Roll No. ☐☐☐☐☐☐☐☐

Q.P. Code 56/1/1

CHEMISTRY (THEORY)

CBSE Class XII Board Examination 2024

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

General Instructions:

1. The paper has 33 questions in five sections (A to E); all of them must be answered.
2. Section A: Q1–16, multiple choice (including Assertion-Reason), 1 mark each.
3. Section B: Q17–21, very short answer, 2 marks each.
4. Section C: Q22–28, short answer, 3 marks each.
5. Section D: Q29–30, case-based, 4 marks each.
6. Section E: Q31–33, long answer, 5 marks each.
7. There is no overall choice, but some questions in Sections B to E offer an internal choice (OR). Calculators are not allowed.

SECTION A

Q1–16 are multiple choice questions of 1 mark each (Q13–16 are Assertion-Reason).

1. Among these first-row transition elements, which one should have the highest third ionisation enthalpy? **1**

(A) Iron (Z = 26) **(B)** Manganese (Z = 25)

(C) Chromium (Z = 24) **(D)** Vanadium (Z = 23)

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2. Which of these compounds gives a ketone when oxidised with chromic anhydride (CrO_3)? **1**

(A) $(CH_3)_2CH–CH_2OH$ **(B)** $CH_3CH_2CH_2OH$

(C) $(CH_3)_3C–OH$ **(D)** $CH_3–CH_2–CH(OH)–CH_3$

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3. A DNA nucleotide is made of three parts. Two of them are β-D-2-deoxyribose and a heterocyclic base. What is the third part? **1**

(A) Adenine **(B)** Phosphoric acid

(C) Sulphuric acid **(D)** Uracil

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4. When a solute associates in a solvent, its van't Hoff factor i is: **1**

(A) always greater than one **(B)** negative

(C) zero **(D)** always less than one

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5. For the reaction X + 2Y → P, which differential rate expression is correct? **1**

(A) $\frac{2\,d[P]}{dt} = \frac{-d[Y]}{dt}$

(B) $\frac{-d[P]}{dt} = \frac{-d[X]}{dt}$

(C) $\frac{+d[X]}{dt} = \frac{-d[P]}{dt}$

(D) $\frac{-2\,d[Y]}{dt} = \frac{+d[P]}{dt}$

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6. Which compound undergoes SN1 reaction fastest? **1**

(A) 3-Bromocyclohexene (Br on the ring carbon next to the ring C=C, i.e. allylic)

(B) (Bromomethyl)cyclohexane, $C_6H_{11}–CH_2Br$

(C) Bromocyclohexane, $C_6H_{11}–Br$

(D) Bromobenzene, $C_6H_5–Br$

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7. What is formed when acetic acid reacts with PCl_5? **1**

(A) $Cl–CH_2–COCl$ **(B)** $Cl–CH_2–COOH$

(C) $CH_3–COCl$ **(D)** $CCl_3–COOH$

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8. Formation of a cyanohydrin from an aldehyde is an example of: **1**

(A) nucleophilic addition
(B) electrophilic addition
(C) nucleophilic substitution
(D) electrophilic substitution

9. In the Arrhenius equation, a graph of log k against 1/T is a straight line. Its slope and intercept are: **1**

(A) slope A/R, intercept E_a
(B) slope A, intercept $-E_a/R$
(C) slope $-E_a/RT$, intercept log A
(D) slope $-E_a/(2.303\ R)$, intercept log A

10. The reaction of an alkyl halide with a sodium alkoxide to give an ether is called: **1**

(A) Wurtz reaction
(B) Reimer-Tiemann reaction
(C) Williamson synthesis
(D) Kolbe reaction

11. Choose the correct order of ease of dehydration with conc. H_2SO_4: **1**

(A) $(CH_3)_3C–OH > (CH_3)_2CH–OH > CH_3CH_2–OH$
(B) $(CH_3)_2CH–OH > CH_3CH_2–OH > (CH_3)_3C–OH$
(C) $CH_3CH_2–OH > (CH_3)_2CH–OH > (CH_3)_3C–OH$
(D) $(CH_3)_2CH–OH > (CH_3)_3C–OH > CH_3CH_2–OH$

12. Which groups of glucose react with each other to give the cyclic hemiacetal (pyranose) form? **1**

(A) Aldehyde group and –OH at C-4
(B) Aldehyde group and –OH at C-5
(C) Ketone group and –OH at C-4
(D) Ketone group and –OH at C-5

13. Assertion (A): Adding NaCl to water lowers its freezing point. **1**
Reason (R): NaCl dissociates in water.

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is not the correct explanation of A.
(C) A is true, but R is false.
(D) A is false, but R is true.

