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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 5 · 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:* [Gattermann–Koch, Kolbe's, Williamson, Swarts, unimolecular, bimolecular, primary, secondary, tertiary, colligative, ideal, non-ideal] Benzene treated with carbon monoxide and HCl in the presence of anhydrous $AlCl_3$/CuCl gives benzaldehyde in the _____ reaction; an alkyl halide heated with sodium alkoxide gives an ether in the _____ synthesis.	1
	(ii) The rate-determining step of an S_N2 reaction is _____, while that of an S_N1 reaction is _____.	1
	(iii) The Lucas reagent gives turbidity at once with a _____ alcohol, and nitrous acid liberates nitrogen gas with a _____ aliphatic amine.	1
	(iv) Properties that depend only on the number of solute particles are called _____ properties; a solution that obeys Raoult's law at all concentrations is called _____.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* The molarity of pure water at room temperature (density 1.0 g mL^{-1}) is about: (a) 55.5 M (b) 18 M (c) 100 M (d) 1.0 M	1
	(vi) A reaction has a rate constant of 4×10^{-3} mol L^{-1} s^{-1}. Its order is: (a) third (b) first (c) zero (d) second	1
	(vii) The potential of the standard hydrogen electrode is: (a) +1.0 V (b) taken as zero at all temperatures (c) −0.059 V (d) zero only at 298 K	1
	(viii) The number of unpaired electrons in $[CoF_6]^{3-}$ is: (a) 0 (b) 2 (c) 3 (d) 4	1
	(ix) Which of the following amines does not react with Hinsberg's reagent? (a) $C_2H_5NH_2$ (b) $C_6H_5NH_2$ (c) $(C_2H_5)_3N$ (d) $(C_2H_5)_2NH$	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** Sucrose is dextrorotatory, but the mixture formed on its hydrolysis is laevorotatory. **Reason:** Fructose is more strongly laevorotatory than glucose is dextrorotatory. (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:** Ethanol gives the iodoform test. **Reason:** Ethanol contains the $CH_3CO–$ group. (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.* Aldehydes and ketones are all around us. Formalin, a 40% aqueous solution of methanal, is used to preserve biological specimens and to make resins. Many pleasant flavours and smells come from carbonyl compounds: vanillin from the vanilla bean, cinnamaldehyde (3-phenylprop-2-enal) from cinnamon bark, and camphor, a ketone, from the camphor tree. Propanone (acetone), the simplest ketone, is a common laboratory and industrial solvent; it mixes with water in all proportions, although its molecules cannot form hydrogen bonds with one another. What is formalin? Give one use.	1
	(xiii) Write the structure of the compound that gives cinnamon its flavour.	1
	(xiv) Why does propanone mix with water in all proportions, although propanone molecules cannot hydrogen bond with one another?	1

Section B (20 marks)

2.	An aqueous solution of NaOH is 20% by mass and has a density of 1.2 g mL^{-1}. Calculate its molarity and molality. (NaOH = 40 g mol^{-1})	2
3.	Write the cell for the reaction $Mg(s) + 2Ag^+(aq) \rightarrow Mg^{2+}(aq) + 2Ag(s)$ and calculate its standard emf. ($E°(Mg^{2+}/Mg) = -2.37$ V, $E°(Ag^+/Ag) = +0.80$ V)	2
4.	How does a catalyst affect (i) the activation energy of a reaction, (ii) its ΔG and equilibrium constant? **OR** For $2NO(g) + O_2(g) \rightarrow 2NO_2(g)$, rate = $k[NO]^2[O_2]$. How does the rate change if the volume of the vessel is halved?	2
5.	(i) Why do the melting points of the 3d transition metals rise to a maximum near the middle of the series? (ii) Why is the melting point of manganese lower than expected?	2
6.	Give the oxidation state, coordination number and number of d electrons of the central metal in (i) $[Cr(NH_3)_3(H_2O)_3]Cl_3$, (ii) $K_4[Mn(CN)_6]$.	2
7.	In each pair, which reacts faster by the S_N2 mechanism? Give a reason. (i) CH_3I or CH_3Cl, (ii) CH_3CH_2Br or $(CH_3)_2CHBr$.	2
8.	Why does phenol undergo electrophilic substitution more easily than benzene, and why are the products mainly ortho and para?	2
9.	Give a chemical test to distinguish: (i) benzaldehyde from acetophenone, (ii) pentan-2-one from pentan-3-one. **OR** Why do aldehydes and ketones have higher boiling points than hydrocarbons of similar molecular mass but lower boiling points than alcohols?	2

