Chemistry

HSC Board Exam February–March 2027 – Practice Paper No. 2

Practice Question Paper

Time: 3 hours **Max. Marks: 70**

(1) The question paper is divided into four sections.
(2) Section A: Q. No. 1 contains ten multiple choice type questions carrying one mark each. Q. No. 2 contains eight very short answer type questions carrying one mark each.
(3) Section B: Q. No. 3 to Q. No. 14 contain twelve short answer type questions carrying two marks each. (Attempt any eight)
(4) Section C: Q. No. 15 to Q. No. 26 contain twelve short answer type questions carrying three marks each. (Attempt any eight)
(5) Section D: Q. No. 27 to Q. No. 31 contain five long answer type questions carrying four marks each. (Attempt any three)
(6) Use of log table is allowed. Use of calculator is not allowed.
(7) Figures to the right indicate full marks.
(8) For each MCQ, the correct answer must be written along with its alphabet, e.g. (A) ..... / (B) ..... Only the first attempt will be considered for evaluation.
(9) Physical constants: R = 8.314 J K^{-1} mol^{-1}; F = 96500 C mol^{-1}; $N_A = 6.022 \times 10^{23}$ mol^{-1}; 2.303RT/F = 0.0592 V at 298 K.

SECTION A – Q.1 Select and write the correct answer for the following multiple choice type of questions. **[10]**

(i) Which of the following ionic solids shows both Schottky and Frenkel defects?
(A) NaCl (B) KCl
(C) AgBr (D) ZnS

(ii) The aqueous solution of which of the following salts has pH greater than 7?
(A) NaCl (B) NH_4Cl
(C) CH_3COONa (D) KNO_3

(iii) For which of the following reactions is $\Delta H = \Delta U$?
(A) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ (B) $H_2(g) + Br_2(g) \rightarrow 2HBr(g)$
(C) $PCl_5(g) \rightarrow PCl_3(g) + Cl_2(g)$ (D) $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$

(iv) For a cell reaction involving two electrons (n = 2), $E°_{cell} = 0.296$ V at 298 K. The equilibrium constant of the cell reaction is _____.
(A) 10^5 (B) 10^{10}
(C) 10^{-10} (D) 10^{20}

(v) According to the Arrhenius equation, the slope of the straight line obtained by plotting $\log_{10} k$ against 1/T is _____.
(A) $-E_a/R$ (B) $-E_a/2.303R$
(C) $E_a/2.303R$ (D) $-2.303R/E_a$

(vi) The hybridisation of xenon in XeF_4 is _____.

(A) sp^3 (B) sp^3d

(C) sp^3d^2 (D) sp^3d^3

(vii) Which of the following complexes can exist as cis and trans (geometric) isomers?

(A) $[Cr(NH_3)_6]^{3+}$ (B) $[Cr(NH_3)_5Cl]^{2+}$

(C) $[Cr(NH_3)_4Cl_2]^{+}$ (D) $[Cr(en)_3]^{3+}$

(viii) Which of the following alcohols gives turbidity immediately with Lucas reagent at room temperature?

(A) Butan-1-ol (B) Butan-2-ol

(C) 2-Methylpropan-1-ol (D) 2-Methylpropan-2-ol

(ix) Benzenediazonium chloride is converted into chlorobenzene by treating it with _____.

(A) CuCl/HCl (B) H_3PO_2

(C) KI (D) warm water

(x) The α-helix (secondary structure) of a protein is stabilised mainly by _____.

(A) peptide bonds (B) hydrogen bonds

(C) disulfide bonds (D) glycosidic bonds

SECTION A – Q.2 Answer the following questions. **[8]**

(i) What is the van't Hoff factor (i) of $K_4[Fe(CN)_6]$ in a dilute aqueous solution, assuming complete dissociation?

(ii) What is the slope of the straight line obtained by plotting $[A]_t$ against t for a zero order reaction?

(iii) Scandium (Z = 21) is regarded as a transition element. Give reason.

(iv) Write the IUPAC name of $CH_3–CH(CH_3)–CH(Cl)–CH_3$.

(v) Write the IUPAC name of $CH_3–CO–CH_2–CH(CH_3)–CH_3$.

(vi) Name the catalyst used in the manufacture of high density polythene (HDP).

(vii) What is meant by zero waste technology (ZWT)?

(viii) Write the relation between the standard Gibbs energy change (ΔG°) of a reaction and its equilibrium constant (K).

