Grade 12 Chemistry Model Paper 3

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, K = 39, Cr = 52, Fe = 56, $F = 96{,}485$ C mol^{-1} and $R = 8.314$ J K^{-1} mol^{-1}.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

Choose the correct option for each of the following questions.

a. How much water must be added to 200 mL of 0.5 N hydrochloric acid to make it 0.2 N?

(i) 100 mL (ii) 200 mL (iii) 300 mL (iv) 500 mL

b. A zero-order reaction has a rate constant of 0.02 mol L^{-1} min^{-1}. If the starting concentration is 0.8 mol/L, what is its half-life?

(i) 10 min (ii) 20 min (iii) 34.7 min (iv) 40 min

c. The cell Ni | Ni^{2+} || Cu^{2+} | Cu has $E^\circ_{cell} = 0.60$ V. What is the standard free energy change of its reaction, $Ni + Cu^{2+} \longrightarrow Ni^{2+} + Cu$?

(i) −57.9 kJ (ii) −115.8 kJ (iii) +115.8 kJ (iv) −231.6 kJ

d. Which of these is a Lewis acid but not a Brønsted–Lowry acid?

(i) NH_3 (ii) BF_3
(iii) HCl (iv) OH^-

e. What is the chief ore of mercury?

(i) calamine (ii) argentite (iii) cinnabar (iv) malachite

f. Why are transition metals and their compounds good catalysts?

(i) They have very high melting points.
(ii) They are always colored.
(iii) They can change their oxidation states easily and provide a surface on which reactants are adsorbed.
(iv) They raise the activation energy of the reaction.

g. In the Hell–Volhard–Zelinsky reaction, a carboxylic acid with an α-hydrogen is treated with which reagents?

(i) zinc amalgam and concentrated hydrochloric acid
(ii) chlorine (or bromine) with a little red phosphorus
(iii) soda lime, heated
(iv) lithium aluminium hydride

h. Ethanoic acid fizzes with sodium hydrogencarbonate solution, but phenol does not. Why?

(i) Phenol is not acidic at all.

(ii) Phenol is insoluble in water.

(iii) Phenol is a weaker acid than carbonic acid, so it cannot set carbon dioxide free from a hydrogencarbonate.

(iv) Phenol reacts with sodium hydrogencarbonate to form a precipitate.

i. Teflon (PTFE) is used to coat non-stick frying pans. Which property makes it suitable?

(i) It is a condensation polymer that softens on heating.

(ii) Its C–F bonds are very strong, so it is chemically inert and stable when heated, and food does not stick to it.

(iii) It conducts heat better than metals.

(iv) It is a natural polymer that is easily digested.

j. Cobalt-60 is used in hospitals to treat cancer. Which property of its radiation makes it useful?

(i) It gives out alpha particles, which travel far through the body.

(ii) It gives out penetrating gamma rays, which can be aimed at a tumor from outside the body.

(iii) Its radiation makes the cancer cells radioactive so that they can be seen.

(iv) It gives out neutrons that turn the tumor into stable atoms.

k. Ordinary paper tears easily when wet, but a kitchen paper towel must soak up water and still hold together. Which treatment of the pulp would best give a towel this wet strength?

(i) More rosin and alum sizing, so that the towel keeps water out.

(ii) A resin that joins neighboring fibers by covalent bonds, which water cannot break.

(iii) Beating the pulp longer, so that the fibers are cut shorter.

(iv) Leaving more lignin in the fibers, so that the towel is browner.

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

Question 2 — 5 marks

Prashant studies the hydrogenation of ethene:

$$CH_2{=}CH_2\,(g) + H_2\,(g) \longrightarrow CH_3{-}CH_3\,(g)$$

The same reaction on the C=C bonds of vegetable oils hardens them into vanaspati ghee. Average bond enthalpies (kJ mol^{-1}): C=C 612, H–H 436, C–C 347, C–H 413.

a. Define bond enthalpy. **[1]**

b. Calculate the enthalpy change of the reaction from the bond enthalpies. **[2]**

c. The value found from enthalpies of formation is -136 kJ mol^{-1}. Which of the two values is the more reliable for this reaction, and why does the value from bond enthalpies differ from it? **[2]**

