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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 4 · 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:* [Stephen, Etard, Rosenmund, Lucas, aldehyde, ketone, ambidentate, chelate, lower, higher, more, less] An alkyl cyanide reduced with $SnCl_2$ and HCl, followed by hydrolysis, gives an _____; this is the _____ reaction.	1
	(ii) A ligand such as NO_2^-, which can bind through either of two atoms, is called _____, while a ligand such as $EDTA^{4-}$, which binds through several atoms at once, forms a _____ complex.	1
	(iii) Ethers have _____ boiling points than isomeric alcohols, and phenols are _____ acidic than alcohols.	1
	(iv) Toluene is oxidised to benzaldehyde by chromyl chloride in the _____ reaction, and benzoyl chloride is reduced to benzaldehyde by hydrogen over $Pd/BaSO_4$ in the _____ reduction.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* The unit of the molal elevation constant (K_b) is: (a) K^{-1} kg mol^{-1} (b) K mol kg^{-1} (c) K kg mol^{-1} (d) mol kg^{-1}	1
	(vi) In a dry (Leclanché) cell, the anode is made of: (a) manganese dioxide (b) zinc (c) graphite (d) lead	1
	(vii) The half-life of a zero-order reaction is: (a) proportional to the square of the initial concentration (b) inversely proportional to the initial concentration (c) independent of the initial concentration (d) directly proportional to the initial concentration	1
	(viii) The ligand ethane-1,2-diamine (en) is: (a) neutral and bidentate (b) neutral and ambidentate (c) neutral and monodentate (d) anionic and bidentate	1
	(ix) Which of the following is an allylic halide? (a) $C_6H_5CH_2Cl$ (b) $CH_2=CHCl$ (c) CH_3CH_2Cl (d) $CH_2=CH–CH_2Cl$	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** Glucose does not give the 2,4-DNP test. **Reason:** In solution glucose exists mainly in a cyclic hemiacetal form. (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:** Potassium permanganate is intensely coloured. **Reason:** The manganese ion in permanganate has unpaired d electrons that cause d–d transitions. (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.* Arenediazonium salts, such as benzenediazonium chloride, are made by treating a primary aromatic amine with sodium nitrite and hydrochloric acid in an ice bath, at 273–278 K. They are seldom stored: above this temperature the solution decomposes, giving off nitrogen. Even so, they are far more stable than alkyl diazonium salts, which cannot be isolated at all. Their real value lies in two kinds of reaction. In one, the $–N_2^+$ group is replaced by another group such as –Cl, –CN, –I or –OH; in the other, the nitrogen is kept and the salt couples with phenols or aromatic amines to give brightly coloured azo compounds, which are used as dyes. Why are diazonium salts prepared at 273–278 K and used at once?	1
	(xiii) Why are arenediazonium salts more stable than alkyl diazonium salts?	1
	(xiv) Name the coloured compound formed when benzenediazonium chloride couples with aniline.	1

Section B (20 marks)

2.	A solution contains 4.9 g of H_2SO_4 in 250 mL. Calculate its molarity and the volume of 0.10 M NaOH needed to neutralise 25 mL of it. (H_2SO_4 = 98 g mol^{-1})	2
3.	When the conductance of an electrolyte solution is measured, (i) why is alternating current used, and (ii) why are the platinum electrodes coated with platinum black? **OR** Predict the products at the cathode and the anode when aqueous copper(II) sulphate is electrolysed with platinum electrodes. Write the electrode reactions.	2
4.	A zero-order reaction has k = 0.0040 mol L^{-1} min^{-1} and an initial concentration of 0.20 mol L^{-1}. How long will it take for the concentration to fall to 0.080 mol L^{-1}? What is its half-life?	2
5.	(i) Calculate the spin-only magnetic moment of the divalent ion of the element with atomic number 26. (ii) Which of the ions Ti^{4+}, V^{3+}, Cu^{+} and Ni^{2+} are colourless? Why?	2
6.	Give the hybridisation and the number of unpaired electrons in (i) $[Mn(CN)_6]^{3-}$, (ii) $[MnCl_4]^{2-}$.	2
7.	Give reasons: (i) Haloalkanes are only slightly soluble in water, although they are polar. (ii) Benzyl chloride reacts readily by the S_N1 mechanism.	2

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8.	Explain why the C–O–H bond angle in methanol (108.9°) is slightly less than the tetrahedral angle, while the C–O–C angle in methoxymethane (111.7°) is slightly greater. **OR** How is phenol obtained from (i) chlorobenzene, (ii) benzenesulphonic acid?	2
9.	Write the structures of the products of: (i) ethanal with hydrazine, (ii) propanone with sodium hydrogensulphite.	2
10.	Give reasons: (i) Benzoic acid does not undergo the Friedel–Crafts reaction. (ii) The two carbon–oxygen bonds in the carboxylate ion are of equal length.	2
11.	How does a nucleoside differ from a nucleotide? Name the products formed on complete hydrolysis of DNA.	2