SECTION B Attempt any EIGHT of the following questions. (Q.3 to Q.14) **[16]**

Q.3 Tungsten, used for bulb filaments, crystallises in a body-centred cubic (bcc) lattice with unit cell edge length 316 pm. Calculate (a) the radius of a tungsten atom and (b) the distance between the centres of two nearest neighbouring atoms. ($\sqrt{3}$ = 1.732)

Q.4 The vapour pressure of pure water at a certain temperature is 3.20 kPa. When 4.8 g of a non-volatile non-electrolyte is dissolved in 72 g of water, the vapour pressure falls to 3.168 kPa. Calculate the molar mass of the solute. (Treat the solution as dilute.)

Q.5 A laboratory assistant prepares a buffer solution that is 0.15 M in acetic acid and 0.30 M in sodium acetate. Calculate the pH of the buffer. (pK_a of acetic acid = 4.74; log 2 = 0.3010)

Q.6 For the reaction $2CO(g) + O_2(g) \rightarrow 2CO_2(g)$, ΔH = −566.0 kJ at 298 K. Calculate ΔU for the reaction at 298 K. (R = 8.314 J K^{-1} mol^{-1})

Q.7 A cycle-parts workshop electroplates a steel handlebar with nickel from a nickel(II) sulfate bath. How long (in minutes) must a steady current of 1.93 A be passed to deposit 1.174 g of nickel? (Ni = 58.7 g mol^{-1}; F = 96500 C mol^{-1})

Q.8 For the reaction A + B → products, the following initial rate data were obtained at 300 K:

Experiment	[A]/mol dm^{-3}	[B]/mol dm^{-3}	Initial rate/mol dm^{-3} s^{-1}
1	0.10	0.10	2.0×10^{-4}
2	0.20	0.10	8.0×10^{-4}
3	0.10	0.20	2.0×10^{-4}

Find the order with respect to A and B, write the rate law and calculate the rate constant.

Q.9 Write balanced chemical equations for:
(a) Ozone is passed through an aqueous solution of potassium iodide.
(b) Copper is heated with concentrated sulfuric acid.

Q.10 For the complex $[Cr(en)_2(NH_3)Cl]SO_4$ (en = ethylenediamine), write:
(a) the oxidation state of chromium
(b) the coordination number of chromium
(c) whether the complex is cationic, anionic or neutral
(d) whether it is homoleptic or heteroleptic.

Q.11 Write chemical equations for:
(a) Wurtz–Fittig reaction using bromobenzene and bromoethane.
(b) Friedel–Crafts alkylation of chlorobenzene with chloromethane.

Q.12 Propanoic acid (molar mass 74 g mol^{-1}) boils at 414 K, whereas butan-1-ol (molar mass 74 g mol^{-1}) boils at 391 K. Explain.

Q.13 Write chemical equations for:
(a) N-Methylethanamine reacts with benzoyl chloride in the presence of pyridine.
(b) Propan-1-amine is treated with nitrous acid ($NaNO_2$ + dil. HCl).

Q.14 A kitchenware company in Nashik makes (a) handles for pressure cookers and (b) coating for non-stick frying pans. Name a suitable polymer for each and give one reason for each choice.

SECTION C Attempt any EIGHT of the following questions. (Q.15 to Q.26) **[24]**

Q.15 (a) In a mixed oxide, the oxide ions (O^{2-}) form a cubic close-packed (ccp) lattice. Monovalent cations A^+ occupy one-fourth of the tetrahedral voids and trivalent cations B^{3+} occupy one-half of the octahedral voids. Deduce the formula of the oxide and show that it is electrically neutral. [2]
(b) What is the coordination number of an ion that occupies (i) an octahedral void (ii) a tetrahedral void? [1]

Q.16 (a) 0.50 g of a protein isolated from soybean is dissolved in water to make 100 cm^3 of solution. The osmotic pressure of the solution at 300 K is 250 Pa. Calculate the molar mass of the protein. (R = 8.314 J K^{-1} mol^{-1}) [2]
(b) If this solution is diluted to 200 cm^3 at the same temperature, what will be its osmotic pressure? [1]

Q.17 A 0.050 M aqueous solution of a weak monoacidic base BOH has a hydronium ion concentration of 1.0×10^{-11} mol dm^{-3} at 298 K. Calculate (a) its degree of dissociation, (b) its dissociation constant K_b and (c) pK_b. (log 2 = 0.3010)

Q.18 (a) Write the electronic configurations of Cr^{3+} (Z = 24) and Fe^{2+} (Z = 26) and calculate the spin-only magnetic moment of each. [2]
(b) What is observed when H_2S gas is passed through acidified potassium dichromate solution? Write the balanced equation. [1]

Q.19 (a) 0.50 mol of an ideal gas expands isothermally and reversibly at 300 K from a volume of 2.0 dm^3 to 20.0 dm^3. Calculate the work done. (R = 8.314 J K^{-1} mol^{-1}) [2]
(b) What are the values of ΔU and q for this process? [1]

