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CBSE Class 12 Chemistry Board Paper 2026 (56/2/1) with Solutions

PREVIOUS YEAR PAPER · CLASS XII · CHEMISTRY (043) · BOARD EXAM 2026 · Q.P. CODE 56/2/1

TIME ALLOWED	MAXIMUM MARKS	QUESTIONS	NAME / ROLL NO.
3 hours	70	33 (A 16 · B 5 · C 7 · D 2 · E 3)	

GENERAL INSTRUCTIONS

Read the following instructions very carefully and strictly follow them:

1. This question paper contains 33 questions. All questions are compulsory.
2. This question paper is divided into FIVE sections – Section A, B, C, D and E.
3. Section A – questions number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
4. Section B – questions number 17 to 21 are very short answer type questions. Each question carries 2 marks.
5. Section C – questions number 22 to 28 are short answer type questions. Each question carries 3 marks.
6. Section D – questions number 29 and 30 are case-based questions. Each question carries 4 marks.
7. Section E – questions number 31 to 33 are long answer type questions. Each question carries 5 marks.
8. There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section – A.
9. Use of calculator is NOT allowed.
10. This is the official 2026 board paper (Q.P. Code 56/2/1). The step marks shown in the solutions are our marking scheme in the CBSE style; CBSE's own marking scheme may award steps differently.
11. The answer key and the marking scheme are at the end of this booklet. Attempt the paper in 3 hours before you look at them.

Questions: CBSE board examination 2026, Q.P. Code 56/2/1, as published by CBSE at cbse.gov.in; structures redrawn. Answers, step marks and worked solutions © Master Testing Agency. Free for personal practice; not for resale. Master Testing Agency is an independent test-prep publisher, not affiliated with, endorsed by or connected to the Central Board of Secondary Education (CBSE) or any other exam-conducting body.

Chapters: Full syllabus · **Topics:** Solutions · Electrochemistry · Chemical Kinetics · d- and f-Block Elements · Coordination Compounds · Haloalkanes and Haloarenes · Alcohols, Phenols and Ethers · Aldehydes, Ketones and Carboxylic Acids · Amines · Biomolecules

SECTION A

Multiple choice questions of 1 mark each (Q13–16 assertion-reason).

1. Consider the following reaction : 1

$Zn_{(s)} + Ag_2O_{(s)} + H_2O(l) \rightarrow Zn^{2+}_{(aq)} + 2Ag_{(s)} + 2OH^-_{(aq)}$

Given : $E°_{Ag^+/Ag} = 0.80$ V, $E°_{Zn^{2+}/Zn} = -0.76$ V, 1 F = 96500 C mol^{-1}

$\Delta_rG°$ for the above reaction is :

(A) – 301.080 kJ mol^{-1} (B) + 310.080 kJ mol^{-1}

(C) –326.070 kJ mol^{-1} (D) –375.060 kJ mol^{-1}

2. Identify the correct statement : 1

(A) Molecularity of a reaction is an experimental quantity. (B) For complex reactions molecularity has no meaning.

(C) Molecularity of a reaction can be zero or even a fraction. (D) Molecularity more than three is very common in chemical reactions.

3. The order for the given reaction is : 1

$A + 2B \rightarrow$ Products

Rate = $k[A]^{½}[B]^1$

(A) 1.5 (B) 1

(C) 0.5 (D) 2

4. Electronic configuration of chromium is : 1

(A) [Ar] $3d^4\ 4s^1$ (B) [Ar] $3d^4\ 4s^2$

(C) [Ar] $3d^5\ 4s^1$ (D) [Ar] $3d^5\ 4s^2$

5. The correct IUPAC name of the complex $[Pt(NH_3)_2Cl_2]$ is : 1

(A) diamminedichloridoplatinum (IV) (B) diamminedichloridoplatinum (II)

(C) dichloridodiammineplatinum (IV) (D) dichloridodiammineplatinum (II)