Section C (21 marks)

12.	How many grams of KCl must be dissolved in 500 g of water to lower its freezing point by 1.0 K? Assume complete dissociation. (K_f = 1.86 K kg mol^{-1}, KCl = 74.5 g mol^{-1}) **OR** Explain on the basis of colligative properties: (a) salt is spread on icy roads in winter; (b) raw mangoes shrivel when placed in strong brine; (c) eating a lot of salt can cause swelling of tissues.	3
13.	For the reaction Fe(s) + Cu^{2+}(aq) ⇌ Fe^{2+}(aq) + Cu(s) at 298 K, calculate (a) E°cell, (b) the equilibrium constant, (c) ΔG°. (E°(Fe^{2+}/Fe) = –0.44 V, E°(Cu^{2+}/Cu) = +0.34 V, F = 96500 C mol^{-1})	3
14.	(a) Write the Arrhenius equation and state what each term means. (b) What would the rate constant be if the activation energy were zero? (c) Why does a small rise in temperature increase the rate of a reaction so much?	3
15.	(i) Write the general outer electronic configurations of the lanthanoids and the actinoids. (ii) Why is Eu^{2+} a strong reducing agent? (iii) Why is the contraction across the actinoids greater than across the lanthanoids? **OR** Write balanced ionic equations for the reaction of acidified permanganate with (i) Fe^{2+} ions, (ii) SO_2, (iii) nitrite ions.	3
16.	One mole each of $CoCl_3 \cdot 6NH_3$, $CoCl_3 \cdot 5NH_3$ and $CoCl_3 \cdot 4NH_3$ is treated with excess silver nitrate, giving 3, 2 and 1 mol of AgCl respectively. Write the structural formulae of the three complexes according to Werner's theory, and state the primary and secondary valence of cobalt in them.	3
17.	How will you convert: (i) toluene to benzyl alcohol, (ii) propene to 1-bromopropane, (iii) bromobenzene to biphenyl?	3

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18.	Arrange in increasing order of the property shown: (i) basic strength in water: CH_3NH_2, $C_6H_5NH_2$, NH_3, $(CH_3)_2NH$; (ii) boiling point: C_2H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$; (iii) solubility in water: $C_6H_5NH_2$, $(C_2H_5)_2NH$, $C_2H_5NH_2$.	3

Section D (15 marks)

19.	A neutral aromatic compound A (C_7H_8O) liberates hydrogen with sodium but gives no colour with neutral $FeCl_3$. Mild oxidation of A gives B (C_7H_6O), and further oxidation gives an acid C ($C_7H_6O_2$). (a) Identify A, B and C. *[1½]* (b) Write the equations for A → B → C. *[1½]* (c) How would you distinguish A from p-cresol? *[1]* (d) What does B give when heated with concentrated NaOH? *[1]* **OR** (a) What is formed when sodium ethanoate is heated with soda lime? *[1]* (b) How will you convert ethanoic acid into (i) ethanamide, (ii) ethanoic anhydride? *[2]* (c) Why is the –COOH group meta-directing in electrophilic substitution? *[1]* (d) Arrange benzoic acid, 4-nitrobenzoic acid and 4-methoxybenzoic acid in increasing order of acidity. *[1]*	5
20.	(a) State Henry's law. Why do scuba divers face "the bends" if they rise to the surface too quickly? *[2]* (b) What mass of urea (60 g mol^{-1}) must be dissolved in 250 g of water so that the vapour pressure of water is lowered by 2%? *[3]* **OR** (a) State one difference between a galvanic cell and an electrolytic cell. *[1]* (b) Calculate the potential of a hydrogen electrode in contact with a solution of pH 3 at 298 K. *[2]* (c) A conductivity cell of cell constant 0.50 cm^{-1} filled with 0.050 M NaOH has a resistance of 40 Ω. Calculate the molar conductivity. *[2]*	5
21.	(a) Write the IUPAC name of $[Co(NH_3)_4(H_2O)Cl]Cl_2$. *[1]* (b) For $[Fe(H_2O)_6]^{2+}$, write the crystal field configuration, the number of unpaired electrons and the spin-only magnetic moment. *[2]* (c) Why is CO a stronger ligand than NH_3? *[1]* (d) Give one use of coordination compounds in medicine and one in chemical analysis. *[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) aldehyde; Stephen.

(ii) ambidentate; chelate.

(iii) lower; more.

(iv) Etard; Rosenmund.

