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Your JEE Guide

MP Board Class XII · Chemistry

Sample Question Paper 4 · 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 relative lowering of vapour pressure of a dilute solution of a non-volatile solute is equal to the: (a) mole fraction of the solute (b) molarity of the solution (c) molality of the solution (d) mole fraction of the solvent	1
	(ii) One faraday is the charge carried by: (a) one electron (b) one mole of protons per second (c) one coulomb (d) one mole of electrons	1
	(iii) In a graph of ln k against 1/T, the slope is equal to: (a) ln A (b) $\frac{E_a}{R}$ (c) $-\frac{E_a}{R}$ (d) $-\frac{E_a}{2.303R}$	1
	(iv) The blue colour of hydrated copper(II) sulphate is due to: (a) the water of crystallisation alone (b) d–d transitions in Cu^{2+} (c) charge transfer from sulphate (d) f–f transitions	1
	(v) Which compound was once used in fire extinguishers? (a) CH_3Cl (b) $CHCl_3$ (c) CCl_4 (d) CH_2Cl_2	1

	(vi) An aldehyde reacts with excess alcohol in the presence of dry HCl to form an: (a) ketone (b) acetal (c) ester (d) ether	1
2.	**(i)** *Fill in the blanks:* The vapour pressure of a solution of a non-volatile solute is _____ than that of the pure solvent.	1
	(ii) Coating iron with a layer of zinc to prevent rusting is called _____.	1
	(iii) The rate law of a reaction can be found only by _____.	1
	(iv) The iron ion with the configuration $[Ar]3d^5$ is _____.	1
	(v) Esterification is the reaction of a carboxylic acid with an _____ in the presence of an acid catalyst.	1
	(vi) Adenine and guanine are _____ bases.	1
3.	**(i)** *Write True or False:* The elevation in boiling point of a dilute solution is directly proportional to its molality.	1
	(ii) The conductivity of an electrolyte solution increases on dilution.	1
	(iii) The molecularity of a reaction can be fractional.	1
	(iv) Transition metals form interstitial compounds with small atoms such as hydrogen, carbon and nitrogen.	1
	(v) Methanol is also called wood spirit.	1
	(vi) RNA contains the base uracil.	1
4.	Match each IUPAC name in column A with the common name in column B:	5

Column A	Column B
(i) Methanal	(a) acetone
(ii) Ethanoic acid	(b) aniline
(iii) Propanone	(c) acetic acid
(iv) Benzenamine	(d) chloroform
(v) Trichloromethane	(e) formaldehyde

5.	**(i)** *Answer in one word or one sentence:* Which law relates the vapour pressure of a solution to the mole fraction of the solvent?	1
	(ii) What is the unit of cell constant?	1

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	(iii) What is the order of a reaction whose rate constant has the unit s^{-1}?	1
	(iv) Which metal is used as the catalyst in the Haber process for ammonia?	1
	(v) Write the formula of benzoyl chloride.	1
6.	Define (a) mole fraction, (b) molarity.	2
7.	The conductivity of a 0.05 M solution of an electrolyte is 0.0062 S cm^{-1}. Calculate its molar conductivity.	2
8.	How does the rate constant of a reaction change with temperature? What is the temperature coefficient?	2
9.	Why are the d-block elements called transition elements? Why are zinc, cadmium and mercury not regarded as such?	2
10.	State the hybridisation, shape and magnetic behaviour of $[Fe(CN)_6]^{4-}$.	2
11.	Why is chlorine in chlorobenzene deactivating, but ortho- and para-directing?	2
12.	What are enzymes? Write two of their characteristics.	2
13.	10 g of a non-volatile solute (molar mass 100 g mol^{-1}) is dissolved in 180 g of water at 298 K, where the vapour pressure of water is 3.17 kPa. Calculate the vapour pressure of the solution. **OR** Distinguish between solutions showing positive and negative deviations from Raoult's law, with one example of each.	3
14.	The same quantity of electricity is passed through solutions of $CuSO_4$ and $AgNO_3$ in series. 0.635 g of copper is deposited. Calculate the mass of silver deposited and the charge passed. (Cu = 63.5, Ag = 108, F = 96500 C mol^{-1}) **OR** Describe the hydrogen–oxygen fuel cell, with the electrode reactions. Give two advantages of fuel cells.	3
15.	A first-order reaction is 20% complete in 15 minutes. Calculate its rate constant and half-life. **OR** Explain, with a Maxwell–Boltzmann distribution curve, why a rise in temperature increases the rate of a reaction.	3
16.	How do the following change across the 3d series of transition elements: (a) atomic radius, (b) ionisation enthalpy, (c) density? **OR** Write the IUPAC name of $[Co(NH_3)_4Cl_2]Cl$. How many ions does it give in water, and how many moles of AgCl does one mole precipitate with $AgNO_3$? What isomerism does it show?	3