Q.20 The active ingredient of a cough syrup decomposes by first order kinetics. At 25 °C, 25 % of it decomposes in 60 days. Calculate (a) the rate constant, (b) the time in which 10 % of the ingredient decomposes (its shelf life) and (c) the half-life. (log 4 = 0.6021, log 3 = 0.4771, log 9 = 0.9542)

Q.21 Write chemical equations for:
(a) Action of bromine water on phenol
(b) Kolbe's reaction
(c) Oxidation of propan-2-ol with acidified potassium dichromate

Q.22 An organic compound A (C_4H_8O) gives a silver mirror with Tollens' reagent but does not give the iodoform test. On oxidation, A gives 2-methylpropanoic acid.
(a) Identify A, with reason. [1]
(b) Write the reaction of A with Tollens' reagent. [1]
(c) Write the reaction of A with HCN and name the product. [1]

Q.23 Three isomeric amines P, Q and R have the molecular formula C_3H_9N. With benzenesulfonyl chloride (Hinsberg's reagent), P gives a product that dissolves in aqueous KOH, Q gives a product insoluble in aqueous KOH, and R does not react. Identify P, Q and R (one structure each) and write the reactions of P and Q with the reagent.

Q.24 (a) Write the reactions of glucose with (i) hydroxylamine and (ii) acetic anhydride. What does each reaction indicate about the structure of glucose? [2]
(b) What are anomers? [1]

Q.25 Propene can be made from 1-bromopropane: $CH_3CH_2CH_2Br + KOH\ (alc.) \rightarrow CH_3CH{=}CH_2 + KBr + H_2O$. 2-Bromopropane can be made from propene: $CH_3CH{=}CH_2 + HBr \rightarrow CH_3CHBrCH_3$.
(a) Calculate the % atom economy for the desired product in each reaction. (C = 12, H = 1, Br = 80, K = 39, O = 16) [2]
(b) Which reaction is greener according to the principle of atom economy? Why? [1]

Q.26 Give reasons:
(a) H_2O is a liquid at room temperature, while H_2S is a gas.
(b) Interhalogen compounds (XX′) are more reactive than the halogens (except fluorine).
(c) Fluorine forms only one oxoacid (HOF), whereas chlorine forms several oxoacids.

SECTION D Attempt any THREE of the following questions. (Q.27 to Q.31) **[12]**

Q.27 (a) A hydrogen–oxygen fuel cell with hot aqueous KOH as electrolyte supplies power and drinking water on a spacecraft. Write the anode and cathode reactions and the net cell reaction. What mass of water is produced when the cell delivers 0.40 F of electricity? (H_2O = 18 g mol^{-1}) [2]

(b) A conductivity cell with cell constant 1.2 cm^{-1} is filled with 0.020 M formic acid (HCOOH) solution. Its resistance is 1500 Ω at 298 K. Calculate the conductivity, the molar conductivity and the degree of dissociation of formic acid. ($\lambda_0(H^+)$ = 349.6 Ω^{-1} cm^2 mol^{-1}; $\lambda_0(HCOO^-)$ = 54.4 Ω^{-1} cm^2 mol^{-1}) [2]

Q.28 (a) Using crystal field theory, draw the d-orbital splitting diagrams for the octahedral complexes $[Fe(H_2O)_6]^{3+}$ and $[Fe(CN)_6]^{3-}$. Predict the number of unpaired electrons and the spin-only magnetic moment of each, and state which one is a high spin complex. (Fe: Z = 26) [3]
(b) Write the IUPAC name of $[Fe(H_2O)_6]Cl_3$. [1]

Q.29 (a) 2-Bromo-2-methylbutane is hydrolysed by aqueous KOH by the S_N1 mechanism. Explain the mechanism, write the rate law, and explain why tertiary alkyl halides prefer the S_N1 path. [3]

(b) Write the IUPAC name of the major alkene formed when 2-bromo-2-methylbutane is heated with alcoholic KOH, and name the rule followed. [1]

Q.30 (a) 2.84 g of sodium sulfate (Na_2SO_4, molar mass 142 g mol^{-1}) is dissolved in 500 g of water. The boiling point of water is raised by 0.0562 K. Calculate the van't Hoff factor and the degree of dissociation of Na_2SO_4. (K_b for water = 0.52 K kg mol^{-1}) [3]

(b) Why is the observed van't Hoff factor smaller than 3? [1]

Q.31 (a) Write chemical equations for: (i) Rosenmund reduction of propanoyl chloride (ii) Heating sodium butanoate with soda lime. [2]

(b) How will you distinguish between aniline and benzylamine by a chemical test? Write the equations. [2]

All the best for your exam!