(v) **(c)** K kg mol^{-1}. *Working:* $K_b = \Delta T_b / m$, so its unit is K ÷ (mol kg^{-1}).

(vi) **(b)** zinc. *Working:* The zinc container is oxidised; the graphite rod in MnO_2 is the cathode.

(vii) **(d)** directly proportional to the initial concentration. *Working:* $t_{1/2} = \frac{[R]_0}{2k}$.

(viii) **(a)** neutral and bidentate. *Working:* It binds through both nitrogen atoms and carries no charge.

(ix) **(d)** $CH_2{=}CH{-}CH_2Cl$. *Working:* The halogen is on the sp³ carbon next to a C=C. ($CH_2{=}CHCl$ is vinylic; $C_6H_5CH_2Cl$ is benzylic.)

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* Very little open-chain aldehyde is present, so the usual carbonyl tests fail.

(xi) **(c)** Assertion is true and Reason is false. *Working:* Mn is +7 in MnO_4^- and has no d electrons ($3d^0$); the colour comes from charge transfer from oxygen to manganese.

(xii) They are unstable; at higher temperatures the solution decomposes (giving phenol and nitrogen).

(xiii) The positive charge of the $-N_2^+$ group is spread over the benzene ring by resonance.

(xiv) p-Aminoazobenzene (a yellow dye).

Section B (20 marks)

2. Moles = 4.9/98 = 0.050; molarity = 0.050/0.250 = 0.20 M (1). 25 mL contains 0.0050 mol H_2SO_4, which needs 0.010 mol NaOH = 100 mL of 0.10 M NaOH (1).

3. (i) Direct current would electrolyse the solution and change its concentration, and gases formed would polarise the electrodes (1). (ii) Platinising increases the effective surface area of the electrodes and reduces polarisation (1).

OR Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$ (1). Anode: $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ (1).

4. $[R] = [R]_0 - kt$, so t = (0.20 − 0.080)/0.0040 = 30 min (1). $t_{½} = [R]_0/2k = 0.20/0.0080 = 25$ min (1).

5. (i) Fe^{2+} is $3d^6$ with 4 unpaired electrons: μ = √24 = 4.90 BM (1). (ii) Ti^{4+} ($3d^0$) and Cu^+ ($3d^{10}$): no d–d transition is possible (1).

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6. (i) Mn^{3+} is $3d^4$; CN^- is strong, so the electrons pair into t_2g: d^2sp^3, two unpaired electrons (1). (ii) Mn^{2+} is $3d^5$; Cl^- is weak: sp^3 (tetrahedral), five unpaired electrons (1).

7. (i) The energy released by forming new attractions with water is less than the energy needed to break the hydrogen bonds between water molecules (1). (ii) The benzyl carbocation is stabilised by resonance with the benzene ring (1).

8. In methanol the two lone pairs on oxygen repel the bond pairs more strongly than bond pairs repel each other, closing the angle (1). In the ether the repulsion between the two bulky methyl groups opens the angle (1).

OR (i) Heating chlorobenzene with NaOH at 623 K and 300 atm gives sodium phenoxide, which is acidified (1). (ii) Fusing benzenesulphonic acid with NaOH gives sodium phenoxide, which is acidified (1).

9. (i) $CH_3CH{=}N{-}NH_2$, ethanal hydrazone (1). (ii) $(CH_3)_2C(OH)SO_3Na$, the bisulphite addition compound (1).

10. (i) The –COOH group deactivates the ring and also binds the $AlCl_3$ catalyst (1). (ii) The ion is a resonance hybrid of two equivalent structures, so each C–O bond is intermediate between single and double (1).

11. A nucleoside is a base joined to a sugar; a nucleotide also has a phosphate group (1). Deoxyribose, phosphoric acid and the bases adenine, guanine, cytosine and thymine (1).

Section C (21 marks)

12. $\Delta T_f = iK_f m$ with i = 2: m = 1.0/(2 × 1.86) = 0.269 mol kg^{-1} (1). Moles in 0.500 kg = 0.134 (1). Mass = 0.134 × 74.5 ≈ 10.0 g (1).

OR (a) The salt solution has a lower freezing point than water, so the ice melts (1). (b) Brine is hypertonic, so water passes out of the mango by osmosis (1). (c) Salt in the body draws water into the tissue spaces by osmosis (1).

13. (a) E° = 0.34 − (−0.44) = 0.78 V (1). (b) log K = 2 × 0.78/0.059 = 26.4, K ≈ 2.8×10^{26} (1). (c) ΔG° = −2 × 96500 × 0.78 = -1.51×10^5 J mol^{-1} (1).

14. (a) $k = Ae^{-E_a/RT}$: A is the frequency (pre-exponential) factor, E_a the activation energy, R the gas constant, T the absolute temperature (1). (b) k = A (1). (c) The fraction of molecules with energy at least E_a rises sharply with temperature (1).