OR

Sneha reads that hydrogen–oxygen fuel cells powered the Apollo spacecraft and now run some buses. In the cell, hydrogen and oxygen react through potassium hydroxide solution between porous electrodes: $2\,H_2\,(g) + O_2\,(g) \longrightarrow 2\,H_2O\,(l)$, $E^\circ_{\text{cell}} = 1.23$ **V.**

a. What is a fuel cell? **[1]**

b. Write the reactions at the anode and the cathode. **[2]**

c. Calculate the standard free energy change for each mole of hydrogen used, and explain why a fuel cell can turn more of the fuel's energy into useful work than an engine burning the same hydrogen. **[2]**

Question 3 — 5 marks

Nirjala learns that the sting of a red ant contains methanoic (formic) acid, HCOOH, a weak acid with $K_a = 1.8 \times 10^{-4}$ at 25 °C.

a. What is a conjugate acid–base pair? Give the pair formed when methanoic acid gives a proton to water. **[1]**

b. Calculate the pH of a 0.10 M solution of methanoic acid. **[2]**

c. The solution is diluted 100 times, to 0.0010 M. Find the degree of ionization before and after diluting, and explain the change with Ostwald's dilution law. **[2]**

Question 4 — 5 marks

Pasang's grandfather tells him about the old copper mines of the hills, where copper was smelted from yellow copper pyrites.

a. Write the formula of copper pyrites and name the method by which this ore is concentrated. **[2]**

b. During smelting, silica is added to the roasted ore. Why? Give the equation. **[1]**

c. In the Bessemer converter no carbon is added, yet the matte (Cu_2S) gives copper metal. Write the equations for this self-reduction, and use oxidation numbers to show which element is reduced and which substance is the reducing agent. **[2]**

Question 5 — 5 marks

Copper sulphate solution turns deep blue when ammonia solution is added in excess, forming $[Cu(NH_3)_4]SO_4$.

a. Write the IUPAC name of $[Cu(NH_3)_4]SO_4$ and the coordination number of copper in it. **[2]**

b. Find the oxidation state of cobalt in $[Co(NH_3)_5Cl]Cl_2$. **[1]**

c. Both $[Ni(CN)_4]^{2-}$ and $[NiCl_4]^{2-}$ contain nickel(II), $3d^8$, with four ligands, but the first is square planar and the second tetrahedral. Which of them is paramagnetic? Calculate its spin-only magnetic moment. **[2]**

Question 6 — 5 marks

Milan treats bromoethane with alcoholic potassium cyanide in one flask and with silver cyanide in another.

a. What is an ambident nucleophile? Give one example. **[1]**

b. Write the equations for the two reactions and name the organic products. **[2]**

c. Explain why the two cyanides give different products. **[2]**

OR

Benzoic acid, as its salt sodium benzoate, is used to preserve fruit juices and sauces.

a. Write the structural formula of benzoic acid, and the name of the reagent that turns toluene into it. **[1]**

b. Write the equations for (i) the preparation of benzoic acid from toluene and (ii) the heating of sodium benzoate with soda lime. **[2]**

c. Benzoic acid is nitrated with difficulty, and gives 3-nitrobenzoic acid. Explain both the difficulty and the position. **[2]**



Question 7 — 5 marks

Isha's teacher nitrates benzene in a fume hood with a mixture of concentrated nitric and sulphuric acids, keeping the temperature below 60 °C.

a. Chlorobenzene nitrated in the same way gives two main products. Write the IUPAC name of the major one. **[1]**

b. Explain, with equations, the role of concentrated sulphuric acid in the nitrating mixture. **[2]**

c. A nitroalkane X, $C_4H_9NO_2$, does not dissolve in sodium hydroxide solution, while its isomer 1-nitrobutane does. Identify X and explain. **[2]**

Question 8 — 5 marks

Kushal heats ethanol with concentrated sulphuric acid and gets a different product at each of two temperatures.

a. Zeise's salt, one of the first organometallic compounds made, contains ethene bonded to platinum. Write its formula. **[1]**

b. Write the equations for heating ethanol with concentrated sulphuric acid (i) in excess at 140 °C (413 K) and (ii) at 170 °C (443 K), and name the products. **[2]**

c. Ethoxyethane (b.p. 35 °C) boils far lower than its isomer butan-1-ol (b.p. 117 °C), yet the two dissolve in water to about the same extent. Explain both facts. **[2]**

Question 9 — 5 marks

Suhana visits a cement plant in Dang, where limestone is quarried nearby, and reads about the plastics, medicines and isotopes used at a hospital in Nepalgunj.

