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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 6 · 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:* [Wurtz, Fittig, Friedel–Crafts, Cannizzaro, Kolbe's, S m^{-1}, S m^2 mol^{-1}, Ω m, zero, first, second] Two molecules of an alkyl halide react with sodium in dry ether in the _____ reaction, while two molecules of an aryl halide react with sodium in the _____ reaction.	1
	(ii) The SI unit of conductivity is _____, and the SI unit of molar conductivity is _____.	1
	(iii) An aldehyde with no α-hydrogen gives an alcohol and the salt of an acid with concentrated alkali in the _____ reaction, and benzene with acetyl chloride and anhydrous $AlCl_3$ gives acetophenone by _____ acylation.	1
	(iv) A reaction whose rate does not depend on the concentration of the reactant is of _____ order, while radioactive decay follows _____-order kinetics.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* If E°cell for a reaction is negative, then: (a) $\Delta G° > 0$ and $K > 1$ (b) $\Delta G° = 0$ and $K = 1$ (c) $\Delta G° > 0$ and $K < 1$ (d) $\Delta G° < 0$ and $K > 1$	1
	(vi) Which of the following is a pseudo first-order reaction? (a) $H_2 + Cl_2 \rightarrow 2HCl$ in sunlight (b) decomposition of NH_3 on hot platinum (c) $2HI \rightarrow H_2 + I_2$ (d) acid hydrolysis of cane sugar	1
	(vii) The shape of $[Ni(CO)_4]$ is: (a) trigonal planar (b) tetrahedral (c) octahedral (d) square planar	1
	(viii) Which of the following alcohols gives turbidity with the Lucas reagent most quickly? (a) 2-methylpropan-2-ol (b) butan-1-ol (c) butan-2-ol (d) 2-methylpropan-1-ol	1
	(ix) Isotonic solutions have the same: (a) boiling point (b) osmotic pressure (c) vapour pressure (d) density	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** 2-Chloro-2-methylpropane undergoes S_N1 reaction faster than 1-chlorobutane. **Reason:** The tertiary carbocation formed from it is much more stable than a primary carbocation. (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:** Proteins lose their biological activity when heated strongly. **Reason:** Heating breaks the peptide bonds of the protein. (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.* The lanthanoids, the fourteen elements that follow lanthanum, are silvery-white soft metals. Their most common oxidation state is +3. Across the series the atomic and ionic radii decrease steadily, the lanthanoid contraction, so neighbouring lanthanoids have very similar chemical properties and are hard to separate. They have many uses. Mischmetall, an alloy of about 95% lanthanoid metals with about 5% iron and traces of other elements, is used with magnesium to make bullets, shells and lighter flints. Mixed lanthanoid oxides are used as catalysts in petroleum cracking, and some lanthanoid oxides are used as phosphors in display screens. What is mischmetall? Give one use.	1
	(xiii) What is the most common oxidation state of the lanthanoids?	1
	(xiv) Why are neighbouring lanthanoids difficult to separate from one another?	1

Section B (20 marks)

2.	Calculate the osmotic pressure at 27 °C of a 0.050 M aqueous solution of $CaCl_2$, assuming complete dissociation. ($R = 0.0821$ L atm K^{-1} mol^{-1})	2
3.	How much charge, in coulombs, is needed (i) to reduce 1 mol of $Cr_2O_7^{2-}$ to Cr^{3+}, (ii) to oxidise 1 mol of H_2O to O_2? **OR** Why is platinum used in the standard hydrogen electrode, and why is it coated with platinum black?	2
4.	Derive the integrated rate equation for a zero-order reaction R → P.	2
5.	Write the electronic configurations of chromium (Z = 24) and copper (Z = 29), and explain why they differ from the expected ones.	2
6.	What is the spectrochemical series? Distinguish between a weak-field and a strong-field ligand, with one example of each.	2
7.	Give reasons: (i) p-Dichlorobenzene has a higher melting point than its ortho and meta isomers. (ii) Haloalkanes have higher boiling points than the alkanes from which they are derived.	2
8.	Write the IUPAC names of (i) $CH_3CH(OH)CH_2CH(CH_3)_2$, (ii) $C_6H_5OCH_2CH_3$.	2
9.	Cyclohexanone forms a cyanohydrin in good yield, but 2,2,6-trimethylcyclohexanone does not. Explain.	2

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10.	Write the products of: (i) benzoic acid with PCl_5, (ii) ethanoic acid with ethanol in the presence of a few drops of concentrated H_2SO_4. **OR** Arrange in increasing order of acid strength: $(CH_3)_2CHCOOH$, $CH_3CH_2CH(Br)COOH$, $CH_3CH(Br)CH_2COOH$, $CH_3CH_2CH_2COOH$.	2
11.	(i) Why is it hard to prepare a pure amine by heating an alkyl halide with ammonia? (ii) Why do amines behave as nucleophiles?	2