15. (i) Lanthanoids: $[Xe]4f^{1\text{-}14}5d^{0\text{-}1}6s^2$; actinoids: $[Rn]5f^{1\text{-}14}6d^{0\text{-}1}7s^2$ (1). (ii) The common, stable oxidation state is +3, so Eu^{2+} readily loses an electron (1). (iii) 5f electrons shield the outer electrons even more poorly than 4f electrons (1).

OR (i) $MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$ (1). (ii) $2MnO_4^- + 5SO_2 + 2H_2O \rightarrow 2Mn^{2+} + 5SO_4^{2-} + 4H^+$ (1). (iii) $2MnO_4^- + 5NO_2^- + 6H^+ \rightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$ (1).

16. $[Co(NH_3)_6]Cl_3$, $[Co(NH_3)_5Cl]Cl_2$, $[Co(NH_3)_4Cl_2]Cl$: only the chloride ions outside the square brackets are precipitated (2). Primary valence (oxidation state) 3; secondary valence (coordination number) 6 (1).

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17. (i) Cl_2 in sunlight gives $C_6H_5CH_2Cl$; aqueous KOH gives $C_6H_5CH_2OH$ (1). (ii) HBr in the presence of a peroxide (anti-Markovnikov addition) (1). (iii) Fittig reaction: $2C_6H_5Br + 2Na \rightarrow$ (dry ether) $C_6H_5–C_6H_5 + 2NaBr$ (1).

18. (i) $C_6H_5NH_2 < NH_3 < CH_3NH_2 < (CH_3)_2NH$ (1). (ii) $(CH_3)_2NH < C_2H_5NH_2 < C_2H_5OH$ (1). (iii) $C_6H_5NH_2 < (C_2H_5)_2NH < C_2H_5NH_2$ (1).

Section D (15 marks)

19. (a) A: benzyl alcohol, $C_6H_5CH_2OH$; B: benzaldehyde, C_6H_5CHO; C: benzoic acid, C_6H_5COOH (½ each). (b) $C_6H_5CH_2OH \rightarrow$ (PCC) C_6H_5CHO (½); $C_6H_5CHO + [O] \rightarrow$ ($KMnO_4$) C_6H_5COOH (1). (c) p-Cresol is a phenol and gives a violet colour with neutral $FeCl_3$; A does not (1). (d) Benzyl alcohol and sodium benzoate (Cannizzaro reaction) (1).

OR (a) Methane: $CH_3COONa + NaOH \rightarrow$ (CaO, heat) $CH_4 + Na_2CO_3$ (1). (b) (i) $CH_3COOH + NH_3 \rightarrow CH_3COONH_4 \rightarrow$ (heat) $CH_3CONH_2 + H_2O$ (1). (ii) $2CH_3COOH \rightarrow$ (P_2O_5, heat) $(CH_3CO)_2O + H_2O$ (1). (c) It withdraws electrons and lowers the electron density most at the ortho and para positions (1). (d) 4-methoxybenzoic < benzoic < 4-nitrobenzoic acid (1).

20. (a) The solubility of a gas in a liquid is proportional to the partial pressure of the gas above it ($p = K_H x$) (1). At depth, extra nitrogen dissolves in the blood; on rising quickly the pressure falls and the gas forms bubbles in the blood (1). (b) Relative lowering = mole fraction of solute = 0.020 (1). Water = 250/18 = 13.89 mol; $n/(n + 13.89) = 0.020$ gives n = 0.283 mol (1). Mass = 0.283 × 60 ≈ 17.0 g (1).

OR (a) A galvanic cell turns chemical energy into electrical energy by a spontaneous reaction; an electrolytic cell uses electrical energy to drive a non-spontaneous reaction (1). (b) For $H^+ + e^- \rightarrow ½H_2$, $E = –0.059 \log(1/[H^+]) = –0.059 \times pH$ (1) = –0.177 V (1). (c) $\kappa = 0.50/40 = 0.0125$ S cm^{-1} (1); $\Lambda_m = 0.0125 \times 1000/0.050 = 250$ S cm^2 mol^{-1} (1).

21. (a) Tetraammineaquachloridocobalt(III) chloride (1). (b) Fe^{2+} is $3d^6$ and H_2O is a weak ligand: $t_2g^4e_g^2$ (1); four unpaired electrons, $\mu = \sqrt{24} = 4.90$ BM (1). (c) Besides donating a lone pair, CO accepts electron density from the metal into its π* orbitals (back-bonding) (1). (d) Cisplatin is used against cancer; EDTA is used to estimate Ca^{2+} and Mg^{2+} (hardness of water), or dimethylglyoxime to detect Ni^{2+} (1).

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