a. Name the two main raw materials of Portland cement. **[1]**

b. Explain the difference between the dry and wet processes of making cement, and why almost every new plant uses the dry process. **[2]**

c. A hospital receives a sample of iodine-131, whose half-life is 8 days. What fraction of it is left after 24 days? **[1]**

d. A nylon-6,6 rope and a polythene sheet are both left for weeks in warm dilute acid. The rope slowly weakens, while the sheet is unchanged. Give the chemical reason. **[1]**

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

Question 10 — 8 marks

Ankit measures the initial rate of a reaction $A + B \longrightarrow$ products **at 25 °C:**

Experiment	[A] (mol/L)	[B] (mol/L)	Initial rate (mol L^{-1} s^{-1})
1	0.10	0.10	2.0×10^{-3}
2	0.20	0.10	8.0×10^{-3}
3	0.10	0.20	4.0×10^{-3}

a. Explain, using collision theory, why only a small fraction of collisions lead to reaction, and why a rise of 10 °C often doubles the rate. **[3]**

b. Find the order with respect to A and to B, write the rate law, and calculate the rate constant with its unit. **[3]**

c. A and B are both gases. By what factor does the rate change if (i) the volume of the vessel is suddenly halved at the same temperature, and (ii) instead, argon is pumped in at the same volume and temperature until the total pressure is doubled? Explain. **[2]**

OR

Sapana standardizes a potassium dichromate solution. She dissolves 3.92 g of Mohr's salt, $(NH_4)_2Fe(SO_4)_2 \cdot 6\,H_2O$ (M = 392), in dilute sulphuric acid and makes it up to 250 mL. 25.0 mL of this solution needs 20.0 mL of the dichromate solution, with diphenylamine as indicator.

a. Why is Mohr's salt chosen as the primary standard rather than iron(II) sulphate crystals, why is the solution made in dilute sulphuric acid, and why is an indicator needed here though none is needed with potassium permanganate? **[3]**

b. Calculate the normality of the Mohr's salt solution, the normality of the dichromate solution and its strength in grams per liter ($K_2Cr_2O_7$, M = 294). **[3]**

c. Write the balanced ionic equation for the titration. Her partner made the Mohr's salt solution in plain water and left it in an open flask for a week before titrating it. Would the normality of the dichromate they found be too high or too low? Explain. **[2]**

Question 11 — 8 marks

Rakshya's laboratory has a mixture of the three ethylamines made by heating bromoethane with ammonia.

a. Explain how Hofmann's method separates the primary, secondary and tertiary amines of such a mixture. **[3]**

b. Write the equations for preparing ethanamine (i) by reducing ethanenitrile and (ii) from bromoethane and ammonia. **[2]**

c. An amine X, C_3H_9N, gives a yellow oily liquid that does not dissolve, and no gas, with cold nitrous acid. Identify X, and write the equation for the reaction. **[3]**

Question 12 — 8 marks

Nima compares aromatic carbonyl compounds made from toluene and benzene.

a. The C=O group adds nucleophiles, while the C=C group of an alkene adds electrophiles. Explain the difference. **[2]**

b. Write the equations for (i) preparing benzaldehyde from toluene by the Étard reaction, (ii) preparing benzaldehyde from benzoyl chloride by the Rosenmund reduction, and (iii) the benzoin condensation of benzaldehyde. **[3]**

c. A compound P, C_8H_8O, gives an orange precipitate with 2,4-dinitrophenylhydrazine and a yellow precipitate with iodine and sodium hydroxide, but no silver mirror with Tollens' reagent. On vigorous oxidation it gives benzoic acid. Identify P and explain each observation. **[3]**

OR

Sangam compares the acid strengths of ethanoic acid and its halogenated derivatives.

a. The C=O group of a carboxylic acid does not give the addition reactions of aldehydes and ketones (it gives no 2,4-DNP precipitate, for example). Explain. **[2]**

b. Write the equations for the reactions of ethanoic acid with (i) sodium hydrogencarbonate and (ii) thionyl chloride, and (iii) for heating sodium ethanoate with soda lime. **[3]**

c. Arrange CH_3COOH, CH_3CH_2COOH, $ClCH_2COOH$ and FCH_2COOH in increasing order of acid strength, and explain the order. **[3]**