Section C (21 marks)

12.	(a) 1.5 g of a non-volatile solute dissolved in 75 g of benzene raises its boiling point by 0.25 K. Calculate the molar mass of the solute. (K_b for benzene = 2.53 K kg mol^{-1}) *[2]* (b) Why does a solution of a non-volatile solute boil at a higher temperature than the pure solvent? *[1]*	3
13.	Calculate the emf at 298 K of the cell Al | Al^{3+}(0.010 M) || Ni^{2+}(0.10 M) | Ni. ($E°(Al^{3+}/Al)$ = −1.66 V, $E°(Ni^{2+}/Ni)$ = −0.25 V) **OR** Write the electrode reactions in the hydrogen–oxygen fuel cell with an alkaline electrolyte. Give two advantages of fuel cells over ordinary batteries.	3
14.	For the reaction A + B → C, experiments show that doubling [B] has no effect on the rate, while doubling [A] doubles it. (i) Write the rate law and give the overall order and the unit of k. (ii) Can the reaction be an elementary step? Why? (iii) How does the rate change if [A] is reduced to one-third?	3
15.	(i) Copper(I) compounds are white and diamagnetic, while copper(II) compounds are coloured and paramagnetic. Explain. (ii) How does the basic strength of the lanthanoid hydroxides change from $La(OH)_3$ to $Lu(OH)_3$? Why? (iii) State one difference between lanthanoids and actinoids in their tendency to form complexes.	3
16.	(a) How many geometrical isomers does the square planar complex $[Pt(NH_3)(Br)(Cl)(py)]$ have? *[1]* (b) Explain why $[Cr(C_2O_4)_3]^{3-}$ shows optical isomerism. *[2]* **OR** The magnetic moment of $[CoCl_4]^{2-}$ is about 3.9 BM. Find the number of unpaired electrons and predict the hybridisation and shape of the complex.	3
17.	An alkyl bromide A (C_4H_9Br) gives B as the main product with alcoholic KOH. Ozonolysis of B gives only ethanal. Identify A and B. What does A give with aqueous KOH? Write the equations.	3

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18.	(i) Distinguish between globular and fibrous proteins, with one example of each. (ii) Name the vitamin whose deficiency causes scurvy. (iii) What is meant by the native state of a protein?	3

Section D (15 marks)

19.	A compound A ($C_5H_{10}O$) forms a precipitate with 2,4-DNP reagent and gives the iodoform test, but does not reduce Tollens' reagent. Clemmensen reduction of A gives n-pentane. (a) Identify A. *[1]* (b) Write the equation for the iodoform reaction of A. *[1]* (c) Name an isomer of A that is a ketone but does not give the iodoform test. *[1]* (d) Name the straight-chain aldehyde isomer of A and write its reaction with Tollens' reagent. *[1]* (e) What is formed when A is reduced with $NaBH_4$? *[1]* **OR** (a) Write the equations for the preparation of ethanamine from (i) ethanenitrile, (ii) nitroethane. *[2]* (b) How will you distinguish ethanamine from N-methylethanamine using nitrous acid? *[2]* (c) Give the IUPAC name of $C_6H_5N(CH_3)_2$. *[1]*	5
20.	(a) What are minimum-boiling and maximum-boiling azeotropes? Give one example of each. *[2]* (b) A 5% (by mass) aqueous solution of a non-volatile solute has a vapour pressure of 745 mm Hg at 373 K. Calculate the molar mass of the solute. *[3]*	5
21.	(a) A first-order reaction has $k = 3.0 \times 10^{-3}\ s^{-1}$. Calculate its half-life and the time for three-quarters of the reactant to be used up. *[2]* (b) Explain how the activation energy can be found from a graph of ln k against 1/T. *[2]* (c) What is threshold energy? *[1]* **OR** (a) Write the IUPAC name of $[Ag(NH_3)_2][Ag(CN)_2]$. *[1]* (b) $[Cu(H_2O)_4]^{2+}$ is pale blue but $[Cu(NH_3)_4]^{2+}$ is deep blue. Explain using crystal field theory. *[2]* (c) Why do tetrahedral complexes not show geometrical isomerism? *[1]* (d) What is the denticity of EDTA? *[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) Wurtz; Fittig.

(ii) S m^{-1}; S m^2 mol^{-1}.

(iii) Cannizzaro; Friedel–Crafts.

(iv) zero; first.

