} L mol^{-1} s^{-1}. Its order is: (a) 2 (b) 0 (c) 1 (d) 3	1
	(viii) Which of the following reacts fastest by the S_N1 mechanism? (a) CH_3Br (b) $(CH_3)_2CHBr$ (c) CH_3CH_2Br (d) $(CH_3)_3CBr$	1
	(ix) Which of the following vitamins is water-soluble? (a) vitamin D (b) vitamin K (c) vitamin A (d) vitamin C	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** The emf of a galvanic cell falls to zero as the cell is used up. **Reason:** The cell reaction then reaches equilibrium, where $\Delta G = 0$. (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion. (c) Assertion is true and Reason is false. (d) Both Assertion and Reason are false.	1
	(xi) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** Propan-1-amine has a higher boiling point than its isomer N,N-dimethylmethanamine. **Reason:** In the gas phase, tertiary amines are less basic than primary amines. (a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. (b) Both Assertion and Reason are true, but Reason is not the correct explanation for Assertion. (c) Assertion is true and Reason is false. (d) Both Assertion and Reason are false.	1

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	(xii) *(C) Read the passage carefully and answer the questions that follow.* Proteins are polymers of α-amino acids. The –COOH group of one amino acid joins the $–NH_2$ group of the next, with the loss of a water molecule, and long chains are built up in this way. The sequence of amino acids in a chain is its primary structure. The chain coils into an α-helix or folds into a β-pleated sheet, held by hydrogen bonds, and these fold further into the overall three-dimensional shape of the protein. When a protein is heated, or the pH around it is changed, these hydrogen bonds and other attractions are broken: the molecule unfolds and loses its biological activity. This is called denaturation. Most enzymes are globular proteins, so they too are destroyed by high temperatures. Name the bond that joins two amino acids in a protein chain.	1
	(xiii) Give one example of denaturation of a protein from everyday life.	1
	(xiv) Why does a protein lose its biological activity when it is denatured?	1

Section B (20 marks)

2.	3.2 g of methanol (CH_3OH) is dissolved in 90 g of water. Calculate the mole fraction of methanol and the molality of the solution.	2
3.	Henry's law constant for N_2 in water at 293 K is 80 kbar. Calculate the amount of N_2, in millimoles, that dissolves in 1 L of water when the partial pressure of N_2 is 0.80 bar. **OR** State Raoult's law for a solution of two volatile liquids. Why does a mixture of ethanol and water show positive deviation from it?	2
4.	The standard emf of a cell in which two electrons are transferred is 0.59 V at 298 K. Calculate ΔG° and the equilibrium constant of the cell reaction. (F = 96500 C mol^{-1})	2
5.	For a reaction, the graph of log[R] against time t is a straight line with slope $–2.0 \times 10^{-3}$ s^{-1}. What is the order of the reaction? Calculate its rate constant.	2
6.	(i) Why do transition elements show variable oxidation states? (ii) Why does manganese show its highest oxidation state in its oxide (Mn_2O_7) rather than in its fluoride? **OR** Write balanced ionic equations for the oxidation of (i) oxalate ions by acidified permanganate, (ii) iodide ions by permanganate in neutral or faintly alkaline solution.	2
7.	Explain, with one example each, (i) linkage isomerism, (ii) ionisation isomerism.	2

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8.	Write the main product and name the reaction: (i) bromoethane is heated with alcoholic KOH; (ii) chlorobenzene and chloromethane are treated with sodium in dry ether.	2
9.	(i) Give a chemical test to distinguish phenol from ethanol. (ii) Why do primary, secondary and tertiary alcohols react with the Lucas reagent at different rates?	2
10.	(i) Give a chemical test to distinguish ethanal from propanone. (ii) Write the equation for the aldol condensation of ethanal.	2
11.	Give reasons: (i) Aniline is a weaker base than methylamine. (ii) Aniline is acetylated before it is nitrated.	2

Section C (21 marks)

