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Your JEE Guide

MP Board Class XII · Chemistry

Sample Question Paper 2 · Session 2026-27

Time allowed: 3 hours **Maximum marks: 70**

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This is an original practice paper written to the MPBSE 2027 sample question paper pattern; it is not issued by MPBSE.

General instructions:

1. All questions are compulsory.
2. Questions 1 to 5 are objective questions (28 in all): choose the correct option, fill in the blanks, true/false, match the columns and answer in one word or sentence. Each sub-question carries 1 mark.
3. Questions 6 to 12 are very short answer questions of 2 marks each. Answer each in about 30 words.
4. Questions 13 to 16 are short answer questions of 3 marks each. Answer each in about 75 words.
5. Questions 17 to 20 are long answer questions of 4 marks each. Answer each in about 120 words.
6. Internal options are given in questions 13 to 20.
7. Draw neat and labelled diagrams wherever necessary.

1.	**(i)** *Choose the correct option and write it:* The solubility of a gas in water, with a rise in temperature: (a) increases (b) decreases (c) first increases, then decreases (d) stays the same	1
	(ii) A cell reaction is spontaneous when: (a) $E°_{cell}$ is positive (b) $E°_{cell}$ is zero (c) $\Delta G°$ is positive (d) $E°_{cell}$ is negative	1
	(iii) The unit of the rate constant of a zero-order reaction is: (a) s^{-1} (b) $L\ mol^{-1}\ s^{-1}$ (c) $L^2\ mol^{-2}\ s^{-1}$ (d) $mol\ L^{-1}\ s^{-1}$	1
	(iv) Which of the following ions is colourless in aqueous solution? (a) Fe^{3+} (b) Cr^{3+} (c) Sc^{3+} (d) Cu^{2+}	1
	(v) Chlorobenzene is less reactive than chloromethane towards nucleophilic substitution because: (a) the C–Cl bond has partial double-bond character (b) chlorine is more electronegative in chlorobenzene (c) benzene is aliphatic (d) chlorobenzene is a gas	1

	(vi) Which of the following is the strongest base in aqueous solution? (a) $(CH_3)_3N$ (b) $C_6H_5NH_2$ (c) $(CH_3)_2NH$ (d) NH_3	1
2.	**(i)** *Fill in the blanks:* The number of moles of solute dissolved in one kilogram of solvent is the _____ of the solution.	1
	(ii) The SI unit of conductance is the _____.	1
	(iii) A _____ increases the rate of a reaction by providing a path of lower activation energy.	1
	(iv) In the actinoids, electrons are progressively added to the _____ orbitals.	1
	(v) Ethers are prepared from alkyl halides and sodium alkoxides by the _____ synthesis.	1
	(vi) The secondary structure of proteins includes the α-helix and the β-_____ sheet.	1
3.	**(i)** *Write True or False:* Osmotic pressure is a colligative property.	1
	(ii) The emf of a cell is an intensive property.	1
	(iii) The half-life of a first-order reaction depends on the initial concentration.	1
	(iv) Potassium dichromate is orange in colour.	1
	(v) Aldehydes are generally more reactive than ketones towards nucleophilic addition.	1
	(vi) Starch is a polymer of fructose.	1
4.	Match each reagent in column A with its use in column B:	5

Column A	Column B
(i) Tollens' reagent	(a) distinguishing primary, secondary and tertiary amines
(ii) Lucas reagent	(b) test for phenol (violet colour)
(iii) Hinsberg's reagent	(c) test for aldehydes (silver mirror)
(iv) Neutral $FeCl_3$	(d) distinguishing primary, secondary and tertiary alcohols
(v) 2,4-DNP	(e) test for the carbonyl group