6. Which of the following is heteroleptic complex ? 1

(A) $[Co(NH_3)_6]^{3+}$ (B) $[Cr(NH_3)_6]^{3+}$

(C) $[Ni(H_2O)_6]^{2+}$ (D) $[Co(NH_3)_4Cl_2]^+$

7. Which of the following molecules is chiral in nature ? 1

(A) Propan–2–*ol* (B) Butan–2–*ol*

(C) 1–Bromobutane (D) 2–Bromopropane

8. Identify the correct increasing order of boiling points of the given compounds : 1

(A) Propan–1– *ol* < butan–1–ol < butan –2–ol < pentan–1–ol (B) Pentan–1– *ol* < butan–1–ol < butan –2–ol < Propan–1–ol

(C) Propan–1– *ol* < butan–2–ol < butan –1–ol < pentan–1–ol (D) Butan–1– *ol* < Butan–2–ol < Propan –1–ol < Pentan–1–ol

9. Identify the compound produced by the reduction of Ethanenitrile with Lithium aluminium hydride : 1

(A) Ethylamine (B) Ethanal

(C) Propylamine (D) Methylamine

10. The base which is present in DNA but not in RNA is : 1

(A) Guanine (B) Cytosine

(C) Thymine (D) Adenine

11. Proteins are polymers of α-amino acids which are joined to each other by : 1

(A) Covalent Bond (B) Peptide Bond

(C) Glycosidic Bond (D) Coordinate Bond

12. Which of the following reactions is not explained by the open chain structure of glucose ? 1

(A) Glucose on prolonged heating with HI forms n-hexane.

(B) Glucose reacts with hydroxylamine to form an oxime.

(C) Glucose gets oxidized to gluconic acid on reaction with bromine water.

(D) Glucose exists in two different crystalline forms, alpha (α) and beta (β).

13. **Assertion (A) :** The molecularity of the given reaction is 2 1

$2HI \longrightarrow H_2 + I_2$

Reason (R) : Two molecules of the reactants are involved in simultaneous collision between them.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

14. **Assertion (A) :** Zinc, cadmium and mercury are not considered as transition elements. 1

Reason (R) : These elements have completely filled orbitals in their ground state as well as in their common oxidation states.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

15. **Assertion (A) :** Aromatic primary amines can be prepared by Gabriel Phthalimide synthesis. 1
Reason (R) : Aryl halides do not undergo nucleophilic substitution with the anion formed by phthalimide.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

16. **Assertion (A) :** Glucose gets oxidized to six carbon gluconic acid on reaction with bromine water. 1
Reason (R) : The carbonyl group is absent in the open chain structure of glucose.

(A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(C) Assertion (A) is true, but Reason (R) is false.

(D) Assertion (A) is false, but Reason (R) is true.

SECTION B

Very short answer questions of 2 marks each.

17. (a) The concentration of the reactant is reduced from 0.6 mol L^{-1} to 0.2 mol L^{-1} in 5 minutes in a first order reaction. Calculate rate constant of the reaction. (log 3 = 0.48) 2

OR

(b) Rate constant k for the first order reaction is 2.54×10^{-3} s^{-1}. Calculate the time required for three-fourth of the reactant to decompose. (log 4 = 0.60)

18. (a) Define activation energy. 2
(b) Write the unit of rate constant for
(i) zero order reaction, (ii) second order reaction.

19. (a) First ionization enthalpy of Cr is lower than that of Zn. Why ? 2
(b) Mention any one property of the transition elements which makes them good catalysts.

20. (a) Define coordination number. 2
(b) Indicate the type of isomerism exhibited by the following complex : $[Co(en)_3]Cl_3$

21. (a) Draw the structure of the given compound : 4–Bromo–3–methylpent–2–ene 2
(b) What happens when chloroethane is treated with aqueous potassium hydroxide ?

SECTION C

Short answer questions of 3 marks each.

22. When 1.5 g of a non-volatile solute was dissolved in 90 g of benzene, the boiling point of benzene got raised from 353.23 K to 353.93 K. Calculate the molar mass of the solute. (Given K_b for benzene = 2.52 K kg mol^{-1}) 3

23. Calculate emf of the following cell at 298 K : 3

$Sn \mid Sn^{2+}$ (0.001 M) || H^+ (0.01 M) | $H_{2(g)}$ (1 bar) | $Pt_{(s)}$

Given : $E°_{Sn^{2+}/Sn} = -0.14$ V, $E°_{H^+/H_2} = 0.00$ V [log 10 = 1]

24. (a) Complete and balance the following equations : 3

(i) $2KMnO_4 \xrightarrow{(513\ K)}$

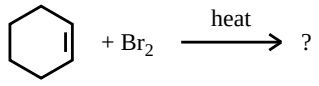
(ii) $Na_2Cr_2O_7 + 2KCl \longrightarrow$

(b) Why is it difficult to separate lanthanoid elements in pure state ?

