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Your JEE Guide

MP Board Class XII · Chemistry

Sample Question Paper 5 · 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:* One mole of each of the following is dissolved in 1 kg of water. Which raises the boiling point the most? (Assume complete dissociation.) (a) NaCl (b) urea (c) glucose (d) Na_3PO_4	1
	(ii) In the electrolysis of molten sodium chloride, sodium is obtained at the: (a) anode (b) cathode (c) both electrodes (d) salt bridge	1
	(iii) The integrated rate equation of a zero-order reaction is: (a) $1/[R] = 1/[R]_0 + kt$ (b) $\ln[R] = \ln[R]_0 - kt$ (c) $[R] = [R]_0 - kt$ (d) $[R] = [R]_0 e^{-kt}$	1
	(iv) A consequence of the lanthanoid contraction is that: (a) zirconium and hafnium have almost the same atomic radius (b) their radii increase across the series (c) lanthanoids show only the +4 state (d) lanthanoids are all radioactive	1
	(v) Which of these alcohols is the most soluble in water? (a) pentan-1-ol (b) hexan-1-ol (c) methanol (d) butan-1-ol	1

	(vi) Aniline is diazotised and the solution is then warmed with water. The product is: (a) chlorobenzene (b) benzene (c) nitrobenzene (d) phenol	1
2.	**(i)** *Fill in the blanks:* A solution with a lower osmotic pressure than another solution is said to be _____ to it.	1
	(ii) The potential difference between the electrodes of a cell when no current is drawn is called its _____.	1
	(iii) For a first-order reaction, a graph of ln[R] against time is a _____ line.	1
	(iv) The f-block elements are also called _____ transition elements.	1
	(v) Haloalkanes are only _____ soluble in water.	1
	(vi) Cellulose is a polymer of _____-D-glucose.	1
3.	**(i)** *Write True or False:* Sea water freezes at a lower temperature than fresh water.	1
	(ii) A salt bridge allows electrons to flow between the two half-cells.	1
	(iii) The rate of a zero-order reaction does not depend on the concentration of the reactant.	1
	(iv) $E^\circ(Cu^{2+}/Cu)$ is negative.	1
	(v) Grignard reagents react with water to form alkanes.	1
	(vi) Glycogen is the storage polysaccharide of animals.	1
4.	Match each compound in column A with the metal it contains in column B:	5

Column A	Column B
(i) Chlorophyll	(a) magnesium
(ii) Haemoglobin	(b) cobalt
(iii) Vitamin B_{12}	(c) iron
(iv) Cisplatin	(d) platinum
(v) Wilkinson's catalyst	(e) rhodium

5.	**(i)** *Answer in one word or one sentence:* Which colligative property is used to find the molar masses of proteins?	1
	(ii) What is the electrolyte in a lead storage battery?	1

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	(iii) What is the minimum energy that colliding molecules must have to react called?	1
	(iv) Write the formula of potassium ferrocyanide.	1
	(v) Name the test used to distinguish primary, secondary and tertiary alcohols.	1
6.	Why is the depression in freezing point of 0.1 m NaCl nearly twice that of 0.1 m glucose?	2
7.	Calculate the emf at 298 K of the cell Fe | Fe^{2+}(0.1 M) || Ag^{+}(0.01 M) | Ag. ($E^\circ(Fe^{2+}/Fe) = -0.44$ V, $E^\circ(Ag^{+}/Ag) = +0.80$ V)	2
8.	What is the half-life of a reaction? Show that the half-life of a first-order reaction is 0.693/k.	2
9.	Write the formulae and colours of the chromate and dichromate ions. How is one converted into the other?	2
10.	Distinguish between homoleptic and heteroleptic complexes, with one example of each.	2
11.	Write the IUPAC names of (a) $CH_2{=}CHCH_2Br$, (b) $(CH_3)_3CCl$.	2
12.	Why does phenol dissolve in aqueous NaOH but not in aqueous $NaHCO_3$?	2
13.	2.0 g of a polymer dissolved in 500 mL of solution at 27 °C has an osmotic pressure of 4.1×10^{-3} atm. Calculate the molar mass of the polymer. (R = 0.0821 L atm K^{-1} mol^{-1}) **OR** What are colligative properties? Name the four colligative properties of dilute solutions.	3
14.	Describe the standard hydrogen electrode. How is it used to measure the standard electrode potential of zinc? **OR** Explain why the rusting of iron is an electrochemical process, and describe three ways of preventing it.	3
15.	Draw an energy profile diagram for a reaction with and without a catalyst. Use it to explain the terms activation energy and effect of a catalyst. **OR** Define the average rate and the unit of rate of a reaction. For $2A \rightarrow B$, write the relation between the rate of disappearance of A and the rate of formation of B.	3