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5.	**(i)** *Answer in one word or one sentence:* What type of azeotrope do nitric acid and water form?	1
	(ii) Name the metal used as a catalyst in the hydrogenation of vegetable oils.	1
	(iii) Write the IUPAC name of CH_3OCH_3.	1
	(iv) Name the product formed when ethanal reacts with HCN.	1
	(v) Name the enzyme that hydrolyses sucrose.	1
6.	What is an ideal solution? Write two of its characteristics.	2
7.	Calculate the electrode potential of a zinc electrode dipped in 0.01 M Zn^{2+} solution at 298 K. ($E°(Zn^{2+}/Zn) = -0.76$ V)	2
8.	Name and explain two factors that affect the rate of a chemical reaction.	2
9.	Calculate the spin-only magnetic moments of Ti^{3+} and V^{2+}. (Atomic numbers: Ti 22, V 23)	2
10.	What is a chelate complex? Give one example.	2
11.	Write the equations for the Wurtz reaction and the Fittig reaction.	2
12.	What is a nucleotide? Name its three components.	2
13.	1.0 g of a non-volatile solute dissolved in 100 g of benzene lowers its freezing point by 0.40 K. Calculate the molar mass of the solute. (K_f for benzene = 5.12 K kg mol^{-1}) **OR** A solution contains 20% ethanol (C_2H_5OH) by mass in water. Calculate the mole fraction of ethanol.	3
14.	Write the reactions at the cathode and the anode when concentrated aqueous sodium chloride is electrolysed. Name the products. **OR** Write the reactions at the anode and the cathode of a mercury cell. Why does it give a nearly constant voltage?	3
15.	The rate constant of a reaction doubles when the temperature rises from 300 K to 310 K. Calculate its activation energy. ($R = 8.314$ J K^{-1} mol^{-1}) **OR** Explain the collision theory of reaction rates. Why do all collisions not lead to products?	3
16.	Write the IUPAC names of: (a) $K_3[Fe(CN)_6]$, (b) $[Co(NH_3)_5Cl]Cl_2$, (c) $[Pt(NH_3)_2Cl_2]$. **OR** Explain, with a diagram, the splitting of d orbitals in an octahedral crystal field.	3

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17.	What are transition elements? Explain four of their characteristic properties. **OR** Write the equations for the preparation of potassium dichromate from chromite ore. Write one reaction showing its oxidising action in acid.	4
18.	How is phenol prepared from (a) chlorobenzene, (b) benzenesulphonic acid, (c) a diazonium salt? (d) How does a nitro group in the ring affect the acidity of phenol? **OR** How are ethers prepared (a) by dehydration of alcohols, (b) by the Williamson synthesis? (c) What happens when methoxymethane is heated with excess HI?	4
19.	Write the equations for: (a) the Rosenmund reduction, (b) the Stephen reaction, (c) the Etard reaction, (d) the Gattermann–Koch reaction. **OR** (a) Explain two factors that affect the acidity of carboxylic acids. (b) Write the equation for the Hell–Volhard–Zelinsky reaction. (c) What is decarboxylation? Give an example.	4
20.	How does Hinsberg's reagent distinguish primary, secondary and tertiary amines? Write the equations. Explain the order of basic strength of the ethylamines in water. **OR** Describe the primary, secondary, tertiary and quaternary structures of proteins.	4

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Answers and Marking Scheme

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

Question 1

(i) **(b)** decreases. *Working:* Dissolution of gases is exothermic, and K_H rises with temperature.

(ii) **(a)** E°cell is positive. *Working:* $\Delta G^\circ = -nFE^\circ$ is then negative.

(iii) **(d)** mol L^{-1} s^{-1}. *Working:* Rate = k, so k has the unit of rate.

(iv) **(c)** Sc^{3+}. *Working:* Sc^{3+} has no d electrons ($3d^0$).

(v) **(a)** the C–Cl bond has partial double-bond character. *Working:* Resonance with the ring strengthens the C–Cl bond.

(vi) **(c)** $(CH_3)_2NH$. *Working:* For methyl amines in water, $2^\circ > 1^\circ > 3^\circ > NH_3$; aniline is weaker still.

Question 2

(i) molality.

