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Your JEE Guide

ISC Class XII · Chemistry Paper 1 (Theory)

Sample Question Paper 3 · 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:* [Hoffmann, Gabriel phthalimide, carbylamine, Clemmensen, Wolff–Kishner, Stephen, four, six, octahedral, tetrahedral, increases, decreases] Primary amines heated with chloroform and alcoholic KOH give foul-smelling isocyanides in the _____ reaction; pure primary aliphatic amines are prepared by the _____ synthesis.	1
	(ii) A carbonyl group is reduced to $–CH_2–$ by zinc amalgam and concentrated HCl in the _____ reduction, and by hydrazine and KOH in ethylene glycol in the _____ reduction.	1
	(iii) The coordination number of iron in $[Fe(C_2O_4)_3]^{3-}$ is _____ and the complex is _____ in shape.	1
	(iv) The solubility of a gas in a liquid _____ as the temperature rises and _____ as the pressure of the gas rises.	1

	(v) *(B) Select and write the correct alternative from the choices given below.* In which of the following mixtures are the attractions between unlike molecules stronger than those between like molecules? (a) ethanol and acetone (b) carbon disulphide and acetone (c) n-hexane and n-heptane (d) phenol and aniline	1
	(vi) The charge needed to oxidise one mole of FeO to Fe_2O_3 is: (a) 2 F (b) 0.5 F (c) 1 F (d) 3 F	1
	(vii) The activation energy of a reaction is lowered by: (a) adding a catalyst (b) raising the temperature (c) increasing the concentration (d) increasing the pressure	1
	(viii) Which of the following is the strongest acid? (a) ethanol (b) p-nitrophenol (c) phenol (d) p-cresol	1
	(ix) Which base is present in RNA but not in DNA? (a) uracil (b) thymine (c) adenine (d) cytosine	1
	(x) Given below are two statements marked Assertion and Reason. Select the correct option. **Assertion:** Ethanal undergoes aldol condensation but methanal does not. **Reason:** Methanal has no α-hydrogen atom. (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:** Zinc salts are white. **Reason:** Zn^{2+} ions have unpaired d electrons. (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.* Many compounds containing several halogen atoms are useful, but some are harmful. Chloroform was once used as an anaesthetic. In air and light it is slowly oxidised to phosgene ($COCl_2$), an extremely poisonous gas, so it is stored in closed, dark-coloured bottles filled completely. Freons, the chlorofluorocarbons once used in refrigerators and air conditioners, are very stable; they drift unchanged into the stratosphere, where ultraviolet light breaks them into free radicals that destroy ozone. DDT, an effective insecticide, is not broken down quickly by animals. It is stored in fatty tissue, and its concentration rises at each step of a food chain. Name the poisonous gas formed when chloroform is exposed to air and light, and write the equation.	1
	(xiii) Why are freons harmful even though they are unreactive at ground level?	1
	(xiv) Why does DDT harm animals higher in a food chain much more than the insects it is sprayed on?	1

Section B (20 marks)

2.	The vapour pressure of pure water at 298 K is 23.8 mm Hg. Calculate the vapour pressure of a solution of 36 g of glucose (180 g mol^{-1}) in 180 g of water at this temperature.	2
3.	Calculate the emf at 298 K of the cell Zn | Zn^{2+}(0.001 M) || Cu^{2+}(0.1 M) | Cu. ($E°_{cell}$ = 1.10 V)	2
4.	The rate of a reaction triples when the temperature is raised from 300 K to 320 K. Calculate its activation energy. (R = 8.314 J K^{-1} mol^{-1}) **OR** State two differences between the order and the molecularity of a reaction.	2
5.	(i) What is seen when the pH of a solution of potassium dichromate is increased? Why? (ii) Why do transition metals and their compounds act as good catalysts?	2
6.	Write the formulae of: (i) tetraamminediaquacobalt(III) chloride, (ii) potassium tetracyanidonickelate(II).	2
7.	Arrange in increasing order of boiling point, and give a reason: bromoform, chloromethane, dibromomethane, bromomethane. **OR** What are enantiomers? Is 2-chlorobutane chiral? Explain.	2
8.	Write the equations for the reaction of ethanol with concentrated sulphuric acid at (i) 443 K, (ii) 413 K.	2
9.	How will you convert: (i) ethanal to propan-2-ol, (ii) benzoic acid to benzaldehyde? Write the equations.	2