25. (a) $[Co(NH_3)_6]^{3+}$ is diamagnetic whereas $[CoF_6]^{3-}$ is paramagnetic. Justify the statement. [Atomic number of Co = 27] 3

(b) Write the electronic configuration for d^4 ion if $\Delta_0 > P$ on the basis of crystal field theory.

26. (a) Write the major product in the following reactions : 3



(b) Define Racemic mixture.

(c) p-dichlorobenzene has a higher melting point as compared to its ortho and meta isomers. Why ?

27. Write the reaction involved in 3

(a) Rosenmund's reduction

(b) Cannizzaro's reaction

(c) Hell – Volhard – Zelinsky reaction

28. (a) (a) Define the following term : Reducing sugar 3

(b) Differentiate between the following :

(i) Fibrous proteins and globular proteins

(ii) Nucleotide and nucleoside

OR

(b) Write the reaction of glucose with the following :

(a) $H_2N - OH$

(b) $(CH_3CO)_2O$

(c) conc·HNO_3

SECTION D

Case-based questions of 4 marks each.

29. Osmosis is a process by which the molecules of a solvent pass from a solution of low solute concentration to a solution of high solute concentration through a semi-permeable membrane. Osmotic pressure is a colligative property. When the applied pressure on a solution exceeds its osmotic pressure, reverse osmosis occurs. When two solutions are separated by a semipermeable membrane and they have same osmotic pressure they are said to be isotonic. Of the two solutions separated by a semipermeable membrane, if one is a lower osmotic pressure, it is said to be hypotonic relative to the second solution. If it has a higher osmotic pressure, than the second solution, it is said to be hypertonic relative to the second solution. The osmotic pressure associated with the fluid inside the blood cell is equivalent to that of 0.9% (mass/volume) sodium chloride solution called normal saline solution and it is safe to inject intravenously. Osmotic pressure is vital in daily life and nature. It helps in explain, why IV fluids match blood's osmotic pressure, its also the principle behind food preservation using salt or sugar.

(a) Calculate the amount of $CaCl_2$ (i = 2.59) dissolved in 2.46 litre of water such that its osmotic pressure is 0.70 atm at 27°C. [Given : R = 0.082 L atm K^{-1} mol^{-1}, molar mass of $CaCl_2$ = 111 g mol^{-1}] [2]

(b) When raisins are kept in water, they get swollen. Name the phenomenon involved in this process. [1]

OR

(b) Why osmotic pressure is more advantageous than other colligative properties ? [1]

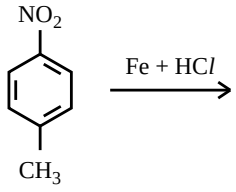
(c) Which phenomenon is responsible for desalination of sea water ? [1]

30. Like NH_3, nitrogen atom of amine is trivalent and carries an unshared pair of electrons. Nitrogen orbitals in amines are therefore sp^3 hybridised and the geometry of amines is pyramidal. Lower aliphatic amines are soluble in water due to the formation of hydrogen bond with water molecules. The solubility decreases as the molar mass of amines increases due to increase in size of hydrophobic part. Higher amines are insoluble in water. However amines are less soluble in water than alcohols because of low electronegativity of nitrogen as compared to oxygen. Boiling points of isomeric amines follow the order 1° > 2° > 3°. It is due to the fact the amines are held together due to hydrogen bonding. Extent of hydrogen bonding is more in primary amines than in secondary amines as two hydrogen atoms are available for hydrogen bond formation. Tertiary amines do not show hydrogen bonding because of the absence of hydrogen atom attached to nitrogen. Amines can be prepared from, nitro compounds, nitriles, amides etc.