14. Assertion (A): Zr and Hf are hard to separate. **1**
Reason (R): Because of lanthanoid contraction, Zr and Hf have almost the same radii.

(A) Both A and R are true, and R is the correct explanation of A.
(B) Both A and R are true, but R is not the correct explanation of A.
(C) A is true, but R is false.
(D) A is false, but R is true.

15. Assertion (A): Ethanoic acid has a lower pK_a than $Cl–CH_2–COOH$. **1**
Reason (R): Chlorine's electron-withdrawing (–I) effect increases the acidity of $Cl–CH_2–COOH$.

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

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

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

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

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16. Assertion (A): Aniline is more basic than ammonia. **1**
Reason (R): In aniline the lone pair on nitrogen is delocalised into the ring by resonance, so it is less available for protonation.

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

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

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

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

SECTION B

Q17–21 are very short answer questions of 2 marks each.

17. Find the electrode potential of an iron electrode dipped in 0.01 M Fe^{2+} solution at 298 K. **2**
($E°(Fe^{2+}/Fe) = −0.45$ V; log 10 = 1)

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18. What is meant by molecularity of a reaction? Give one condition under which a bimolecular reaction can behave kinetically as first order. **2**

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19. What is formed when D-glucose is treated with: **2**
(a) HI (prolonged heating)
(b) conc. HNO_3

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20. Draw the major monohalo product in each reaction: **2**
(i) Styrene ($C_6H_5–CH=CH_2$) + HBr →
(ii) Cyclohexene + Br_2 in UV light →

OR

Give reasons:
(i) Grignard reagents must be prepared in anhydrous conditions.
(ii) With aqueous KOH alkyl halides give alcohols, but with alcoholic KOH they give alkenes.

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21. Write the chemical equation when: **2**
(a) butan-2-one is treated with Zn(Hg) and conc. HCl
(b) two molecules of benzaldehyde are treated with conc. NaOH

SECTION C

Q22–28 are short answer questions of 3 marks each.

22. A conductivity cell filled with 0.05 M KCl shows a resistance of 100 Ω at 25 °C. The same cell filled with 0.02 M $AgNO_3$ shows 90 Ω. Find the conductivity and molar conductivity of the $AgNO_3$ solution. **3**

(Conductivity of 0.05 M KCl = $1.35 \times 10^{-2}\ \Omega^{-1}\ cm^{-1}$)

23. For $2NO(g) + Br_2(g) \rightarrow 2NOBr(g)$, the initial rates measured were: **3**

Expt 1: [NO] = 0.05, $[Br_2]$ = 0.05 mol L^{-1}, rate = 1.0×10^{-3} mol $L^{-1}\ s^{-1}$

Expt 2: [NO] = 0.05, $[Br_2]$ = 0.15, rate = 3.0×10^{-3}

Expt 3: [NO] = 0.15, $[Br_2]$ = 0.05, rate = 9.0×10^{-3}

(a) Find the order with respect to NO and Br_2.

(b) Find the rate constant k.

(c) Find the rate when [NO] = 0.4 M and $[Br_2]$ = 0.2 M.

24. (a) Write the formula of potassium tetrahydroxidozincate(II). **3**

(b) Put these in increasing order of conductivity of their solutions: $[Cr(NH_3)_5Cl]Cl_2$, $[Cr(NH_3)_3Cl_3]$, $[Cr(NH_3)_6]Cl_3$

(c) Name the isomerism shown by: (i) $[Co(NH_3)_5NO_2]^{2+}$ (ii) $[Co(en)_3]Cl_3$

25. (a) Which one is an allylic halide: (i) $CH_3–CH=CH–Br$ or (ii) $CH_2=CH–CH(Br)–CH_3$? **3**

(b) Which is more reactive towards nucleophilic substitution – chlorobenzene or 2,4,6-trinitrochlorobenzene – and why?

(c) Which isomer of C_4H_9Cl has the lowest boiling point?

26. (a) Write the mechanism of: $CH_3CH_2OH \rightarrow (H^+, 443\ K) \rightarrow CH_2=CH_2$ **3**

(b) Write the main product:

(i) $CH_3–CH_2–CH=CH_2$ treated with (a) B_2H_6 and then (b) H_2O_2/OH^-

(ii) Phenol treated with (a) aq. NaOH and then (b) CO_2, H^+

27. Answer any three: **3**

(a) What is a peptide linkage?

(b) What bonds hold the two strands of the DNA double helix together?

(c) Which of these is a polysaccharide: sucrose, glucose, starch, fructose?