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10.	Give reasons: (i) Benzoic acid is a stronger acid than ethanoic acid. (ii) Carboxylic acids have higher boiling points than alcohols of comparable molecular mass.	2
11.	Complete the equations: (i) $C_6H_5N_2^+Cl^-$ + C_6H_5OH (in alkali) → (ii) $C_6H_5N_2^+Cl^-$ + H_3PO_2 + H_2O →	2

Section C (21 marks)

12.	(a) 6.0 g of a non-volatile non-electrolyte dissolved in 100 g of water raises the boiling point by 0.52 K. Calculate the molar mass of the solute. (K_b = 0.52 K kg mol^{-1}) *[2]* (b) Why is elevation of boiling point called a colligative property? *[1]* **OR** (a) Liquids A and B form an ideal solution. Their vapour pressures when pure are 100 kPa and 60 kPa. For a solution with mole fraction of A = 0.40, calculate the total vapour pressure and the mole fraction of A in the vapour. *[2]* (b) What are the values of ΔH_{mix} and ΔV_{mix} for an ideal solution? *[1]*	3
13.	(a) Write the reactions at the anode and the cathode, and the overall reaction, when iron rusts in moist air. *[2]* (b) Give one method of preventing rusting. *[1]*	3
14.	A first-order reaction is 20% complete in 25 minutes. Calculate (a) its rate constant, (b) its half-life, (c) the fraction of the reactant left after three half-lives.	3
15.	Account for the following: (i) The third ionisation enthalpy of manganese is unusually high. (ii) CrO_3 is a strong oxidising agent, whereas MoO_3 and WO_3 are not. (iii) Most first-row transition metals show the +2 oxidation state, but scandium shows only +3.	3
16.	(a) An aqueous solution of $[Ni(H_2O)_6]^{2+}$ is green. When ethane-1,2-diamine is added it turns violet as $[Ni(en)_3]^{2+}$ forms. Explain using crystal field theory. *[2]* (b) Why is anhydrous copper(II) sulphate white while the hydrated salt is blue? *[1]* **OR** Explain the bonding in metal carbonyls such as $[Ni(CO)_4]$.	3
17.	An alcohol A ($C_4H_{10}O$) is oxidised to a ketone B (C_4H_8O), which gives the iodoform test. On heating with concentrated H_2SO_4, A gives C as the main product. Identify A, B and C and write the equations.	3
18.	(i) Glucose pentaacetate does not react with hydroxylamine. What does this show? (ii) What are anomers? (iii) How does an α-helix differ from a β-pleated sheet?	3

Section D (15 marks)

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19. (5)

A compound A (C_8H_8O) forms an orange-red precipitate with 2,4-DNP reagent and gives the iodoform test, but does not reduce Tollens' reagent. On vigorous oxidation it gives benzoic acid.

(a) Identify A. *[1]*

(b) Write the equation for the iodoform reaction of A. *[1]*

(c) What is formed when A reacts with hydroxylamine? *[1]*

(d) What is formed by the Clemmensen reduction of A? *[1]*

(e) Why does A not reduce Tollens' reagent? *[1]*

OR

(a) Write the equations for the Gabriel phthalimide synthesis of ethanamine. Why can it not be used for aniline? *[2]*

(b) Arrange $C_6H_5NH_2$, $C_2H_5NH_2$ and $(C_2H_5)_2NH$ in increasing order of pK_b. *[1]*

(c) Why does nitration of aniline give a large amount of the m-nitro product? *[1]*

(d) How will you convert nitrobenzene into benzoic acid? *[1]*

20. (5)

(a) The limiting molar conductivities of NH_4Cl, NaOH and NaCl are 129.8, 248.1 and 126.5 S cm^2 mol^{-1}. Calculate Λ°_m for NH_4OH. *[2]*

(b) A current of 0.50 A is passed through acidified water for 1930 s. Calculate the volume of hydrogen at STP liberated at the cathode. (F = 96500 C mol^{-1}; molar volume at STP = 22.4 L) *[2]*

(c) Why can the potential of a single electrode not be measured? *[1]*

21. (5)