(a) Complete the following equations :

(i) CH_3CONH_2 —(i) $LiAlH_4$, (ii) $H_2O \rightarrow$

(ii)

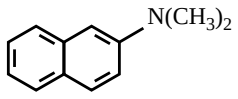


[2]

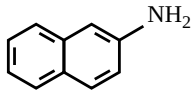
(b) Why primary amines have higher boiling points than tertiary amines ? [1]

(c) Classify the following amines as primary, secondary or tertiary :

(i)



(ii)



[1]

OR

(c) Out of Butan–1–amine and Butan–1–ol, which is more soluble in water ? [1]

SECTION E

Long answer questions of 5 marks each.

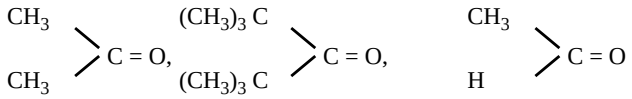
31. (a) (a) How will you convert the following : 5

(i) Propanone to Propene

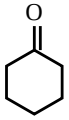
(ii) Benzoic acid to Benzaldehyde

(iii) Benzene to m-Nitroacetophenone

(b) (i) Arrange the following compounds in increasing order of their reactivity towards HCN :



(ii) Identify the compounds, which would undergo Aldol condensation :

HCHO, C_6H_5CHO, CH_3CHO, 

OR

(b) (a) Give chemical tests to distinguish between the following pairs of compounds :

(i) Acetophenone and Benzophenone

(ii) Propanal and Propanone

(iii) Pentan–2–one and Pentan–3–one

(b) (i) Which of the following acids is stronger and why ? CH_2FCOOH, CH_3COOH

(ii) Arrange the following compounds in the increasing order of their boiling points : CH_3OCH_3, $CH_3CH_2CH_3$, CH_3CH_2OH, CH_3CHO

32. (a) (a) The conductivity of 0.1 mol L^{-1} solution of NaC*l* is 1.06×10^{-2} S cm^{-1}. Calculate its molar conductivity and degree of dissociation. $\lambda°_{Na^+} = 50.1$ S cm^2 mol^{-1}, $\lambda°_{Cl^-} = 76.5$ S cm^2 mol^{-1} 5

(b) (i) Following cell reaction occurs in a galvanic cell : $2Ag^+_{(aq)} + Zn_{(s)} \longrightarrow 2Ag_{(s)} + Zn^{2+}_{(aq)}$ $E°_{(cell)} = +1.56$ V. Predict the direction of flow of current.

(ii) Differentiate between a primary battery and a secondary battery.

OR

(b) (a) Resistance of a conductivity cell filled with 0.1 M KC*l* solution is 100 Ω. If the resistance of the same cell when filled with 0.01 mol L^{-1} KC*l* solution is 300 Ω, calculate the conductivity and molar conductivity of 0.01 mol L^{-1} KC*l* solution. The conductivity of 0.1 M KC*l* solution is 1.29×10^{-2} S cm^{-1}.

(b) (i) Write any two advantages of $H_2 - O_2$ fuel cell.

(ii) Why does the cell potential of mercury cell remain constant throughout the life ?

33. (a) An organic compound ‘A’ with molecular formula C_2H_6O reacts with active metals such as sodium to give compound ‘B’ and hydrogen gas. ‘A’ on treatment with iodine and sodium hydroxide gives ‘C’ and in presence of H_2SO_4 at 413 K gives ‘D’ ($C_4H_{10}O$). ‘D’ on reaction with excess of HI gives ‘E’. Identify ‘A’, ‘B’, ‘C’, ‘D’ and ‘E’ and write all the reactions involved. 5

OR

(b) (a) Write the reagents which are used in the given conversions :

(i) Phenol to 2, 4, 6 – tribromophenol

(ii) Propene to propan–1–ol

(iii) Butan–2–one to butan–2–ol

(b) Explain the mechanism of acid catalyzed hydration of alkene to form corresponding alcohol.

END OF THE QUESTION PAPER

ANSWER KEY — SECTION A

Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13	Q14	Q15	Q16
(A)	(B)	(A)	(C)	(B)	(D)	(B)	(C)	(A)	(C)	(B)	(D)	(A)	(A)	(D)	(C)

MARKING SCHEME AND WORKED SOLUTIONS

Marks for each step are shown in brackets, as in the CBSE marking scheme. Any correct alternative method earns full marks.