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16.	Name the catalyst used in each process: (a) the Haber process, (b) the contact process for sulphuric acid, (c) hydrogenation of oils, (d) the polymerisation of ethene (Ziegler–Natta). Why are transition metals good catalysts? **OR** Write balanced ionic equations for the reaction of permanganate in neutral or faintly alkaline solution with (a) thiosulphate ions, (b) manganese(II) ions.	3
17.	Explain, with a diagram, the splitting of d orbitals in a tetrahedral crystal field. Why is Δ_t smaller than Δ_0, and why are low-spin tetrahedral complexes rare? **OR** What factors affect the magnitude of the crystal field splitting Δ_0? Explain any three.	4
18.	Write one method, with an equation, for preparing alcohols from each of: (a) alkenes by acid-catalysed hydration, (b) alkenes by hydroboration–oxidation, (c) aldehydes and ketones, (d) Grignard reagents. **OR** Explain (a) why alcohols have much higher boiling points than hydrocarbons and ethers of similar mass, (b) why lower alcohols are soluble in water, (c) why phenol is less soluble than ethanol, (d) the effect of branching on the boiling point of alcohols.	4
19.	Write one method, with an equation, for preparing carboxylic acids from each of: (a) a primary alcohol, (b) a nitrile, (c) a Grignard reagent, (d) an alkylbenzene. **OR** Write the products of the reactions of ethanoic acid with (a) PCl_5, (b) $SOCl_2$, (c) NH_3 followed by heating, (d) $LiAlH_4$.	4
20.	What are disaccharides? Name the monosaccharide units and the type of linkage in sucrose, maltose and lactose. Which of them are reducing sugars? **OR** How are amino acids classified as essential and non-essential? Give one example of each. Write the equation for the formation of a peptide bond between two molecules of glycine.	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) **(d)** Na_3PO_4. *Working:* Na_3PO_4 gives four ions (i = 4).

(ii) **(b)** cathode. *Working:* $Na^+ + e^- \rightarrow Na$ is a reduction.

(iii) **(c)** $[R] = [R]_0 - kt$. *Working:* Rate = k, so [R] falls linearly with time.

(iv) **(a)** zirconium and hafnium have almost the same atomic radius. *Working:* Hf (5d) should be larger than Zr (4d), but the contraction cancels the increase.

(v) **(c)** methanol. *Working:* Solubility falls as the hydrophobic alkyl chain grows.

(vi) **(d)** phenol. *Working:* $C_6H_5N_2^+Cl^- + H_2O \rightarrow C_6H_5OH + N_2 + HCl$.

Question 2

(i) hypotonic.

(ii) emf (electromotive force).

(iii) straight.

(iv) inner.

(v) slightly.

(vi) β.

Question 3

(i) True: the dissolved salts lower the freezing point.

(ii) False: it carries ions; electrons flow through the external wire.

(iii) True.

(iv) False: it is +0.34 V.

(v) True.

(vi) True.

4. (i) – (a) magnesium; (ii) – (c) iron; (iii) – (b) cobalt; (iv) – (d) platinum; (v) – (e) rhodium

Question 5

(i) Osmotic pressure.

(ii) Sulphuric acid (about 38%).

(iii) Threshold energy.

(iv) $K_4[Fe(CN)_6]$.

(v) The Lucas test.

6. Depression of freezing point depends on the number of solute particles (1). NaCl gives two ions per formula unit (i ≈ 2), while glucose does not dissociate (i = 1) (1).