(a) The following initial rates were measured for the reaction A + B → products:

[A] (mol L^{-1})	[B] (mol L^{-1})	Initial rate (mol L^{-1} s^{-1})
0.10	0.10	2.0×10^{-3}
0.20	0.10	4.0×10^{-3}
0.10	0.20	8.0×10^{-3}

Find the order with respect to A and B, write the rate law and calculate k. *[3]*

(b) Draw an energy profile diagram and use it to explain how a catalyst speeds up a reaction. *[2]*

OR

(a) What type of isomerism is shown by $[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$? *[1]*

(b) Give an example of hydrate isomerism. *[1]*

(c) How many ions does $[Co(NH_3)_5Cl]Cl_2$ give per formula unit in water, and how many moles of AgCl does one mole of it precipitate with excess $AgNO_3$? *[1]*

(d) Arrange I^-, F^-, H_2O, NH_3 and CN^- in increasing order of crystal field strength. *[1]*

(e) Why are low-spin tetrahedral complexes rarely seen? *[1]*

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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) carbylamine; Gabriel phthalimide.

(ii) Clemmensen; Wolff–Kishner.

(iii) six; octahedral.

(iv) decreases; increases.

(v) **(d)** phenol and aniline. *Working:* Phenol and aniline form strong hydrogen bonds with each other (O–H···N), stronger than those in the pure liquids.

(vi) **(c)** 1 F. *Working:* Iron changes from +2 to +3: one electron per Fe.

(vii) **(a)** adding a catalyst. *Working:* A catalyst provides a path of lower activation energy; temperature changes how many molecules have that energy, not the energy itself.

(viii) **(b)** p-nitrophenol. *Working:* The $-NO_2$ group withdraws electrons and stabilises the phenoxide ion; $-CH_3$ in p-cresol does the opposite.

(ix) **(a)** uracil. *Working:* RNA has uracil in place of thymine.

(x) **(a)** Both Assertion and Reason are true, and Reason is the correct explanation for Assertion. *Working:* Aldol condensation starts with removal of an α-hydrogen to form a carbanion, which methanal cannot form.

(xi) **(c)** Assertion is true and Reason is false. *Working:* Zn^{2+} is $3d^{10}$: there are no unpaired electrons and no d–d transitions, which is why its salts are white.

(xii) Phosgene (carbonyl chloride): $2CHCl_3 + O_2 \rightarrow 2COCl_2 + 2HCl$.

(xiii) They reach the stratosphere unchanged, where ultraviolet light breaks them into radicals that destroy the ozone layer.

(xiv) It is not metabolised quickly and is stored in fatty tissue, so its concentration builds up at each step of the food chain.

Section B (20 marks)

2. Moles: glucose 0.20, water 10.0; x(water) = 10.0/10.2 = 0.980 (1). p = 0.980 × 23.8 = 23.3 mm Hg (1).

3. $E = E^\circ - \frac{0.059}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$ (1) $= 1.10 - 0.0295\log 10^{-2} = 1.10 + 0.059 = 1.159$ V (1).

4. $\log 3 = \frac{E_a}{2.303R}\cdot\frac{20}{300\times320}$ (1). $E_a = 0.477 \times 19.15 \times 4800 \approx 4.38 \times 10^4$ J mol^{-1} = 43.8 kJ mol^{-1} (1).

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OR Order is found by experiment, while molecularity is the number of species taking part in an elementary step (1). Order can be zero or fractional; molecularity is always a whole number (1).

5. (i) The orange colour turns yellow, because dichromate changes to chromate: $Cr_2O_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$ (1). (ii) They show variable oxidation states and can form intermediate complexes, and their surfaces adsorb reactants (1).

6. (i) $[Co(NH_3)_4(H_2O)_2]Cl_3$ (1). (ii) $K_2[Ni(CN)_4]$ (1).

7. $CH_3Cl < CH_3Br < CH_2Br_2 < CHBr_3$ (1). The molecular mass and size, and hence the van der Waals forces, increase in this order (1).

OR Stereoisomers that are non-superimposable mirror images of each other (1). Yes: C2 carries four different groups (H, Cl, CH_3 and C_2H_5), so the molecule is chiral (1).