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10.	How will you convert (i) nitrobenzene to N-phenylethanamide, (ii) aniline to 2,4,6-tribromoaniline? Write the equations.	2
11.	Classify as monosaccharide, disaccharide or polysaccharide: ribose, maltose, starch, fructose, cellulose, lactose. Which glycosidic linkages are present in amylopectin?	2

Section C (21 marks)

12.	100 mL of a 2% (w/v) urea solution is mixed with 100 mL of a 3.42% (w/v) sucrose solution. Calculate the osmotic pressure of the mixture at 300 K. (Urea = 60, sucrose = 342 g mol^{-1}; R = 0.0821 L atm K^{-1} mol^{-1}) **OR** Define (a) molality, (b) mole fraction, (c) parts per million. Why is molality preferred to molarity in work on colligative properties?	3
13.	Write the reactions at the anode and the cathode, and the overall reaction, when a lead storage battery is discharged. What happens when it is recharged?	3
14.	The half-life of ^{14}C is 5730 years. A piece of old wood has 60% of the ^{14}C found in living wood. Estimate its age. (Radioactive decay is a first-order process.)	3
15.	(i) Why do transition metals form a large number of complex compounds? (ii) What is disproportionation? Give an example from manganese chemistry. (iii) Which is the stronger oxidising agent in acid, $Cr_2O_7^{2-}$ or MnO_4^-? (E° values 1.33 V and 1.51 V)	3
16.	Use valence bond theory to explain the hybridisation and the magnetic behaviour of (i) $[Cr(NH_3)_6]^{3+}$, (ii) $[Ni(NH_3)_6]^{2+}$. Calculate the spin-only magnetic moment of each.	3
17.	(a) What is formed when phenol is treated with concentrated nitric acid? *[1]* (b) Phenol with dilute nitric acid gives a mixture of o- and p-nitrophenol. How are they separated? *[1]* (c) Anisole heated with HI gives phenol and iodomethane, not iodobenzene and methanol. Why? *[1]* **OR** (a) Write the Williamson synthesis of ethoxybenzene. *[1]* (b) What is formed when anisole reacts with CH_3Cl in the presence of anhydrous $AlCl_3$? *[1]* (c) Why are ethers stored in tightly closed, dark bottles? *[1]*	3
18.	(i) What is a reducing sugar? Is sucrose one? (ii) Glycine melts at about 505 K with decomposition, unlike most organic compounds of similar size. Why? (iii) Name the fat-soluble vitamin needed for the clotting of blood.	3

Section D (15 marks)

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19.	A compound A (C_3H_9N) reacts with nitrous acid, giving off nitrogen and forming an alcohol B (C_3H_8O). Oxidation of B gives C, which gives the iodoform test but does not reduce Tollens' reagent. (a) Identify A, B and C. *[1½]* (b) Write the equations for A → B and B → C. *[1½]* (c) Write the equation for the carbylamine reaction of A. *[1]* (d) Name an isomer of A that does not react with Hinsberg's reagent. *[1]*	5
20.	(a) The conductivity of 0.0010 M acetic acid is 4.95×10^{-5} S cm^{-1} and Λ°_m = 390.5 S cm^2 mol^{-1}. Calculate its molar conductivity, its degree of dissociation and its dissociation constant. *[3]* (b) Why does a mercury cell give a nearly constant voltage throughout its life? *[1]* (c) What is the function of a salt bridge? *[1]* **OR** (a) Why does every collision between reactant molecules not lead to a reaction? *[2]* (b) The activation energy of a reaction is 60 kJ mol^{-1}. By what factor does its rate increase when the temperature rises from 300 K to 310 K? *[2]* (c) How does a catalyst affect the activation energy of the reverse reaction? *[1]*	5
21.	(a) Complete and balance: $Cr_2O_7^{2-} + H_2S + H^+ \rightarrow$ *[1]* (b) What happens when potassium permanganate is heated strongly? Write the equation. *[1]* (c) Why is the chemistry of the actinoids difficult to study? *[1]* (d) Why is $E^\circ(Zn^{2+}/Zn)$ more negative than that of copper? *[1]* (e) Why is the second ionisation enthalpy of copper unusually high? *[1]* **OR** (a) Why is $[Co(CN)_6]^{3-}$ a low-spin complex? *[1]* (b) Describe the facial and meridional isomers of $[Co(NH_3)_3(NO_2)_3]$. *[2]* (c) Why is a complex with a chelating ligand more stable than one with similar monodentate ligands? *[1]* (d) Name the coordination entity and the counter ion in $K_4[Fe(CN)_6]$. *[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) Gattermann–Koch; Williamson.

(ii) bimolecular; unimolecular.

(iii) tertiary; primary.

(iv) colligative; ideal.

(v) **(a)** 55.5 M. *Working:* 1 L of water is 1000 g = 1000/18 = 55.5 mol.