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7. Fe + 2Ag⁺ → Fe²⁺ + 2Ag; E° = 0.80 – (–0.44) = 1.24 V (½). $E = 1.24 - \frac{0.059}{2}\log\frac{0.1}{(0.01)^2}$ (½) = 1.24 – 0.0295 × 3 ≈ 1.15 V (1).

8. The time in which the concentration of a reactant falls to half its initial value (1). From $k = \frac{2.303}{t}\log\frac{[R]_0}{[R]}$ with [R] = [R]₀/2: $t_{1/2} = \frac{2.303\log 2}{k} = \frac{0.693}{k}$ (1).

9. Chromate CrO_4^{2-}, yellow; dichromate $Cr_2O_7^{2-}$, orange (1). Acid changes chromate into dichromate and alkali reverses it: $2CrO_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$ (1).

10. Homoleptic: the metal is bound to only one kind of ligand, e.g. $[Co(NH_3)_6]^{3+}$ (1). Heteroleptic: more than one kind of ligand, e.g. $[Co(NH_3)_4Cl_2]^+$ (1).

11. (a) 3-Bromoprop-1-ene (1). (b) 2-Chloro-2-methylpropane (1).

12. Phenol is acidic enough to react with the strong base NaOH, forming soluble sodium phenoxide (1). It is a weaker acid than carbonic acid, so it cannot react with $NaHCO_3$ (1).

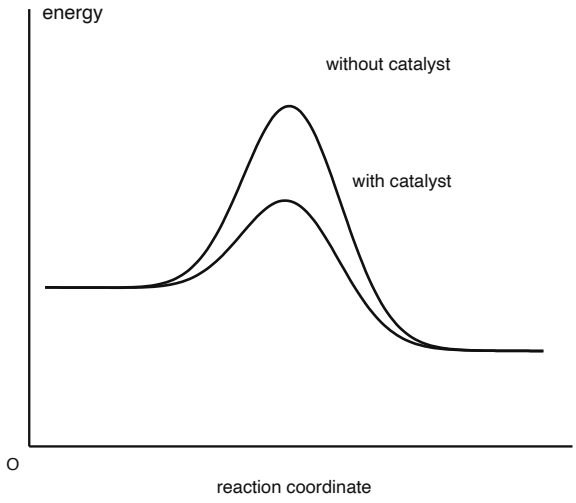
13. $M = \frac{wRT}{\pi V}$ (1) $= \frac{2.0\times0.0821\times300}{4.1\times10^{-3}\times0.5}$ (1) ≈ 2.4 × 10⁴ g mol⁻¹ (1).

OR Properties of dilute solutions that depend only on the number of solute particles, not on their nature (1). Relative lowering of vapour pressure, elevation of boiling point, depression of freezing point and osmotic pressure (2).

14. A platinum electrode coated with platinum black dips into 1 M H⁺ solution with pure hydrogen at 1 bar bubbled through it; its potential is taken as zero (1½). It is joined to a Zn electrode in 1 M Zn²⁺ solution; the emf of the cell measured (0.76 V, with zinc as the anode) gives E°(Zn²⁺/Zn) = –0.76 V (1½).

OR Different parts of the iron act as anode ($Fe \rightarrow Fe^{2+} + 2e^-$) and cathode ($O_2 + 4H^+ + 4e^- \rightarrow 2H_2O$), with moisture as the electrolyte (1½). Painting or oiling, galvanising with zinc, and connecting a more reactive metal such as magnesium as a sacrificial anode (1½).

15. Diagram (1):



Activation energy is the energy difference between the reactants and the activated complex at the top of the curve (1). A catalyst provides a lower path, so more molecules can react; ΔH and the equilibrium are unchanged (1).