12.	1.17 g of NaCl is dissolved in 200 g of water. The solution freezes at −0.36 °C. Calculate the van't Hoff factor and the degree of dissociation of NaCl. (K_f for water = 1.86 K kg mol^{-1}, Na = 23, Cl = 35.5)	3
13.	(a) How long will it take to deposit 2.70 g of aluminium from molten Al_2O_3 with a current of 5.0 A? (Al = 27, F = 96500 C mol^{-1}) *[2]* (b) Name the products at the cathode and the anode when concentrated aqueous NaCl is electrolysed. *[1]* **OR** A conductivity cell filled with 0.1 M KCl (κ = 0.0129 S cm^{-1}) has a resistance of 1500 Ω. Filled with a 0.02 M solution of an electrolyte, it has a resistance of 5200 Ω. Calculate the cell constant and the molar conductivity of the electrolyte.	3
14.	The concentration of a reactant A changed with time as follows: t (min): 0, 10, 20, 30 [A] (mol L^{-1}): 0.80, 0.40, 0.20, 0.10 (a) Show that the reaction is first order. (b) Calculate the rate constant. (c) Find [A] after 50 minutes.	3
15.	(i) Why is $E°(Cu^{2+}/Cu)$ positive (+0.34 V) unlike most other 3d metals? (ii) Name a lanthanoid that shows the +4 oxidation state and one that shows +2. (iii) Why do actinoids show a wider range of oxidation states than lanthanoids?	3
16.	Explain why $[Fe(CN)_6]^{3-}$ is an inner-orbital complex with one unpaired electron while $[FeF_6]^{3-}$ is an outer-orbital complex with five unpaired electrons. Calculate the spin-only magnetic moment of each.	3

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17.	(a) Which reacts faster by the S_N2 mechanism, 1-bromobutane or 2-bromobutane? Why? *[1]* (b) Why is optically active 2-bromobutane racemised in an S_N1 reaction? *[1]* (c) What is meant by inversion of configuration in an S_N2 reaction? *[1]* **OR** tert-Butyl methyl ether is to be prepared by the Williamson synthesis. Which pair of reactants should be used? Write the equation and explain why the other pair fails.	3
18.	(i) What are essential amino acids? Give one example. (ii) State two differences between DNA and RNA in their composition. (iii) Name the disease caused by the deficiency of vitamin B_{12}.	3

Section D (15 marks)

19.	A compound A ($C_2H_4O_2$) gives CO_2 with sodium carbonate. A reacts with PCl_5 to give B, and B with ammonia gives C. C on heating with Br_2 and KOH gives D, and D on heating with chloroform and alcoholic KOH gives E, which has an offensive smell. (a) Identify A, B, C, D and E. *[2½]* (b) Write the equation for the conversion of C into D and name the reaction. *[1½]* (c) Why is D more basic than ammonia? *[1]*	5
20.	(a) What is an azeotrope? Which type of azeotrope does a mixture of ethanol and water form? *[1]* (b) 3.42 g of sucrose ($C_{12}H_{22}O_{11}$, molar mass 342 g mol^{-1}) in 100 g of water lowers the freezing point by 0.186 K. Calculate K_f for water. *[2]* (c) Using this value, find the depression in freezing point caused by 2.7 g of glucose (molar mass 180 g mol^{-1}) in 100 g of water. *[1]* (d) What is reverse osmosis? Give one use. *[1]* **OR** (a) Calculate the osmotic pressure at 27 °C of a solution of 3.42 g of sucrose (342 g mol^{-1}) in 500 mL of solution. (R = 0.0821 L atm K^{-1} mol^{-1}) *[2]* (b) What concentration of glucose, in g L^{-1}, would be isotonic with it? *[1]* (c) What happens to red blood cells placed in a 2% NaCl solution? Why? *[1]* (d) Why is osmotic pressure preferred to other colligative properties for finding the molar masses of proteins? *[1]*	5

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21.	(a) Write the IUPAC name of $[Co(en)_2Cl_2]^+$. How many geometrical isomers does it have, and which of them is optically active? *[3]* (b) Calculate the spin-only magnetic moments of Mn^{2+} and Cr^{3+}. (Atomic numbers: Mn = 25, Cr = 24) *[2]* **OR** (a) Write the equations for the preparation of potassium permanganate from pyrolusite. *[2]* (b) Draw the structures of the chromate and dichromate ions and show how they are interconverted by changing the pH. *[2]* (c) Why do zirconium and hafnium occur together and are difficult to separate? *[1]*	5

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Answers and Marking Scheme

Marks for each step are shown in brackets. Any correct alternative method gets full credit.

Section A (14 marks)

Question 1

(i) Finkelstein; Swarts.

(ii) negative; maximum.

(iii) three; electrolytic.

(iv) salicylaldehyde; Reimer–Tiemann.

(v) **(c)** 1.9. *Working:* $i = 1 + \alpha(n - 1) = 1 + 0.9 \times 1$.

(vi) **(b)** +2. *Working:* $x + 6(-1) = -4$.

(vii) **(a)** 2. *Working:* The unit $(\text{mol L}^{-1})^{1-n}\ \text{s}^{-1}$ equals $\text{L mol}^{-1}\ \text{s}^{-1}$ when $n = 2$.

(viii) **(d)** $(CH_3)_3CBr$. *Working:* It forms the most stable (tertiary) carbocation.

(ix) **(d)** vitamin C. *Working:* The B-group vitamins and vitamin C are water-soluble; A, D, E and K are fat-soluble.

