Grade 12 Chemistry Model Paper 2

MODEL PAPER

Full marks 75 · 3 hours

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 75

Answer every question; where a question has an OR question, answer either one. Time: 3 hours.

A practice paper by Science Playground, made to CDC's Specification Grid 2078, Grade 12 Chemistry (Che. 302); not an official CDC or NEB paper. Mark it yourself online: the QR code below opens the paper with its answers.

A full practice run of the NEB Grade 12 Chemistry paper (Che. 302): 75 marks in 3 hours, 12 questions in three groups. Group A is one question of 11 multiple-choice items, about 25 minutes; groups B and C have short- and long-answer questions of two to four parts, with each part's marks shown. Questions 2 and 6 in group B and Questions 10 and 12 in group C each have an OR question: answer either the question or its OR question, every part from the same one, and mark only the one you answered. Write on paper first, then tap your choice in group A and open each other part's answer to give yourself the marks its scheme allows. Where needed, take the atomic masses H = 1, C = 12, N = 14, O = 16, S = 32, Ca = 40, $R = 8.314\ \text{J K}^{-1}\ \text{mol}^{-1}$, $F = 96{,}485\ \text{C mol}^{-1}$, $K_w = 1.0 \times 10^{-14}$ and $\frac{2.303RT}{F} = 0.0592\ \text{V}$ at 25 °C.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

Choose the correct option for each of the following questions.

a. 4.9 g of sulphuric acid (M = 98) is dissolved in water and made up to 500 mL. What is the normality of the solution?

(i) 0.05 N (ii) 0.1 N (iii) 0.2 N (iv) 0.4 N

b. The molar solubility of calcium fluoride, CaF_2, in water at 25 °C is 2.0×10^{-4} mol/L. What is its solubility product?

(i) 4.0×10^{-8}

(ii) 8.0×10^{-12}

(iii) 1.6×10^{-11}

(iv) 3.2×10^{-11}

c. For $N_2(g) + 3\,H_2(g) \longrightarrow 2\,NH_3(g)$, $\Delta H^\circ = -92.2$ kJ and $\Delta S^\circ = -198.1\ \text{J K}^{-1}$ at 25 °C. What is ΔG° at 25 °C?

(i) −33.2 kJ (ii) −151.2 kJ (iii) +33.2 kJ (iv) −92.2 kJ

d. Which of these does a catalyst do to a reversible reaction?

(i) It makes the reaction more exothermic.

(ii) It shifts the equilibrium towards the products.

(iii) It gives a path of lower activation energy, so both the forward and backward reactions go faster.

(iv) It raises the energy of the reactant molecules.

e. Which metal is the catalyst in the Haber process for making ammonia?

(i) nickel (ii) platinum (iii) iron (iv) vanadium

f. Why doesn't copper give hydrogen with dilute hydrochloric acid?

(i) Copper forms a protective oxide coat in acid.

(ii) Its standard reduction potential is positive, so it cannot reduce H^+ ions to hydrogen.

(iii) Copper is a transition metal, and transition metals do not react with acids.

(iv) Copper chloride is insoluble, so the reaction stops at once.

g. What is power alcohol?

(i) ethanol made by fermentation of molasses only

(ii) a mixture of ethanol with petrol, used as a motor fuel

(iii) ethanol made poisonous with methanol so that it cannot be drunk

(iv) 100% pure ethanol

h. What is the main product when nitrobenzene is reduced with zinc dust and ammonium chloride solution (a neutral medium)?

(i) aniline

(ii) N-phenylhydroxylamine

(iii) azobenzene

(iv) 4-aminophenol

i. Engineers often prefer Portland pozzolana cement (PPC) to ordinary Portland cement (OPC) for the thick concrete of a dam. Why?

(i) PPC sets much faster than OPC.

(ii) PPC gives out less heat as it sets, so a thick mass cracks less, and it resists water and sulphates better.

(iii) PPC has more gypsum, which makes it stronger at once.

(iv) PPC contains no calcium silicates.

j. Paracetamol, sold in every medical shop in Nepal, lowers a fever and eases pain. To which two groups of drugs does it belong?

(i) antibiotic and antiseptic

(ii) tranquilizer and antacid

(iii) antipyretic and analgesic

(iv) antihistamine and antimalarial

k. A nucleus of uranium-238 ($^{238}_{92}\mathrm{U}$) gives out one alpha particle and then two beta particles (β^-), one after the other. Which statement about the final nucleus is correct?

(i) It is thorium-234, with 2 fewer protons and 2 fewer neutrons than uranium-238.

(ii) It is uranium-234, with 2 fewer neutrons than uranium-238.

(iii) It is uranium-234, with 4 fewer neutrons than uranium-238.

(iv) It is plutonium-234, with 2 more protons than uranium-238.