8. (i) $C_2H_5OH \rightarrow CH_2{=}CH_2 + H_2O$: dehydration to ethene (1). (ii) $2C_2H_5OH \rightarrow C_2H_5OC_2H_5 + H_2O$: diethyl ether (1).

9. (i) $CH_3CHO + CH_3MgBr \rightarrow (CH_3)_2CHOMgBr \rightarrow (H_2O)\ (CH_3)_2CHOH$ (1). (ii) $C_6H_5COOH + SOCl_2 \rightarrow C_6H_5COCl$; $C_6H_5COCl + H_2 \rightarrow (Pd/BaSO_4)\ C_6H_5CHO + HCl$ (1).

10. (i) The phenyl group (sp^2 carbon) withdraws electrons and stabilises the benzoate ion, whereas the methyl group releases electrons (1). (ii) Carboxylic acid molecules are held in pairs (dimers) by two hydrogen bonds, which are stronger than the hydrogen bonding in alcohols (1).

11. (i) p-Hydroxyazobenzene, HO–C_6H_4–N=N–C_6H_5, an orange dye, + HCl (coupling) (1). (ii) $C_6H_6 + N_2 + H_3PO_3 + HCl$ (1).

Section C (21 marks)

12. (a) Molality = $\Delta T_b/K_b$ = 1.0 mol kg^{-1} (1); moles = 1.0 × 0.100 = 0.10, so M = 6.0/0.10 = 60 g mol^{-1} (1). (b) It depends only on the number of solute particles, not on their nature (1).

OR (a) P = 0.40 × 100 + 0.60 × 60 = 76 kPa (1); y_A = 40/76 = 0.53 (1). (b) Both are zero (1).

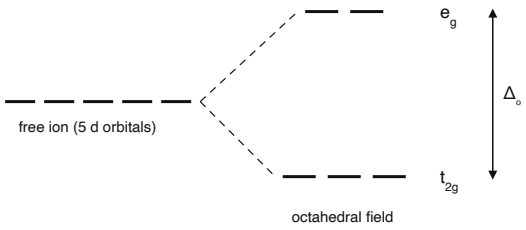
13. (a) Anode: $2Fe \rightarrow 2Fe^{2+} + 4e^-$; cathode: $O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$ (1). Overall: $2Fe + O_2 + 4H^+ \rightarrow 2Fe^{2+} + 2H_2O$; Fe^{2+} is further oxidised to hydrated ferric oxide, $Fe_2O_3{\cdot}xH_2O$ (1). (b) Galvanising (zinc coating), painting or oiling (1).

14. (a) $k = \frac{2.303}{25} \log \frac{100}{80} = 8.93 \times 10^{-3}$ min^{-1} (1). (b) $t_{½}$ = 0.693/k ≈ 77.6 min (1). (c) $(½)^3$ = 1/8 (1).

15. (i) The third electron must be removed from Mn^{2+}, which has the stable half-filled $3d^5$ configuration (1). (ii) In group 6 the higher oxidation states become more stable down the group, so Cr(VI) is readily reduced to Cr(III) while Mo(VI) and W(VI) are stable (1). (iii) The +2 state comes from losing the two 4s electrons; scandium ($3d^14s^2$) loses all three outer electrons to reach the stable noble-gas configuration of Sc^{3+} (1).

16. (a) en is a stronger-field ligand than water, so Δ_0 becomes larger (1). The complex then absorbs light of shorter wavelength (higher energy), so the complementary colour seen changes from green to violet (1).

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(b) Without water ligands there is no crystal field splitting of the right size for visible light, so no colour is seen (1).

OR The carbon of CO donates its lone pair into an empty metal orbital, forming a σ bond (1). The metal donates electrons from filled d orbitals into the empty antibonding π* orbitals of CO, forming a π bond (1). The two effects reinforce each other (synergic bonding), strengthening the metal–carbon bond (1).

17. A: butan-2-ol, $CH_3CH(OH)CH_2CH_3$; B: butan-2-one, $CH_3COCH_2CH_3$ (1). $CH_3CH(OH)C_2H_5 + [O] \rightarrow CH_3COC_2H_5 + H_2O$ (1). C: but-2-ene, $CH_3CH{=}CHCH_3$, the more substituted alkene (Saytzeff rule): $CH_3CH(OH)CH_2CH_3 \rightarrow CH_3CH{=}CHCH_3 + H_2O$ (1).