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* $\Delta G = -nFE$, so $E = 0$ exactly when the reaction is at equilibrium and no more net reaction can drive electrons.

(xi) **(c)** Assertion is true and Reason is false. *Working:* The Assertion is true: the primary amine has N–H bonds and forms intermolecular hydrogen bonds, while the tertiary amine has none. The Reason is false: in the gas phase the order is 3° > 2° > 1°.

(xii) The peptide bond, –CO–NH–.

(xiii) Coagulation of egg white on boiling (or curdling of milk).

(xiv) It unfolds and loses its specific three-dimensional shape, on which its activity depends; the primary structure is unaffected.

Section B (20 marks)

2. Moles: methanol 3.2/32 = 0.10, water 90/18 = 5.0. $x(\text{methanol}) = 0.10/5.10 = 0.0196$ (1). Molality $= 0.10/0.090 = 1.11\ \text{mol kg}^{-1}$ (1).

3. $x(N_2) = p/K_H = 0.80/80000 = 1.0 \times 10^{-5}$ (1). 1 L of water is 55.5 mol, so $n(N_2) \approx 1.0 \times 10^{-5} \times 55.5 = 5.55 \times 10^{-4}$ mol = 0.555 mmol (1).

OR The partial vapour pressure of each component equals its mole fraction in the solution times its vapour pressure when pure: $p_A = x_A p^\circ_A$ (1). Ethanol breaks some of the hydrogen bonds of water, and the ethanol–water attractions are weaker than those in the pure liquids, so molecules escape more easily (1).

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4. $\Delta G^\circ = -nFE^\circ = -2 \times 96500 \times 0.59 = -1.14 \times 10^5$ J mol^{-1} (1). log K = $nE^\circ/0.059 = 2 \times 0.59/0.059 = 20$, so $K = 1 \times 10^{20}$ (1).

5. A straight line for log[R] against t shows first order (1). Slope = $-k/2.303$, so $k = 2.303 \times 2.0 \times 10^{-3} = 4.61 \times 10^{-3}$ s^{-1} (1).

6. (i) The (n – 1)d and ns electrons have similar energies, so different numbers of them can take part in bonding (1). (ii) Oxygen can form multiple (pπ–dπ) bonds with the metal, which fluorine cannot; so Mn reaches +7 in Mn_2O_7 but only +4 in MnF_4 (1).

OR (i) $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ (1). (ii) $2MnO_4^- + H_2O + I^- \rightarrow 2MnO_2 + 2OH^- + IO_3^-$ (1).

7. (i) An ambidentate ligand bonds through different atoms: $[Co(NH_3)_5(NO_2)]Cl_2$ and $[Co(NH_3)_5(ONO)]Cl_2$ (1). (ii) An ion inside and an ion outside the coordination sphere exchange places: $[Co(NH_3)_5(SO_4)]Br$ and $[Co(NH_3)_5Br]SO_4$ (1).

8. (i) $CH_3CH_2Br + KOH(alc) \rightarrow CH_2{=}CH_2 + KBr + H_2O$: dehydrohalogenation (β-elimination) (1). (ii) $C_6H_5Cl + 2Na + CH_3Cl \rightarrow C_6H_5CH_3 + 2NaCl$: Wurtz–Fittig reaction (1).

9. (i) Neutral $FeCl_3$ gives a violet colour with phenol but not with ethanol (1). (ii) The reaction goes through a carbocation; tertiary carbocations form most easily, so 3° alcohols give turbidity at once, 2° in about five minutes and 1° only on heating (1).

10. (i) Fehling's solution gives a red precipitate (Cu_2O) with ethanal but not with propanone (1). (ii) $2CH_3CHO \rightarrow$ (dil. NaOH) $CH_3CH(OH)CH_2CHO \rightarrow$ (heat) $CH_3CH{=}CHCHO + H_2O$ (1).

11. (i) In aniline the lone pair on nitrogen is delocalised into the benzene ring and is less available for a proton; in methylamine the CH_3 group pushes electrons to nitrogen (1). (ii) Acetylation protects the $-NH_2$ group from oxidation by nitric acid and reduces its activating effect, so the p-nitro product is obtained (1).

Section C (21 marks)

12. Molality = (1.17/58.5)/0.200 = 0.10 mol kg^{-1}; ΔT_f (no dissociation) = 1.86 × 0.10 = 0.186 K (1). i = 0.36/0.186 = 1.94 (1). For NaCl, i = 1 + α, so α = 0.94, i.e. 94% (1).

13. (a) 2.70 g = 0.10 mol Al; $Al^{3+} + 3e^- \rightarrow Al$ needs 0.30 F = 28950 C (1). t = 28950/5.0 = 5790 s ≈ 96.5 min (1). (b) Cathode: H_2; anode: Cl_2 (1).