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17.	Using valence bond theory, explain why $[CoF_6]^{3-}$ is paramagnetic while $[Co(NH_3)_6]^{3+}$ is diamagnetic. State two limitations of valence bond theory. **OR** Explain the chelate effect. Give two examples of chelating ligands and one use of a chelate complex.	4
18.	Write the equations for the following reactions of chlorobenzene: (a) chlorination, (b) nitration, (c) sulphonation, (d) Friedel–Crafts methylation. **OR** Give one use and one harmful effect each of dichloromethane, chloroform, iodoform and carbon tetrachloride.	4
19.	Write the equations for: (a) nitration of phenol with dilute nitric acid, (b) its nitration with concentrated nitric acid, (c) bromination of phenol in CS_2 at low temperature, (d) Kolbe's reaction. **OR** Describe Tollens' test, Fehling's test and the iodoform test, with equations, and state which compounds each detects.	4
20.	Write one method each, with equations, for preparing amines by: (a) reduction of nitro compounds, (b) ammonolysis of alkyl halides, (c) reduction of nitriles, (d) reduction of amides. **OR** Describe the double helix structure of DNA. Write two differences between DNA and RNA in function.	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) **(a)** mole fraction of the solute. *Working:* Raoult's law: $(p^\circ - p)/p^\circ = x_{solute}$.

(ii) **(d)** one mole of electrons. *Working:* $1\ F = N_A e \approx 96500\ C$.

(iii) **(c)** $-\frac{E_a}{R}$. *Working:* $\ln k = \ln A - E_a/(RT)$.

(iv) **(b)** d–d transitions in Cu^{2+}. *Working:* Cu^{2+} ($3d^9$) in a field of water ligands absorbs red-orange light.

(v) **(c)** CCl_4. *Working:* Its use has stopped because it is toxic and harms the ozone layer.

(vi) **(b)** acetal. *Working:* Via a hemiacetal.

Question 2

(i) lower.

(ii) galvanisation.

(iii) experiment.

(iv) Fe^{3+}.

(v) alcohol.

(vi) purine.

Question 3

(i) True.

(ii) False: it decreases; molar conductivity increases.

(iii) False: it is always a whole number.

(iv) True.

(v) True.

(vi) True.

4. (i) – (e) formaldehyde; (ii) – (c) acetic acid; (iii) – (a) acetone; (iv) – (b) aniline; (v) – (d) chloroform

Question 5

(i) Raoult's law.

(ii) cm^{-1} (or m^{-1}).

(iii) First order.

(iv) Iron.

(v) C_6H_5COCl.

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6. (a) The number of moles of a component divided by the total number of moles of all components (1). (b) The number of moles of solute in one litre of solution (1).

7. $\Lambda_m = \kappa \times 1000/c$ (1) = $0.0062 \times 1000/0.05 = 124$ S cm² mol⁻¹ (1).

8. It increases; for many reactions it roughly doubles for a 10 K rise (1). The ratio of the rate constants at two temperatures 10 K apart, usually k_{308}/k_{298} (1).

9. Their properties are intermediate (transitional) between those of the s-block and p-block elements (1). Zn, Cd and Hg have completely filled d orbitals in the atom and in their common ions (1).

10. Fe^{2+} is $3d^6$; CN^- is a strong ligand and pairs all the electrons: d^2sp^3, octahedral (1). No unpaired electrons, so diamagnetic (1).

11. Its –I effect withdraws electrons and makes the ring less reactive than benzene (1). Its +R effect (lone pairs in resonance with the ring) raises the electron density mainly at the ortho and para positions (1).

12. Biological catalysts, mostly globular proteins (1). Any two: they are highly specific; they work under mild conditions of temperature and pH; they are needed only in very small amounts (1).

13. Moles: solute 0.10, water 10.0 (1). x(water) = 10.0/10.1 = 0.990 (1). p = $0.990 \times 3.17 \approx 3.14$ kPa (1).

OR Positive deviation: A–B attractions are weaker than A–A and B–B, vapour pressure is higher than expected, $\Delta H_{mix} > 0$, e.g. ethanol and acetone (1½). Negative deviation: A–B attractions are stronger, vapour pressure is lower, $\Delta H_{mix} < 0$, e.g. chloroform and acetone (1½).