Group B Short answers, each on one content area — 40 marks

Question 2 — 5 marks

Utsab builds a cell from a nickel rod in 1 M nickel sulphate and a silver rod in 1 M silver nitrate, joined by a salt bridge. $E^\circ_{\mathrm{Ni^{2+}/Ni}} = -0.26\ \mathbf{V}$, $E^\circ_{\mathrm{Ag^{+}/Ag}} = +0.80\ \mathbf{V}$, $E^\circ_{\mathrm{Zn^{2+}/Zn}} = -0.76\ \mathbf{V}$, $E^\circ_{\mathrm{Al^{3+}/Al}} = -1.66\ \mathbf{V}$.

a. Define standard electrode potential. **[1]**

b. Write the cell notation of Utsab's cell, marking the anode and the cathode, and calculate its standard emf. **[2]**

c. Can zinc sulphate solution be stored in an aluminium can? Explain with the help of the electrode potentials. **[2]**

OR

Rojina wants to know how much calcium carbonate is in a lump of limestone from a quarry in Makwanpur. She dissolves 1.25 g of the powdered sample in 50.0 mL of 0.50 N hydrochloric acid. The acid left over needs 25.0 mL of 0.40 N sodium hydroxide for neutralization.

a. State the law of equivalence. **[1]**

b. How many milliequivalents of hydrochloric acid reacted with the calcium carbonate? **[2]**

c. Find the percentage of calcium carbonate in the limestone, and explain why Rojina did not titrate the limestone directly with the acid. **[2]**

Question 3 — 5 marks

Kritika follows the hydrolysis of methyl ethanoate in dilute hydrochloric acid:

$$CH_3COOCH_3 + H_2O \xrightarrow{H^+} CH_3COOH + CH_3OH$$

She finds that 30% of the ester is hydrolyzed in 40 minutes.

a. What is a pseudo-first-order reaction? **[1]**

b. Calculate the rate constant of the reaction. **[2]**

c. Find how long it takes for 90% of the ester to be hydrolyzed. Kritika expects that if she starts again with twice the concentration of ester, 90% of it will be hydrolyzed in half that time. Is she right? Explain. **[2]**

Question 4 — 5 marks

Aman's family runs a hardware shop in Biratnagar that sells cast iron pans, steel rods (TMT bars) for building and wrought iron gates. All three are made from the iron of a blast furnace.

a. Name two ores of iron and give their formulas. **[2]**

b. Explain the role of limestone in the blast furnace, with equations. **[1]**

c. Steel for TMT bars is made by blowing oxygen through molten pig iron, which burns off carbon as its oxides. Take pig iron as iron with 4.00% carbon, and suppose no iron is lost. What mass of carbon must be burnt off from 1.00 tonne of it to leave steel with 0.50% carbon? **[2]**

Question 5 — 5 marks

The elements from scandium to zinc fill the 3d orbitals.

a. Write any two characteristic properties of transition metals. **[2]**

b. Find the oxidation state of chromium in potassium dichromate, $K_2Cr_2O_7$, and the number of its 3d electrons in that state (Z of chromium = 24). **[1]**

c. The +2 ion of a metal M of the first transition series (Sc to Zn) has a spin-only magnetic moment of 5.92 BM in a weak-field complex. Identify M, and say whether its +3 ion should be more or less stable than its +2 ion, giving the reason. **[2]**

Question 6 — 5 marks

Anjila has a bottle of 2-bromopropane, the two alcohols of formula C_3H_8O, and an ether whose label has faded.

a. Write the structural formula of 2-bromopropane and say whether it is a primary, secondary or tertiary haloalkane. **[1]**

b. How would she tell propan-1-ol from propan-2-ol with Lucas reagent? Name the reagent's contents and say what she would see. **[2]**

c. The ether, X, is $C_4H_{10}O$. Heated with excess concentrated hydroiodic acid, it gives water and only one organic product. Identify X, giving your reason, and write the equation. **[2]**

OR

Ethyl ethanoate gives the fruity smell of some nail-polish removers.

a. What is esterification? **[1]**

b. Write the equations for the preparation of ethyl ethanoate from ethanoic acid, and for its hydrolysis by boiling with sodium hydroxide solution. **[2]**

c. Esterification is done with concentrated sulphuric acid and an excess of the alcohol. Explain why both are used. **[2]**

Question 7 — 5 marks

Chlorobenzene is made from benzene, and was once the starting point for most of the world's phenol.

a. Name the reaction in which benzenediazonium chloride is warmed with copper(I) chloride in hydrochloric acid to give chlorobenzene. **[1]**

b. The chlorine atom of chlorobenzene makes the ring react more slowly with electrophiles than benzene does, yet it sends the new group to the ortho and para positions. Explain both. **[2]**

c. Phenol made from chlorobenzene gives a white precipitate at once with bromine water, while benzene needs liquid bromine and an iron(III) bromide catalyst to be brominated. Write the equation for phenol, and explain the difference. **[2]**

Question 8 — 5 marks

Rehan has three amines, CH_3NH_2, $(CH_3)_2NH$ and $C_6H_5NH_2$, and a sample of ammonia solution.