(ii) siemens (S).

(iii) catalyst.

(iv) 5f.

(v) Williamson.

(vi) pleated.

Question 3

(i) True.

(ii) True: it does not depend on the size of the cell.

(iii) False: it is 0.693/k.

(iv) True.

(v) True.

(vi) False: it is a polymer of α-glucose.

4. (i) – (c) test for aldehydes (silver mirror); (ii) – (d) distinguishing primary, secondary and tertiary alcohols; (iii) – (a) distinguishing primary, secondary and tertiary amines; (iv) – (b) test for phenol (violet colour); (v) – (e) test for the carbonyl group

Question 5

(i) A maximum-boiling azeotrope.

(ii) Nickel.

(iii) Methoxymethane.

(iv) Ethanal cyanohydrin (2-hydroxypropanenitrile).

(v) Invertase.

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6. A solution that obeys Raoult's law at all concentrations (1). $\Delta H_{mix} = 0$ and $\Delta V_{mix} = 0$; the A–B attractions are the same as A–A and B–B (1).

7. $E = E^\circ - \frac{0.059}{2}\log\frac{1}{[Zn^{2+}]}$ (1) = –0.76 – 0.0295 × 2 = –0.819 V (1).

8. Any two: concentration of reactants (more collisions); temperature (more molecules with energy above the activation energy); a catalyst (lower activation energy); surface area of solid reactants (1 + 1).

9. Ti^{3+} is $3d^1$, one unpaired electron: $\sqrt{3}$ = 1.73 BM (1). V^{2+} is $3d^3$, three unpaired electrons: $\sqrt{15}$ = 3.87 BM (1).

10. A complex in which a ligand binds the metal through two or more donor atoms, forming a ring (1). E.g. $[Co(en)_3]^{3+}$ or the Ca^{2+}–EDTA complex (1).

11. Wurtz: $2CH_3Br + 2Na \rightarrow$ (dry ether) $CH_3–CH_3 + 2NaBr$ (1). Fittig: $2C_6H_5Cl + 2Na \rightarrow$ (dry ether) $C_6H_5–C_6H_5 + 2NaCl$ (1).

12. The repeating unit of a nucleic acid (1). A nitrogenous base, a pentose sugar and a phosphate group (1).

13. $M = \frac{K_f \times w \times 1000}{\Delta T_f \times W}$ (1) $= \frac{5.12 \times 1.0 \times 1000}{0.40 \times 100}$ (1) = 128 g mol^{-1} (1).

OR In 100 g: 20 g ethanol = 0.435 mol and 80 g water = 4.44 mol (1½). x(ethanol) = 0.435/4.88 ≈ 0.089 (1½).

14. Cathode: $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$ (water is reduced in preference to Na^+) (1). Anode: $2Cl^- \rightarrow Cl_2 + 2e^-$ (1). Products: hydrogen at the cathode, chlorine at the anode, and NaOH in solution (1).

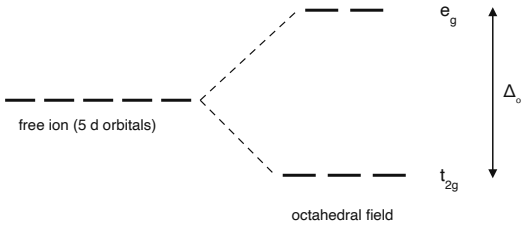
OR Anode: $Zn(Hg) + 2OH^- \rightarrow ZnO + H_2O + 2e^-$ (1). Cathode: $HgO + H_2O + 2e^- \rightarrow Hg + 2OH^-$ (1). The overall reaction, $Zn(Hg) + HgO \rightarrow ZnO + Hg$, involves no ions in solution whose concentration changes, so the voltage stays near 1.35 V (1).

15. $\log\frac{k_2}{k_1} = \frac{E_a}{2.303R}\cdot\frac{T_2 - T_1}{T_1T_2}$ (1). 0.301 = $\frac{E_a}{19.15} \times \frac{10}{93000}$ (1). $E_a \approx 5.36 \times 10^4$ J mol^{-1} = 53.6 kJ mol^{-1} (1).