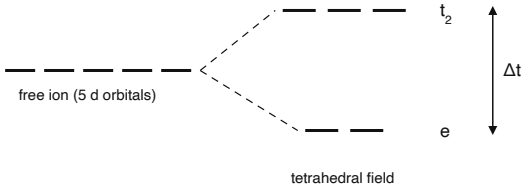
OR The change in concentration of a reactant or product divided by the time taken (1). Unit: mol L⁻¹ s⁻¹ (1). $-\frac{1}{2}\frac{d[A]}{dt} = \frac{d[B]}{dt}$ (1).

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16. (a) Iron (½). (b) V_2O_5 (½). (c) Nickel (½). (d) $TiCl_4$ with $Al(CH_3)_3$ (½). They show variable oxidation states and form unstable intermediates, and they provide a surface for reactants to adsorb on (1).

OR (a) $8MnO_4^- + 3S_2O_3^{2-} + H_2O \rightarrow 8MnO_2 + 6SO_4^{2-} + 2OH^-$ (1½). (b) $2MnO_4^- + 3Mn^{2+} + 2H_2O \rightarrow 5MnO_2 + 4H^+$ (1½).

17. Diagram (1):



In a tetrahedral field the t_2 orbitals (d_{xy}, d_{yz}, d_{zx}) are raised and the e orbitals lowered, the reverse of the octahedral case (1). There are only four ligands and none points directly at an orbital, so $\Delta_t \approx (4/9)\Delta_0$ (1). Δ_t is almost always less than the pairing energy, so electrons stay unpaired (1).

OR The nature of the ligand: strong-field ligands such as CN^- give a larger Δ_0 than weak ones such as I^- (1⅓). The oxidation state of the metal: a higher charge pulls the ligands closer, increasing Δ_0 (1⅓). The metal itself: Δ_0 increases from 3d to 4d to 5d metals (1⅓).

18. (a) $CH_3CH{=}CH_2 + H_2O \rightarrow (H^+)\ CH_3CH(OH)CH_3$ (1). (b) $CH_3CH{=}CH_2 + (H{-}BH_2)_2 \rightarrow (CH_3CH_2CH_2)_3B \rightarrow (H_2O_2/OH^-)\ CH_3CH_2CH_2OH$ (1). (c) $RCHO + H_2 \rightarrow$ (Pd) RCH_2OH; $RCOR' \rightarrow RCH(OH)R'$ (or with $NaBH_4$) (1). (d) $HCHO + RMgX \rightarrow RCH_2OMgX \rightarrow (H_2O)\ RCH_2OH$ (1).

OR (a) Alcohol molecules are linked by intermolecular hydrogen bonds (1). (b) They form hydrogen bonds with water (1). (c) The large hydrophobic benzene ring outweighs the effect of the –OH group (1). (d) Branching lowers the boiling point by reducing the surface area and van der Waals forces (1).

19. (a) $RCH_2OH \rightarrow$ (alkaline $KMnO_4$, then H^+) RCOOH (1). (b) $RCN + 2H_2O \rightarrow (H^+)\ RCOOH + NH_3$ (1). (c) $RMgX + CO_2 \rightarrow RCOOMgX \rightarrow (H_3O^+)$ RCOOH (1). (d) $C_6H_5CH_3 \rightarrow$ (alkaline $KMnO_4$, then H^+) C_6H_5COOH (1).

OR (a) $CH_3COCl + POCl_3 + HCl$ (1). (b) $CH_3COCl + SO_2 + HCl$ (1). (c) CH_3COONH_4, which on heating gives $CH_3CONH_2 + H_2O$ (1). (d) Ethanol, CH_3CH_2OH (1).

20. Carbohydrates that give two monosaccharide units on hydrolysis (1). Sucrose: α-D-glucose and β-D-fructose, linked C1–C2 (1). Maltose: two α-D-glucose units, C1–C4 (½). Lactose: β-D-galactose and β-D-glucose, C1–C4 (½). Maltose and lactose are reducing; sucrose is not (1).

OR Essential amino acids cannot be made in the body and must come from food, e.g. valine; non-essential ones can be made, e.g. glycine (2). $H_2NCH_2COOH + H_2NCH_2COOH \rightarrow H_2NCH_2CO{-}NHCH_2COOH + H_2O$ (glycylglycine; the –CO–NH– link is the peptide bond) (2).

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