a. Write the IUPAC name of $(CH_3)_2NCH_2CH_3$ and classify it. **[1]**

b. Ethanamine, $C_2H_5NH_2$, is treated with nitrous acid (sodium nitrite and dilute hydrochloric acid) in the cold. Write the equation, name the main organic product and say what is seen. **[2]**

c. Arrange the three amines and ammonia in increasing order of their basic strength in aqueous solution, and give the reasons. **[2]**

Question 9 — 5 marks

Gyanu visits a handmade lokta paper workshop in Baglung and reads about the closed Bhrikuti paper mill at Gaindakot, which made pulp from rice straw, babiyo grass and bamboo.

a. Name the natural polymer of which paper fibers are mainly made. **[1]**

b. Explain the difference between mechanical pulping and chemical (kraft) pulping, and why kraft pulp gives stronger paper. **[2]**

c. A kraft mill gives a pulp yield of 45% of the dry mass of its bamboo chips. How much pulp does it make from 20 tonnes of dry chips? **[1]**

d. In a library's conservation room, Gyanu sees brown, brittle pages of a book printed in the 1950s on rosin-and-alum sized paper being soaked in a dilute solution of magnesium hydrogencarbonate and dried. Give the chemical reason this saves the book. **[1]**

Group C Long answers, each on one content area — 24 marks

Question 10 — 8 marks

Sudarshan's family in Chitwan cooks on biogas, which is mostly methane. Standard enthalpies at 25 °C: of combustion of methane -890.3 kJ mol^{-1}, of formation of $CO_2(g)$ -393.5 kJ mol^{-1} and of $H_2O(l)$ -285.8 kJ mol^{-1}.

a. Ice melts by itself at 10 °C although melting takes in heat. Explain, with the help of entropy and Gibbs free energy, why a process can be spontaneous though it is endothermic. **[3]**

b. Use Hess's law to calculate the standard enthalpy of formation of methane. **[3]**

c. For $N_2O_4(g) \rightleftharpoons 2\,NO_2(g)$, $\Delta G^\circ = +4.7$ kJ mol^{-1} at 25 °C. Calculate its equilibrium constant at 25 °C. Given that $\Delta H^\circ = +57.2$ kJ mol^{-1}, say whether K becomes larger or smaller when the gas is warmed, and justify your answer from $\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$. **[2]**

OR

A laboratory technician in Dhulikhel makes up 0.10 M solutions of three salts: ammonium chloride, sodium ethanoate and sodium chloride. $K_a(CH_3COOH) = 1.75 \times 10^{-5}$**.**

a. Explain, with equations, why the ammonium chloride solution is acidic, the sodium ethanoate solution basic and the sodium chloride solution neutral. **[3]**

b. Calculate the pH of the 0.10 M sodium ethanoate solution. **[3]**

c. Ethanoic acid is titrated with sodium hydroxide. Which indicator would you choose, phenolphthalein (pH range 8.3–10) or methyl orange (3.1–4.4)? Justify your choice. **[2]**

Question 11 — 8 marks

Shreya studies the derivatives of ethanoic acid: ethanoyl chloride, ethanoic anhydride, ethyl ethanoate and ethanamide.

a. Ethanoyl chloride reacts violently with cold water, but ethanamide has to be boiled with acid or alkali for a long time to be hydrolyzed. Explain this order of reactivity. **[3]**

b. Write the equations for the reaction of ethanoyl chloride with (i) water and (ii) ethanol. **[2]**

c. An ester A, $C_6H_{12}O_2$, is boiled with dilute sulphuric acid and gives an acid B and an alcohol C. When C is oxidized with acidified potassium dichromate, it gives B. Identify A, B and C, and write the equations for the hydrolysis and the oxidation. **[3]**

Question 12 — 8 marks

Tenzing compares the carbonyl compounds methanal, ethanal, propanone and benzaldehyde.

a. Why are aldehydes generally more reactive than ketones towards nucleophilic addition? **[2]**

b. Using a suitable Grignard reagent and carbonyl compound each time, show how you would prepare (i) a primary alcohol, propan-1-ol, (ii) a secondary alcohol, propan-2-ol, and (iii) a tertiary alcohol, 2-methylpropan-2-ol. **[3]**

c. Ethanal gives a silver mirror with Tollens' reagent and a red precipitate with Fehling's solution. Benzaldehyde gives the silver mirror but not the red precipitate, and propanone gives neither. Explain these results, and write the equation for ethanal with Tollens' reagent. **[3]**

OR

Two bottles have lost their labels: one holds propanal, CH_3CH_2CHO**, the other propanone,** CH_3COCH_3**. Both have the formula** C_3H_6O**.**

a. Both compounds give an orange-red precipitate with 2,4-dinitrophenylhydrazine (Brady's reagent). What does this test show, and why can't it tell them apart? **[2]**

b. Write the equations for (i) the Clemmensen reduction of propanone, (ii) the addition of HCN to propanal, and (iii) the reduction of propanone with lithium aluminium hydride, naming each product. **[3]**

c. Choose one test that gives a positive result with propanone but not with propanal, and one that gives a positive result with propanal but not propanone. Give the observation for each, and explain why propanal fails the first test. **[3]**