OR Molecules must collide to react; the rate is proportional to the number of collisions per second (1). Only collisions with energy at least equal to the activation energy (1), and with the proper orientation of the molecules, are effective (1).

16. (a) Potassium hexacyanidoferrate(III) (1). (b) Pentaamminechloridocobalt(III) chloride (1). (c) Diamminedichloridoplatinum(II) (1).

OR Diagram (1):



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The ligands approach along the axes, so the $d_{x^2-y^2}$ and d_{z^2} orbitals (e_g), which point at them, are raised in energy (1). The d_{xy}, d_{yz} and d_{zx} orbitals (t_2g), which lie between the axes, are lowered; the gap is Δ_0 (1).

17. Elements with partly filled d orbitals in the atom or in a common oxidation state (1). Variable oxidation states, because (n – 1)d and ns electrons have similar energies (¾). Coloured ions, from d–d transitions (¾). Paramagnetism, from unpaired electrons (¾). Catalytic activity and complex formation, from variable oxidation states and vacant d orbitals (¾).

OR $4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \rightarrow 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2$ (1). $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$ (1). $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$ (1). $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$ (1).

18. (a) Chlorobenzene with NaOH at 623 K and 300 atm, then acid (1). (b) Fusion with NaOH, then acid (1). (c) Warming benzenediazonium chloride with water: $C_6H_5N_2^+Cl^- + H_2O \rightarrow C_6H_5OH + N_2 + HCl$ (1). (d) It increases the acidity, especially at the ortho and para positions, by withdrawing electrons and stabilising the phenoxide ion (1).

OR (a) $2C_2H_5OH \rightarrow$ (conc. H_2SO_4, 413 K) $C_2H_5OC_2H_5 + H_2O$ (1½). (b) $RONa + R'X \rightarrow ROR' + NaX$, using a primary alkyl halide (1½). (c) $CH_3OCH_3 + 2HI \rightarrow 2CH_3I + H_2O$ (1).

19. (a) $C_6H_5COCl + H_2 \rightarrow$ ($Pd/BaSO_4$) $C_6H_5CHO + HCl$ (1). (b) $RCN + SnCl_2 + HCl \rightarrow RCH{=}NH \rightarrow$ (H_3O^+) RCHO (1). (c) $C_6H_5CH_3 + CrO_2Cl_2$ (in CS_2) → complex → (H_3O^+) C_6H_5CHO (1). (d) $C_6H_6 + CO + HCl \rightarrow$ (anhydrous $AlCl_3/CuCl$) C_6H_5CHO (1).

OR (a) Electron-withdrawing groups such as –Cl or $–NO_2$ increase acidity by stabilising the carboxylate ion; electron-donating groups such as $–CH_3$ decrease it (2). (b) $CH_3COOH + Cl_2 \rightarrow$ (red P) $ClCH_2COOH + HCl$ (1). (c) Loss of CO_2: $RCOONa + NaOH \rightarrow$ (CaO, heat) $RH + Na_2CO_3$ (1).

20. Primary amine: $C_6H_5SO_2Cl + RNH_2 \rightarrow C_6H_5SO_2NHR$, soluble in alkali (1). Secondary: $C_6H_5SO_2NR_2$, insoluble in alkali (1). Tertiary amines do not react (½). In water, $(C_2H_5)_2NH > (C_2H_5)_3N > C_2H_5NH_2 > NH_3$, because the inductive effect, solvation of the cation by hydrogen bonding and steric hindrance act together (1½).

OR Primary: the sequence of amino acids in the chain (1). Secondary: the α-helix or β-pleated sheet held by hydrogen bonds (1). Tertiary: the overall folding of the chain, giving fibrous or globular shapes (1). Quaternary: the arrangement of two or more polypeptide chains (subunits) (1).

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