(v) **(c)** $\Delta G^\circ > 0$ and $K < 1$. *Working:* $\Delta G^\circ = -nFE^\circ$ is positive, and $\Delta G^\circ = -RT \ln K$ gives $K < 1$.

(vi) **(d)** acid hydrolysis of cane sugar. *Working:* Water, a reactant, is present in such large excess that its concentration hardly changes.

(vii) **(b)** tetrahedral. *Working:* Ni(0) uses sp^3 hybrid orbitals; the complex is tetrahedral and diamagnetic.

(viii) **(a)** 2-methylpropan-2-ol. *Working:* It is a tertiary alcohol and forms the most stable carbocation.

(ix) **(b)** osmotic pressure. *Working:* They have the same total concentration of solute particles, so no net osmosis occurs between them.

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* The rate of an S_N1 reaction depends on how easily the carbocation forms.

(xi) **(c)** Assertion is true and Reason is false. *Working:* Heating breaks hydrogen bonds and other weak attractions that hold the protein's shape (denaturation); the peptide bonds and primary structure remain.

(xii) An alloy of about 95% lanthanoid metals and about 5% iron; used with magnesium in bullets, shells and lighter flints.

(xiii) +3.

(xiv) Because of the lanthanoid contraction their ionic radii, and hence their chemical properties, are very similar.

Section B (20 marks)

2. $CaCl_2 \rightarrow Ca^{2+} + 2Cl^-$, so $i = 3$ (1). $\pi = iCRT = 3 \times 0.050 \times 0.0821 \times 300 = 3.69$ atm (1).

3. (i) Two Cr atoms each change from +6 to +3: $6\ F = 6 \times 96500 = 5.79 \times 10^5$ C (1). (ii) $H_2O \rightarrow \tfrac{1}{2}O_2 + 2H^+ + 2e^-$: $2\ F = 1.93 \times 10^5$ C (1).

OR Platinum is inert and does not react with the solution, but conducts electrons (1). Platinum black adsorbs hydrogen and catalyses $H_2 \rightleftharpoons 2H^+ + 2e^-$, so equilibrium is reached quickly (1).

4. Rate $= -d[R]/dt = k$, so $d[R] = -k\,dt$ (1). Integrating, $[R] = -kt + C$; at $t = 0$, $[R] = [R]_0$, so $[R] = [R]_0 - kt$ (1).

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5. Cr: [Ar]$3d^5 4s^1$; Cu: [Ar]$3d^{10} 4s^1$ (1). Half-filled and completely filled d subshells are extra stable, so one 4s electron moves into 3d (1).

6. The arrangement of ligands in order of increasing crystal field splitting they produce (1). A weak-field ligand (e.g. Cl^-) gives Δ_0 smaller than the pairing energy, so high-spin complexes; a strong-field ligand (e.g. CN^-) gives Δ_0 larger than the pairing energy, so low-spin complexes (1).

7. (i) The symmetrical para isomer packs better in the crystal lattice (1). (ii) Haloalkanes have greater molecular mass and are polar, so their intermolecular forces are stronger (1).

8. (i) 4-Methylpentan-2-ol (1). (ii) Ethoxybenzene (1).

9. Cyanohydrin formation is a nucleophilic attack of CN^- on the carbonyl carbon (1). In 2,2,6-trimethylcyclohexanone the methyl groups next to the carbonyl hinder this attack (1).

10. (i) $C_6H_5COOH + PCl_5 \rightarrow C_6H_5COCl + POCl_3 + HCl$ (1). (ii) $CH_3COOH + C_2H_5OH \rightleftharpoons CH_3COOC_2H_5 + H_2O$, esterification (1).

OR $(CH_3)_2CHCOOH < CH_3CH_2CH_2COOH < CH_3CH(Br)CH_2COOH < CH_3CH_2CH(Br)COOH$ (1). Alkyl branching (+I) lowers acidity; Br (–I) raises it, more so the closer it is to –COOH (1).

11. (i) The amine formed is itself a nucleophile and reacts further, so a mixture of primary, secondary and tertiary amines and the quaternary salt is obtained (1). (ii) The nitrogen atom has a lone pair of electrons that it can donate (1).

Section C (21 marks)

12. (a) $M = \frac{K_b \times w \times 1000}{\Delta T_b \times W} = \frac{2.53 \times 1.5 \times 1000}{0.25 \times 75}$ (1) ≈ 202 g mol^{-1} (1). (b) Its vapour pressure is lower, so it must be heated to a higher temperature before its vapour pressure equals the external pressure (1).

13. $2Al + 3Ni^{2+} \rightarrow 2Al^{3+} + 3Ni$, n = 6; E° = –0.25 – (–1.66) = 1.41 V (1). $E = 1.41 - \frac{0.059}{6} \log \frac{(0.010)^2}{(0.10)^3}$ (1) $= 1.41 - 0.0098 \log 0.1 = 1.42$ V (1).