Q1. Answer (A). E°cell = 0.80 − (−0.76) = 1.56 V, n = 2. ΔG° = −nFE° = −2 × 96500 × 1.56 = −301 080 J = −301.080 kJ mol⁻¹.

Q2. Answer (B). Molecularity applies only to elementary steps; for a complex reaction it has no meaning. It is a theoretical whole number (1, 2 or rarely 3), never zero or fractional.

Q3. Answer (A). Order = sum of the powers in the rate law: ½ + 1 = 1.5 (the stoichiometric coefficients do not matter).

Q4. Answer (C). Cr (Z = 24) is [Ar] $3d^5\ 4s^1$: a half-filled d subshell is extra stable.

Q5. Answer (B). Ligands in alphabetical order (ammine before chlorido); Pt: x + 0 − 2 = 0, so +2: diamminedichloridoplatinum(II).

Q6. Answer (D). A heteroleptic complex has more than one kind of ligand: $[Co(NH_3)_4Cl_2]^+$ (NH_3 and Cl^-).

Q7. Answer (B). Butan-2-ol, $CH_3CH(OH)CH_2CH_3$, has a carbon with four different groups (H, OH, CH_3, C_2H_5). The others have no such carbon.

Q8. Answer (C). Boiling point rises with molar mass, and among isomers branching lowers it: propan-1-ol (370 K) < butan-2-ol (373 K) < butan-1-ol (390 K) < pentan-1-ol (411 K).

Q9. Answer (A). $CH_3C{\equiv}N + 4[H]$ ($LiAlH_4$) → $CH_3CH_2NH_2$, ethylamine (ethanamine).

Q10. Answer (C). DNA has A, G, C and T; RNA has uracil in place of thymine.

Q11. Answer (B). Amino acids link through the amide –CO–NH– bond, called the peptide bond (glycosidic bonds join sugar units).

Q12. Answer (D). The existence of α- and β-forms is explained only by the cyclic (hemiacetal) structure; (A), (B) and (C) follow from the open chain with a –CHO group.

Q13. Answer (A). The decomposition of HI is an elementary bimolecular step: two HI molecules collide at once. R explains A. Answer (A).

Q14. Answer (A). Zn, Cd and Hg have $(n-1)d^{10}$ in the atom and in their common +2 state, so they have no partly filled d orbitals; that is exactly why they are not regarded as transition elements. Answer (A).

Q15. Answer (D). Gabriel synthesis cannot make aromatic primary amines (A is false) because aryl halides do not undergo nucleophilic substitution with the phthalimide anion (R is true). Answer (D).

Q16. Answer (C). Bromine water oxidises the –CHO group to –COOH, giving six-carbon gluconic acid: A is true. The open chain has a carbonyl (aldehyde) group: R is false. Answer (C).

Q17. (2 marks) Answer: (a) ≈ 0.221 min⁻¹; (b) ≈ 544 s.
(a) $k = (2.303/t)\log([R]_0/[R]) = (2.303/5)\log(0.6/0.2) = (2.303/5) \times 0.48$ [1]
$k \approx 0.221\ min^{-1}$ ($\approx 3.7 \times 10^{-3}\ s^{-1}$). [1]
OR (b) When ¾ has decomposed, $[R] = [R]_0/4$: $t = (2.303/k)\log 4$ [1]
$t = 2.303 \times 0.60/(2.54 \times 10^{-3}) \approx 544$ s. [1]

Q18. (2 marks) Answer: mol L^{-1} s^{-1}; L mol^{-1} s^{-1}.
(a) Activation energy is the minimum extra energy that reacting molecules must absorb (above their average energy) to reach the activated complex and react: E_a = threshold energy − average energy of the reactants. [1]
(b) (i) mol L^{-1} s^{-1} (ii) L mol^{-1} s^{-1} (mol^{-1} L s^{-1}). [½ + ½]