14. 0.635 g Cu = 0.010 mol, needing 0.020 mol of electrons (1). The same 0.020 mol of electrons deposits 0.020 mol Ag = 2.16 g (1). Charge = $0.020 \times 96500 = 1930$ C (1).

OR Hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous NaOH (1). Anode: $2H_2 + 4OH^- \rightarrow 4H_2O + 4e^-$; cathode: $O_2 + 2H_2O + 4e^- \rightarrow 4OH^-$ (1). They are pollution-free and convert energy efficiently (about 70%) (1).

15. $k = \frac{2.303}{15} \log \frac{100}{80}$ (1) = 0.0149 min⁻¹ (1). $t_{½} = 0.693/k \approx 46.6$ min (1).

OR The curve shows the fraction of molecules with each kinetic energy (1). At the higher temperature the curve flattens and shifts to higher energies (1). The area beyond E_a, i.e. the fraction of molecules that can react, increases sharply, so the rate rises (1).

16. (a) It decreases at first and then stays nearly constant, as the added d electrons shield the outer electrons (1). (b) It increases gradually, with some irregularities (1). (c) It increases from scandium to copper, as the atoms become smaller and heavier (1).

OR Tetraamminedichloridocobalt(III) chloride (1). Two ions; one mole of AgCl (1). Geometrical (cis–trans) isomerism (1).

17. Co^{3+} is $3d^6$. F^- is weak: the four unpaired electrons remain, and 4s, 4p and 4d orbitals give sp^3d^2, an outer-orbital, high-spin complex with four unpaired electrons (1½). NH_3 pairs the electrons, leaving two 3d orbitals for d^2sp^3: inner-orbital, no unpaired electrons (1½). Limitations: it does not explain the colour of complexes, and it does not distinguish clearly between weak and strong ligands (1).

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OR Complexes with polydentate ligands that form rings are more stable than similar complexes with unidentate ligands (1½). Examples: ethane-1,2-diamine, oxalate, $EDTA^{4-}$ (any two) (1). EDTA is used to estimate hardness of water, or to treat lead poisoning (1½).

18. (a) With Cl_2/anhydrous $FeCl_3$: 1,2- and 1,4-dichlorobenzene (1). (b) With conc. HNO_3 + conc. H_2SO_4: 2- and 4-chloronitrobenzene (1). (c) With conc. H_2SO_4: 2- and 4-chlorobenzenesulphonic acid (1). (d) With CH_3Cl/anhydrous $AlCl_3$: 2- and 4-chlorotoluene (1).

OR CH_2Cl_2: solvent and paint remover; harms the central nervous system (1). $CHCl_3$: solvent; oxidised in air to poisonous phosgene (1). CHI_3: antiseptic; objectionable smell (1). CCl_4: once used in fire extinguishers and as a solvent; damages the liver and depletes ozone (1).

19. (a) o- and p-nitrophenol (1). (b) 2,4,6-trinitrophenol (picric acid) (1). (c) o- and p-bromophenol (1). (d) Sodium phenoxide + CO_2 → (400 K, 4–7 atm) sodium salicylate → (H^+) salicylic acid (1).

OR Tollens' test: aldehydes reduce ammoniacal silver nitrate to a silver mirror, $RCHO + 2[Ag(NH_3)_2]^+ + 3OH^- \rightarrow RCOO^- + 2Ag + 4NH_3 + 2H_2O$ (1½). Fehling's test: aliphatic aldehydes give a red precipitate, $RCHO + 2Cu^{2+} + 5OH^- \rightarrow RCOO^- + Cu_2O + 3H_2O$ (1½). Iodoform test: compounds with $CH_3CO–$ (or $CH_3CH(OH)–$) give yellow CHI_3 with I_2 and NaOH (1).

20. (a) $C_6H_5NO_2 + 6[H] \rightarrow$ (Sn/HCl) $C_6H_5NH_2 + 2H_2O$ (1). (b) $RX + NH_3 \rightarrow RNH_2 + HX$ (further reaction gives 2° and 3° amines) (1). (c) $RCN + 4[H] \rightarrow$ ($LiAlH_4$ or Na/C_2H_5OH) RCH_2NH_2 (1). (d) $RCONH_2 \rightarrow$ ($LiAlH_4$, then H_2O) RCH_2NH_2 (1).

OR Two polynucleotide chains coil round each other in a right-handed helix, held by hydrogen bonds between complementary bases, A with T and G with C (2). DNA stores genetic information and passes it on in replication; RNA takes part in protein synthesis (2).

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