OR Anode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$; cathode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (1½). They work as long as fuel is supplied, convert energy more efficiently (about 70%), and do not pollute (1½).

14. (i) Rate = $k[A]^1[B]^0$; first order overall; k in s^{-1} (1). (ii) No: in an elementary step involving A and B the rate would depend on both, so the reaction must take place by more than one step (1). (iii) It falls to one-third (1).

15. (i) Cu^+ is $3d^{10}$, with no unpaired electron and no d–d transition; Cu^{2+} is $3d^9$, with one unpaired electron and possible d–d transitions (1). (ii) Basic strength decreases: the ions become smaller, so the M–OH bond becomes more covalent (1). (iii) Actinoids form complexes much more readily than lanthanoids (1).

16. (a) Three (1). (b) Three bidentate oxalate ligands wrap round the octahedron in a propeller shape (1); the complex has no plane of symmetry, so it exists as two non-superimposable mirror images (1).

OR $\mu = \sqrt{n(n+2)} = 3.9$ gives n = 3 (1). Co^{2+} is $3d^7$; with the weak ligand Cl^-, 4s and 4p orbitals are used (1): sp^3 hybridisation, tetrahedral (1).

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17. B is but-2-ene, $CH_3CH{=}CHCH_3$, because it splits into two CH_3CHO (1). A is 2-bromobutane: $CH_3CHBrCH_2CH_3 + KOH(alc) \rightarrow CH_3CH{=}CHCH_3 + KBr + H_2O$ (1). With aqueous KOH: $CH_3CHBrCH_2CH_3 + KOH \rightarrow CH_3CH(OH)CH_2CH_3 + KBr$ (butan-2-ol) (1).

18. (i) Globular proteins have chains folded into compact spherical shapes and are usually water-soluble (insulin, albumin); fibrous proteins have long parallel chains and are insoluble (keratin, myosin) (1). (ii) Vitamin C (ascorbic acid) (1). (iii) The natural, biologically active shape of the protein in a living cell (1).

Section D (15 marks)

19. (a) Pentan-2-one, $CH_3COCH_2CH_2CH_3$ (1). (b) $CH_3COC_3H_7 + 3I_2 + 4NaOH \rightarrow C_3H_7COONa + CHI_3 + 3NaI + 3H_2O$ (1). (c) Pentan-3-one, $C_2H_5COC_2H_5$ (1). (d) Pentanal: $C_4H_9CHO + 2[Ag(NH_3)_2]^+ + 3OH^- \rightarrow C_4H_9COO^- + 2Ag + 4NH_3 + 2H_2O$ (1). (e) Pentan-2-ol (1).

OR (a) (i) $CH_3CN + 4[H] \rightarrow$ ($LiAlH_4$ or Na/C_2H_5OH) $CH_3CH_2NH_2$ (1). (ii) $CH_3CH_2NO_2 + 3H_2 \rightarrow$ (Ni) $CH_3CH_2NH_2 + 2H_2O$ (1). (b) Ethanamine gives off nitrogen gas, forming ethanol (1); N-methylethanamine forms a yellow oily N-nitrosamine and no gas (1). (c) N,N-Dimethylbenzenamine (N,N-dimethylaniline) (1).

20. (a) Solutions with large positive deviation from Raoult's law boil at a constant temperature below that of either component, e.g. ethanol–water (about 95% ethanol) (1). Those with large negative deviation boil above either component, e.g. nitric acid–water (about 68% HNO_3) (1). (b) Relative lowering = (760 − 745)/760 = 0.0197 = mole fraction of solute (1). 100 g of solution: 5 g solute, 95 g = 5.28 mol water; n/(n + 5.28) = 0.0197 gives n = 0.106 mol (1). M = 5/0.106 ≈ 47 g mol^{-1} (1).

21. (a) $t_{½} = 0.693/(3.0 \times 10^{-3}) = 231$ s (1); three-quarters is two half-lives = 462 s (1). (b) $\ln k = \ln A - E_a/RT$, so the graph is a straight line (1) of slope $-E_a/R$; $E_a = -R \times$ slope (1). (c) The minimum energy colliding molecules must have for the collision to lead to reaction (1).

OR (a) Diamminesilver(I) dicyanidoargentate(I) (1). (b) NH_3 is a stronger-field ligand than H_2O, so the splitting is larger (1); the complex absorbs light of a different, shorter wavelength, changing the colour seen (1). (c) In a tetrahedron all four positions are adjacent to one another, so cis and trans arrangements are not possible (1). (d) Six (hexadentate) (1).

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