18. (i) Glucose has no free aldehyde group; it exists in a cyclic form (1). (ii) Cyclic forms of a sugar that differ only in the configuration of the –OH at C1, e.g. α- and β-D-glucose (1). (iii) In an α-helix one chain coils, held by hydrogen bonds within the chain; in a β-pleated sheet stretched chains lie side by side, held by hydrogen bonds between chains (1).

Section D (15 marks)

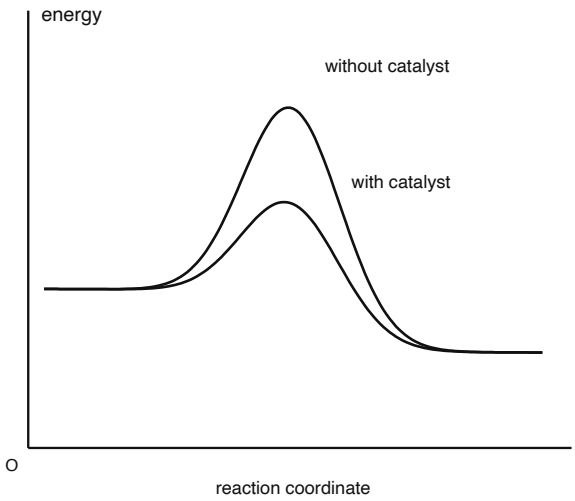
19. (a) Acetophenone, $C_6H_5COCH_3$ (1). (b) $C_6H_5COCH_3 + 3I_2 + 4NaOH \rightarrow C_6H_5COONa + CHI_3 + 3NaI + 3H_2O$ (1). (c) Acetophenone oxime, $C_6H_5C(=NOH)CH_3$ (1). (d) Ethylbenzene, $C_6H_5CH_2CH_3$ (1). (e) It is a ketone, with no hydrogen on the carbonyl carbon to be oxidised (1).

OR (a) Phthalimide + KOH → potassium phthalimide; + C_2H_5I → N-ethylphthalimide; hydrolysis with NaOH gives $C_2H_5NH_2$ and sodium phthalate (1). Aryl halides do not undergo nucleophilic substitution with the phthalimide anion (1). (b) $(C_2H_5)_2NH < C_2H_5NH_2 < C_6H_5NH_2$ (1). (c) In the strongly acidic mixture aniline is protonated to the anilinium ion, which directs to the meta position (1). (d) Sn/HCl → aniline; $NaNO_2$/HCl at 273–278 K → diazonium salt; CuCN/KCN → benzonitrile; acid hydrolysis → benzoic acid (1).

20. (a) $\Lambda°(NH_4OH) = \Lambda°(NH_4Cl) + \Lambda°(NaOH) - \Lambda°(NaCl)$ (1) = 129.8 + 248.1 − 126.5 = 251.4 S cm² mol⁻¹ (1). (b) Q = 965 C = 0.010 F (1); $2H^+ + 2e^- \rightarrow H_2$ gives 0.0050 mol H_2 = 0.112 L = 112 mL (1). (c) Oxidation and reduction must occur together; only the difference of potential between two electrodes can be measured (1).

21. (a) Doubling [A] doubles the rate: first order in A (½). Doubling [B] makes the rate four times: second order in B (½). Rate = $k[A][B]^2$ (1). $k = 2.0 \times 10^{-3}/(0.10 \times 0.10^2) = 2.0$ L² mol⁻² s⁻¹ (1). (b) Diagram (1):

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A catalyst provides an alternative path with a lower activation energy, so more molecules have enough energy to react; ΔH is unchanged (1).

OR (a) Coordination isomerism (1). (b) $[Cr(H_2O)_6]Cl_3$ (violet) and $[Cr(H_2O)_5Cl]Cl_2 \cdot H_2O$ (grey-green) (1). (c) Three ions; two moles of AgCl (1). (d) $I^- < F^- < H_2O < NH_3 < CN^-$ (1). (e) The tetrahedral splitting, about 4/9 of Δ_0, is almost always smaller than the pairing energy (1).

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