(vi) **(c)** zero. *Working:* The rate constant has the same unit as the rate only for a zero-order reaction.

(vii) **(b)** taken as zero at all temperatures. *Working:* It is the reference electrode, assigned zero by convention.

(viii) **(d)** 4. *Working:* Co^{3+} is $3d^6$; F^- is a weak ligand, so the complex is high spin, $t_2g^4e_g^2$.

(ix) **(c)** $(C_2H_5)_3N$. *Working:* A tertiary amine has no hydrogen on nitrogen.

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* Hydrolysis gives equal amounts of glucose (+52.5°) and fructose (–92.4°), so the mixture (invert sugar) turns the plane of polarised light to the left.

(xi) **(c)** Assertion is true and Reason is false. *Working:* Ethanol has the $CH_3CH(OH)–$ group, which iodine in alkali first oxidises to CH_3CHO, which then gives iodoform.

(xii) A 40% aqueous solution of methanal (formaldehyde), used to preserve biological specimens.

(xiii) Cinnamaldehyde: $C_6H_5–CH=CH–CHO$.

(xiv) The oxygen of the carbonyl group forms hydrogen bonds with water molecules.

Section B (20 marks)

2. 100 g of solution has 20 g NaOH = 0.50 mol and 80 g of water; its volume is 100/1.2 = 83.3 mL. Molarity = 0.50/0.0833 = 6.0 M (1). Molality = 0.50/0.080 = 6.25 mol kg^{-1} (1).

3. Mg(s) | Mg^{2+}(aq) || Ag^+(aq) | Ag(s) (1). $E° = 0.80 – (–2.37) = 3.17$ V (1).

4. (i) It provides a new path with a lower activation energy, for both the forward and the backward reactions (1). (ii) It changes neither ΔG nor the equilibrium constant; it only helps equilibrium to be reached sooner (1).

OR Halving the volume doubles each concentration (1). Rate becomes $k(2[NO])^2(2[O_2])$ = 8 times the original (1).

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5. (i) The number of unpaired d electrons available for metallic bonding increases up to the middle of the series and then falls as the electrons pair up (1). (ii) Manganese has the stable $3d^5 4s^2$ configuration, so its d electrons take less part in metallic bonding (1).

6. (i) +3, 6, d^3 (1). (ii) +2, 6, d^5 (1).

7. (i) CH_3I: the C–I bond is weaker and iodide is a better leaving group (1). (ii) CH_3CH_2Br: the primary carbon is less hindered for attack from the back (1).

8. The lone pairs on oxygen are delocalised into the ring (+R effect), increasing its electron density (1). Resonance places this extra negative charge at the ortho and para positions (1).

9. (i) Tollens' reagent: benzaldehyde gives a silver mirror, acetophenone does not (1). (ii) Iodoform test: pentan-2-one (CH_3CO–) gives a yellow precipitate, pentan-3-one does not (1).

OR The polar C=O group gives dipole–dipole attractions, which hydrocarbons lack (1). Unlike alcohols, they cannot form hydrogen bonds with one another (1).

10. (i) $C_6H_5NO_2 \rightarrow$ (Sn/HCl) $C_6H_5NH_2$; $C_6H_5NH_2 + (CH_3CO)_2O \rightarrow C_6H_5NHCOCH_3 + CH_3COOH$ (1). (ii) $C_6H_5NH_2 + 3Br_2(aq) \rightarrow 2,4,6\text{-}Br_3C_6H_2NH_2$ (white precipitate) + 3HBr (1).

11. Monosaccharides: ribose, fructose; disaccharides: maltose, lactose; polysaccharides: starch, cellulose (1). α(1→4) links along the chains and α(1→6) links at the branches (1).

Section C (21 marks)

12. Urea: 2.0 g = 0.0333 mol; sucrose: 3.42 g = 0.0100 mol; total 0.0433 mol in 0.200 L, C = 0.217 M (1½). π = CRT = 0.217 × 0.0821 × 300 = 5.34 atm (1½).

OR (a) Moles of solute per kilogram of solvent; (b) moles of a component divided by total moles (1). (c) Mass of a component per million parts by mass of the solution (1). Molality involves only masses, so it does not change with temperature, while molarity does (1).

13. Anode: $Pb + SO_4^{2-} \rightarrow PbSO_4 + 2e^-$; cathode: $PbO_2 + SO_4^{2-} + 4H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$ (1). Overall: $Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$ (1). On charging, the reaction is reversed and $PbSO_4$ is turned back into Pb and PbO_2 (1).

14. k = 0.693/5730 = 1.21×10^{-4} y^{-1} (1). $t = \frac{2.303}{k} \log \frac{100}{60}$ (1) = $1.90 \times 10^4 \times 0.222 \approx 4.2 \times 10^3$ years (1).