Q19. (2 marks) Answer: half-filled $3d^5 4s^1$ vs filled $3d^{10} 4s^2$; variable oxidation states.
(a) Cr is $3d^5 4s^1$: the single 4s electron is removed easily. Zn is $3d^{10} 4s^2$: the electron comes from a completely filled, stable $4s^2$ (with a filled $3d^{10}$ core) and the nuclear charge is higher, so more energy is needed. [1]
(b) Their ability to show variable oxidation states (and to form unstable intermediate complexes); they also provide a large surface for adsorption. [1]

Q20. (2 marks) Answer: optical isomerism.
(a) Coordination number is the number of ligand donor atoms directly bonded to the central metal atom/ion. [1]
(b) Optical isomerism: $[Co(en)_3]^{3+}$ exists as two non-superimposable mirror images (d and l forms). [1]

Q21. (2 marks) Answer: $CH_3CH=C(CH_3)CH(Br)CH_3$; ethanol.
(a) CH_3–CH=C(CH_3)–CH(Br)–CH_3 (C1 to C5: double bond between C2 and C3, CH_3 on C3, Br on C4). [1]
(b) Nucleophilic substitution gives ethanol: $C_2H_5Cl + KOH(aq) \rightarrow C_2H_5OH + KCl$. [1]

Q22. (3 marks) Answer: 60 g mol^{-1}.
$\Delta T_b = 353.93 - 353.23 = 0.70$ K. [1]
$M_2 = K_b \times w_2 \times 1000/(\Delta T_b \times w_1) = 2.52 \times 1.5 \times 1000/(0.70 \times 90)$ [1]
$= 3780/63 = 60$ g mol^{-1}. [1]

Q23. (3 marks) Answer: ≈ 0.11 V (0.1105 V).
Cell reaction: $Sn + 2H^+ \rightarrow Sn^{2+} + H_2$, n = 2; E°cell = 0.00 − (−0.14) = 0.14 V. [1]
$E = E° - (0.059/2) \log([Sn^{2+}]/[H^+]^2) = 0.14 - 0.0295 \log(0.001/(0.01)^2) = 0.14 - 0.0295 \log 10$ [1]
$E = 0.14 - 0.0295 = 0.1105$ V ≈ 0.11 V. [1]

Q24. (3 marks) Answer: $K_2MnO_4 + MnO_2 + O_2$; $K_2Cr_2O_7 + 2NaCl$; very similar sizes and properties.
(a) (i) $2KMnO_4 \xrightarrow{(513\ K)} K_2MnO_4 + MnO_2 + O_2$ [1] (ii) $Na_2Cr_2O_7 + 2KCl \rightarrow K_2Cr_2O_7 + 2NaCl$ [1]
(b) Because of the lanthanoid contraction their atomic and ionic sizes are almost the same and they show the same (+3) oxidation state, so their chemical properties are very similar. [1]

Q25. (3 marks) Answer: low spin t_2g^6 vs high spin $t_2g^4 e_g^2$; $t_2g^4\ e_g^0$.
(a) Co^{3+} is $3d^6$. NH_3 is a strong field ligand: the electrons pair in t_2g, giving $t_2g^6\ e_g^0$ (d^2sp^3, inner orbital), with no unpaired electron: diamagnetic. [1]
F^- is a weak field ligand: $t_2g^4\ e_g^2$ (sp^3d^2, outer orbital) with 4 unpaired electrons: paramagnetic. [1]
(b) $\Delta_0 > P$: the fourth electron pairs in t_2g: $t_2g^4\ e_g^0$. [1]

Q26. (3 marks) Answer: 3-bromocyclohexene; equimolar d + l; symmetry, better packing.
(a) With bromine at high temperature cyclohexene undergoes allylic substitution: 3-bromocyclohexene (Br on the carbon next to the double bond). (Without heat, in CCl_4, addition would give trans-1,2-dibromocyclohexane.) [1]
(b) A racemic mixture is an equimolar mixture of the two enantiomers (d and l); it is optically inactive because their rotations cancel. [1]
(c) The para isomer is symmetrical and fits into the crystal lattice better than the ortho and meta isomers, so its intermolecular forces in the solid are stronger. [1]

Q27. (3 marks) Answer: see the model answer.
(a) $C_6H_5COCl + H_2 \xrightarrow{(Pd/BaSO_4)} C_6H_5CHO + HCl$ [1]
(b) $2HCHO + \text{conc. } KOH \rightarrow CH_3OH + HCOOK$ (an aldehyde without α-H is both reduced and oxidised) [1]
(c) $CH_3COOH \xrightarrow{(i)\ Cl_2/red\ P,\ (ii)\ H_2O} ClCH_2COOH$ (α-halogenation of a carboxylic acid with α-H) [1]

Q28. (3 marks) Answer: see the model answer.