(d) Give one example each of a water-soluble and a fat-soluble vitamin.

28. Compound A ($C_6H_{12}O_2$) is reduced by $LiAlH_4$ to two compounds B and C. Oxidation of B with PCC gives D. D with dilute NaOH followed by heating gives E. Catalytic hydrogenation of E gives C. Further oxidation of D gives F, a monobasic acid of molar mass 60. Identify A to F. **3**

SECTION D

Q29–30 are case-based questions of 4 marks each (choice in part (c)).

29. Batteries and fuel cells are practical galvanic cells. A useful battery must be light, compact and give a nearly constant voltage. Primary batteries work only once, while secondary batteries can be recharged. Fuel cells convert the energy of combustion of a fuel directly into electricity (one was used in the Apollo space programme). **4**

(a) How do primary batteries differ from secondary batteries? (1)

(b) A mercury cell gives 1.35 V that stays constant throughout its life. Why? (1)

(c) Write the reactions that take place when a lead storage battery is recharged. (2)

OR

(c) Write two advantages of fuel cells over other galvanic cells.

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30. Valence bond theory explains formation, magnetism and shape of complexes, while crystal field theory looks at how ligands (taken as point charges) split the degenerate d-orbitals of the metal. The splitting gives different electron arrangements in strong and weak fields, and d–d transitions explain the colour of complexes. Complexes are used in metallurgy, analysis and medicine. **4**

(a) What is crystal field splitting energy? (1)

(b) Explain the violet colour of $[Ti(H_2O)_6]^{3+}$ using crystal field theory. (1)

(c) Explain why $[Cr(NH_3)_6]^{3+}$ is paramagnetic but $[Ni(CN)_4]^{2-}$ is diamagnetic. [Cr = 24, Ni = 28] (2)

OR

(c) Explain why $[Fe(CN)_6]^{3-}$ is an inner orbital complex while $[Fe(H_2O)_6]^{3+}$ is an outer orbital complex. [Fe = 26]

SECTION E

Q31–33 are long answer questions of 5 marks each.

31. (i) At the same temperature CO_2 is more soluble in water than O_2. Which gas has the higher Henry's constant K_H, and why? **5**

(ii) What happens to the size of red blood cells placed in an aqueous solution containing more than 0.9% (mass/volume) NaCl?

(iii) A 1 molal aqueous solution of electrolyte A_2B_3 is 60% ionised. Find the boiling point of the solution. (K_b of water = 0.52 K kg mol^{-1})

OR

(i) At 25 °C the vapour pressures of pure A and B are 75 mm Hg and 25 mm Hg. A and B are mixed so that the mole fraction of A in the liquid is 0.4. Find the mole fraction of B in the vapour.

(ii) Define a colligative property. Which colligative property is preferred for finding the molar mass of macromolecules?

(iii) Why are equimolar solutions of NaCl and glucose not isotonic?

32. Answer any five: **5**

(a) Why is N,N-diethylbenzenesulphonamide insoluble in alkali?

(b) Why does aniline not undergo Friedel-Crafts reaction?

(c) Give a simple chemical test to tell methylamine from aniline.

(d) Write the reaction(s) of Gabriel phthalimide synthesis.

(e) How will you convert aniline into p-bromoaniline?

(f) Complete: benzenediazonium chloride treated with (i) HBF_4, then (ii) $NaNO_2$/Cu, heat →

(g) Benzoic acid is heated with NH_3 to give A; A with Br_2 + NaOH gives B. Write A and B.

33. (i) Account for: **5**

(1) Zn, Cd and Hg have low melting and boiling points.

(2) Both are d^4 species, yet Cr^{2+} is a strong reducing agent while Mn^{3+} is a strong oxidising agent.

(3) E° for Cu^{2+}/Cu is +0.34 V (positive).

(ii) Complete and balance:

(1) $KMnO_4$ → (heat)

(2) $Cr_2O_7^{2-} + 6I^- + 14H^+$ →

OR

(i) Which is more stable in aqueous solution, Cu_2Cl_2 or $CuCl_2$, and why?

(ii) Write the general electronic configuration of f-block elements.

(iii) Which of Sc^{3+}, Fe^{3+}, Zn^{2+} is coloured in aqueous solution, and why? [Sc = 21, Fe = 26, Zn = 30]

(iv) How is potassium dichromate obtained from sodium chromate?

(v) Why do transition metals and their compounds act as catalysts?

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Questions restated from the CBSE Class XII Board Examination 2024 (set 56/1/1) for practice. Reading passages and map items are described, not reproduced.