15. (i) Their ions are small and highly charged, and they have vacant d orbitals of suitable energy to accept lone pairs (1). (ii) One species is oxidised and reduced at the same time: $3MnO_4^{2-} + 4H^+ \rightarrow 2MnO_4^- + MnO_2 + 2H_2O$ (1). (iii) MnO_4^-, which has the higher reduction potential (1).

16. (i) Cr^{3+} is $3d^3$; two empty 3d orbitals are used: d^2sp^3, inner-orbital, three unpaired electrons, μ = √15 = 3.87 BM (1½). (ii) Ni^{2+} is $3d^8$; only one 3d orbital could be emptied by pairing, so 4s, 4p and 4d are used: sp^3d^2, outer-orbital, two unpaired electrons, μ = √8 = 2.83 BM (1½).

17. (a) 2,4,6-Trinitrophenol (picric acid) (1). (b) By steam distillation: o-nitrophenol is steam volatile because of intramolecular hydrogen bonding (1). (c) The O–C(aryl) bond has partial double-bond character and is hard to break, so iodide attacks the methyl carbon (1).

OR (a) $C_6H_5ONa + C_2H_5Br \rightarrow C_6H_5OC_2H_5 + NaBr$ (1). (b) 2-Methoxytoluene and 4-methoxytoluene (Friedel–Crafts alkylation) (1). (c) In air and light they slowly form peroxides, which can explode (1).

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18. (i) A sugar that reduces Fehling's or Tollens' reagent because it has a free aldehyde or ketone group; sucrose is not (1). (ii) It exists as a dipolar ion (zwitterion), $H_3N^+CH_2COO^-$, held by strong ionic attractions (1). (iii) Vitamin K (1).

Section D (15 marks)

19. (a) A: propan-2-amine, $(CH_3)_2CHNH_2$; B: propan-2-ol, $(CH_3)_2CHOH$; C: propanone, CH_3COCH_3 (½ each). (b) $(CH_3)_2CHNH_2 + HNO_2 \rightarrow (CH_3)_2CHOH + N_2 + H_2O$ (1); $(CH_3)_2CHOH + [O] \rightarrow CH_3COCH_3 + H_2O$ (½). (c) $(CH_3)_2CHNH_2 + CHCl_3 + 3KOH \rightarrow (CH_3)_2CHNC + 3KCl + 3H_2O$ (1). (d) N,N-Dimethylmethanamine, $(CH_3)_3N$ (1).

20. (a) $\Lambda_m = 4.95 \times 10^{-5} \times 1000/0.0010 = 49.5$ S cm² mol⁻¹ (1); $\alpha = 49.5/390.5 = 0.127$ (1); $K_a = c\alpha^2/(1 - \alpha) = 0.0010 \times 0.0161/0.873 \approx 1.84 \times 10^{-5}$ (1). (b) Its overall reaction, $Zn(Hg) + HgO \rightarrow ZnO + Hg$, involves no ions whose concentration changes (1). (c) It completes the circuit and keeps the two half-cells electrically neutral (1).

OR (a) Only collisions in which the molecules have at least the threshold (activation) energy (1) and the proper orientation lead to products (1). (b) $\log \frac{k_2}{k_1} = \frac{60000}{2.303 \times 8.314} \cdot \frac{10}{300 \times 310} = 0.337$ (1), so $k_2/k_1 \approx 2.2$ (1). (c) It lowers it by the same amount as the forward activation energy (1).

21. (a) $Cr_2O_7^{2-} + 3H_2S + 8H^+ \rightarrow 2Cr^{3+} + 3S + 7H_2O$ (1). (b) $2KMnO_4 \rightarrow K_2MnO_4 + MnO_2 + O_2$ (1). (c) They are radioactive, and many have short half-lives and are available only in tiny amounts (1). (d) Zinc has a low enthalpy of atomisation and Zn^{2+} ($3d^{10}$) is stable with a high hydration enthalpy (1). (e) The second electron is removed from the stable, completely filled $3d^{10}$ configuration of Cu^+ (1).

OR (a) CN^- is a strong-field ligand, so Δ_0 is larger than the pairing energy and the six d electrons pair in t_2g (1). (b) In the fac isomer the three NH_3 groups occupy one face of the octahedron (all mutually cis) (1); in the mer isomer they lie in a plane around the metal, two of them trans (1). (c) The chelate effect: ring formation makes the complex more stable, largely because more free particles (higher entropy) are released when the chelate replaces monodentate ligands (1). (d) $[Fe(CN)_6]^{4-}$ is the coordination entity; K^+ is the counter ion (1).

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