(a) (a) A reducing sugar reduces Fehling's solution and Tollens' reagent; it has a free aldehyde or ketone group (all monosaccharides, maltose, lactose). [1]

(b) (i) Fibrous proteins have long thread-like chains held side by side by H-bonds and disulphide links and are insoluble in water (keratin, myosin); globular proteins are coiled into spheres and are water soluble (insulin, albumin). [1] (ii) A nucleoside is base + sugar; a nucleotide is base + sugar + phosphate. [1]

OR (b) (a) Glucose + NH_2OH → glucose oxime, $HOCH_2(CHOH)_4CH{=}NOH$ (+ H_2O). [1]

(b) With acetic anhydride: glucose pentaacetate (five –OH groups acetylated). [1]

(c) With conc. HNO_3: saccharic (glucaric) acid, $HOOC(CHOH)_4COOH$. [1]

Q29. (4 marks) Answer: (a) ≈ 3.0 g; (b) osmosis; (c) reverse osmosis.

(a) $\pi = iCRT = i(n/V)RT$, so $n = \pi V/(iRT) = 0.70 \times 2.46/(2.59 \times 0.082 \times 300) = 1.722/63.71 \approx 0.0270$ mol. [1]

Mass = $0.0270 \times 111 \approx 3.0$ g of $CaCl_2$. [1]

(b) Osmosis (endosmosis): water enters the raisins through their skin, which acts as a semipermeable membrane. [1]

OR (b) It is measured at room temperature and its magnitude is large even for very dilute solutions, so it suits macromolecules such as proteins and polymers, which are unstable at higher temperatures. [1]

(c) Reverse osmosis. [1]

Q30. (4 marks) Answer: (a) $CH_3CH_2NH_2$; p-toluidine; (c) tertiary, primary; OR butan-1-ol.

(a) (i) CH_3CONH_2 —$LiAlH_4$, H_2O→ $CH_3CH_2NH_2$ (ethanamine). [1] (ii) 4-Nitrotoluene —Fe + HCl→ 4-methylaniline (p-toluidine), $CH_3–C_6H_4–NH_2$. [1]

(b) Primary amines have two H atoms on N and form intermolecular hydrogen bonds; tertiary amines have no N–H and cannot, so less energy is needed to separate their molecules. [1]

(c) (i) Tertiary (N,N-dimethylnaphthalen-2-amine); (ii) primary (naphthalen-2-amine). [½ + ½]

OR (c) Butan-1-ol: O is more electronegative than N, so its hydrogen bonds with water are stronger. [1]

Q31. (5 marks) Answer: (a)(b) $(CH_3)_3CCOC(CH_3)_3 < CH_3COCH_3 < CH_3CHO$; CH_3CHO and cyclohexanone; (b)(b) CH_2FCOOH; propane < dimethyl ether < ethanal < ethanol.

(a) (a) (i) CH_3COCH_3 —$NaBH_4$ (or H_2/Ni)→ $CH_3CH(OH)CH_3$ —conc. H_2SO_4, heat→ $CH_3CH{=}CH_2$. [1]

(ii) C_6H_5COOH —$SOCl_2$→ C_6H_5COCl —H_2, $Pd/BaSO_4$ (Rosenmund)→ C_6H_5CHO. [1]

(iii) C_6H_6 —CH_3COCl, anhyd. $AlCl_3$ (Friedel–Crafts)→ $C_6H_5COCH_3$ —conc. HNO_3 + conc. H_2SO_4→ m-nitroacetophenone (–$COCH_3$ is meta-directing). [1]

(b) (i) Increasing reactivity: $(CH_3)_3C–CO–C(CH_3)_3 < CH_3COCH_3 < CH_3CHO$ (bulky, electron-releasing groups hinder attack on the carbonyl carbon). [1]