OR Cell constant = κR = 0.0129 × 1500 = 19.35 cm^{-1} (1). κ = 19.35/5200 = 3.72×10^{-3} S cm^{-1} (1). $\Lambda_m = 3.72 \times 10^{-3} \times 1000/0.02 = 186$ S cm^2 mol^{-1} (1).

14. (a) [A] halves every 10 min whatever its value: a constant half-life means first order (1). (b) k = 0.693/10 = 0.0693 min^{-1} (1). (c) 50 min is five half-lives: 0.80/32 = 0.025 mol L^{-1} (1).

15. (i) Copper has a high enthalpy of atomisation and ionisation, which the hydration enthalpy of Cu^{2+} does not make up (1). (ii) Cerium (Ce^{4+}); europium (Eu^{2+}) (1). (iii) The 5f, 6d and 7s levels are close in energy, so more electrons can take part in bonding (1).

16. Fe^{3+} is $3d^5$. CN^- is a strong ligand and pairs the electrons into three 3d orbitals, leaving two 3d orbitals for d^2sp^3 hybridisation: one unpaired electron (1). F^- is weak; the electrons stay unpaired and 4s, 4p and 4d orbitals give sp^3d^2 (1). μ = √(n(n + 2)): 1.73 BM and 5.92 BM (1).

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17. (a) 1-Bromobutane: the primary carbon is less hindered for back-side attack (1). (b) The planar carbocation can be attacked equally from both faces, giving both enantiomers (1). (c) The nucleophile attacks from the side opposite the leaving group, so the product has the opposite spatial arrangement (1).

OR Use CH_3Br and sodium tert-butoxide: $CH_3Br + (CH_3)_3CONa \rightarrow (CH_3)_3COCH_3 + NaBr$ (1½). With $(CH_3)_3CBr$ and CH_3ONa, the strong base removes a β-hydrogen from the tertiary halide and 2-methylpropene is formed by elimination (1½).

18. (i) Amino acids that the body cannot make and must get from food, e.g. valine (1). (ii) DNA has deoxyribose and the base thymine; RNA has ribose and uracil instead of thymine (1). (iii) Pernicious anaemia (1).

Section D (15 marks)

19. (a) A: CH_3COOH; B: CH_3COCl; C: CH_3CONH_2; D: CH_3NH_2; E: CH_3NC (½ each). (b) $CH_3CONH_2 + Br_2 + 4KOH \rightarrow CH_3NH_2 + K_2CO_3 + 2KBr + 2H_2O$ (1); Hoffmann bromamide degradation (½). (c) The methyl group pushes electrons to nitrogen, making its lone pair more available (1).

20. (a) A liquid mixture that boils at a constant temperature with the same composition in liquid and vapour; ethanol–water forms a minimum-boiling azeotrope (1). (b) Molality = 0.010/0.100 = 0.10 (1); $K_f = 0.186/0.10 = 1.86$ K kg mol^{-1} (1). (c) Molality = 0.015/0.100 = 0.15; $\Delta T_f = 1.86 \times 0.15 = 0.279$ K (1). (d) When a pressure larger than the osmotic pressure is applied to the solution, solvent flows out through the membrane; used to desalinate sea water (1).

OR (a) $C = 0.010/0.500 = 0.020$ mol L^{-1} (1); $\pi = CRT = 0.020 \times 0.0821 \times 300 = 0.49$ atm (1). (b) 0.020 mol L^{-1} of glucose = 3.6 g L^{-1} (1). (c) They shrink, because the solution is hypertonic and water flows out of the cells (1). (d) It is large enough to measure even for very dilute solutions, and it is measured at room temperature, so proteins are not denatured (1).

21. (a) Dichloridobis(ethane-1,2-diamine)cobalt(III) ion (1). Two geometrical isomers, cis and trans (1); the cis isomer is optically active (1). (b) Mn^{2+} is $3d^5$ with 5 unpaired electrons: $\sqrt{35} = 5.92$ BM (1). Cr^{3+} is $3d^3$ with 3 unpaired electrons: $\sqrt{15} = 3.87$ BM (1).

OR (a) $2MnO_2 + 4KOH + O_2 \rightarrow 2K_2MnO_4 + 2H_2O$ (1); in acid, $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$ (1). (b) Chromate is tetrahedral CrO_4^{2-}; dichromate is two CrO_4 tetrahedra sharing one oxygen (Cr–O–Cr) (1). $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$: acid gives dichromate, alkali gives chromate (1). (c) Lanthanoid contraction makes their atomic radii almost the same, so their chemical properties are very similar (1).

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