(ii) CH_3CHO and cyclohexanone: they have α-hydrogen atoms (HCHO and C_6H_5CHO have none). [1]

OR (b) (a) (i) Iodoform test (I_2 + NaOH): acetophenone (a methyl ketone) gives a yellow precipitate of CHI_3; benzophenone does not. [1] (ii) Tollens' (or Fehling's) test: propanal gives a silver mirror (red precipitate); propanone does not (propanone gives the iodoform test). [1] (iii) Iodoform test: pentan-2-one ($CH_3CO–$) gives yellow CHI_3; pentan-3-one does not. [1]

(b) (i) CH_2FCOOH: the −I effect of F stabilises the carboxylate ion, so it is the stronger acid. [1] (ii) $CH_3CH_2CH_3 < CH_3OCH_3 < CH_3CHO < CH_3CH_2OH$. [1]

Q32. (5 marks) Answer: (a) 106 S cm² mol⁻¹, α ≈ 0.84; current Ag → Zn; (b) 4.3 × 10⁻³ S cm⁻¹, 430 S cm² mol⁻¹.
(a) (a) $\Lambda m = \kappa \times 1000/C = 1.06 \times 10^{-2} \times 1000/0.1 = 106$ S cm² mol⁻¹. [1]
$\Lambda°m = 50.1 + 76.5 = 126.6$ S cm² mol⁻¹. [1]
$\alpha = \Lambda m/\Lambda°m = 106/126.6 \approx 0.84$. [1]
(b) (i) Zn is the anode: electrons flow from the zinc electrode to the silver electrode in the external circuit, so the current flows from the silver electrode to the zinc electrode (Ag → Zn). [1] (ii) A primary battery cannot be recharged once used up (dry cell, mercury cell); a secondary battery can be recharged by passing current in the opposite direction and reused (lead storage cell, Ni–Cd cell). [1]
OR (b) (a) Cell constant $G^* = \kappa R = 1.29 \times 10^{-2} \times 100 = 1.29$ cm⁻¹. [1]
For 0.01 M KCl: $\kappa = G^*/R = 1.29/300 = 4.3 \times 10^{-3}$ S cm⁻¹. [1]
$\Lambda m = \kappa \times 1000/C = 4.3 \times 10^{-3} \times 1000/0.01 = 430$ S cm² mol⁻¹ (with the data as given). [1]
(b) (i) High efficiency (about 70%) and pollution-free (the only product is water); it runs continuously as long as the gases are supplied. [1] (ii) The overall reaction Zn(Hg) + HgO → ZnO + Hg involves no ions in solution whose concentration changes, so the cell potential stays constant (about 1.35 V). [1]

Q33. (5 marks) Answer: A ethanol, B sodium ethoxide, C iodoform, D diethyl ether, E iodoethane.
(a) A = ethanol C_2H_5OH; B = sodium ethoxide C_2H_5ONa; C = iodoform CHI_3; D = ethoxyethane $C_2H_5OC_2H_5$; E = iodoethane C_2H_5I. [2½]
$2C_2H_5OH + 2Na \rightarrow 2C_2H_5ONa + H_2$ [½]
$C_2H_5OH + 4I_2 + 6NaOH \rightarrow CHI_3 + HCOONa + 5NaI + 5H_2O$ [1]
$2C_2H_5OH \xrightarrow{\text{conc. } H_2SO_4,\ 413\ K} C_2H_5OC_2H_5 + H_2O$ [½]
$C_2H_5OC_2H_5 + 2HI\ (\text{excess}) \rightarrow 2C_2H_5I + H_2O$ [½]
OR (b) (a) (i) Bromine water (Br_2/H_2O). [1] (ii) Diborane, then H_2O_2/OH^- (hydroboration–oxidation). [1] (iii) $NaBH_4$ (or $LiAlH_4$, or H_2/Ni). [1]
(b) Step 1: the alkene is protonated by H_3O^+ (electrophilic attack) to give a carbocation. Step 2: water attacks the carbocation (nucleophilic attack) to give a protonated alcohol. Step 3: loss of a proton (deprotonation) gives the alcohol, Markovnikov orientation. [2]

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