Grade 11 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 2077, Grade 11 Chemistry (Che. 301); 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 NEB's Grade 11 Chemistry paper (Che. 301): 75 marks in 3 hours. Question 1 is group A, 11 multiple-choice items; questions 2 to 9 are group B and questions 10 to 12 group C, each of two to four parts with the marks of each part. Questions 2 and 4 in group B and Question 11 in group C have an OR question: answer either one. Take $N\mathrm{A} = 6.022 \times 10^{23}$ per mol, the molar volume of a gas at STP as 22.4 L, $R = 0.0821$ L atm/(mol K) and 1 F = 96,500 C; atomic masses are given where a question needs them. Write your answers on paper as in the exam hall, then tap your choice in group A, open each other part's answer and give yourself the marks its scheme allows.

Group A Multiple choice — 11 marks

Question 1 — 11 × 1 = 11

Choose the correct option for each of the following questions.

a. According to the modern periodic law, the properties of the elements are periodic functions of their

(i) atomic masses (ii) atomic numbers

(iii) numbers of neutrons (iv) densities

b. What is the hybridization of each carbon atom in ethyne, HC≡CH?

(i) sp (ii) sp^2 (iii) sp^3 (iv) sp^3d

c. A catalyst is added to a reaction mixture that is already at equilibrium. What happens?

(i) The equilibrium shifts towards the products.

(ii) The equilibrium shifts towards the reactants.

(iii) The equilibrium constant increases.

(iv) The amounts don't change; both reactions speed up equally.

d. What is the oxidation number of chromium in potassium dichromate, $K_2Cr_2O_7$?

(i) +3 (ii) +5 (iii) +6 (iv) +7

e. What is the percentage of nitrogen by mass in urea, $CO(NH_2)_2$? (C = 12, O = 16, N = 14, H = 1)

(i) 23.3% (ii) 28.0% (iii) 46.7% (iv) 63.6%

f. Why are the alkali metals strong reducing agents?

(i) They lose their single outer electron very easily (low ionization energy).

(ii) They have high densities.

(iii) They have high electron affinities.

(iv) They form covalent compounds.

g. Nitric oxide from the engines of high-flying aircraft also destroys ozone in the stratosphere, in two steps: $NO + O_3 \longrightarrow NO_2 + O_2$, then $NO_2 + O \longrightarrow NO + O_2$. What does this show about nitric oxide?

(i) Each NO molecule can destroy only one ozone molecule.

(ii) It is made again in the second step, so it acts as a catalyst.

(iii) NO protects the ozone layer by joining with it to form NO_2.

(iv) It is a product formed when ozone breaks down.

h. What is the first stage in developing a new product?

(i) Test marketing (ii) Business analysis

(iii) Commercialization (iv) Idea generation

i. In the contact process, the sulphur dioxide made from pyrite is passed over moist iron(III) hydroxide before it reaches the catalyst. Why?

(i) To remove arsenic oxide, which would poison the vanadium(V) oxide catalyst

(ii) To dry the sulphur dioxide

(iii) To oxidize the sulphur dioxide to sulphur trioxide

(iv) To cool the gas before it enters the contact chamber

j. Which of these is an advantage of urea over other nitrogenous fertilizers?

(i) It does not absorb moisture from the air.

(ii) It can be left on the surface of moist soil without any loss of nitrogen.

(iii) It contains phosphorus as well as nitrogen.

(iv) It has the most nitrogen of any solid nitrogen fertilizer.

k. Urea is made from ammonia and carbon dioxide: $2\,NH_3 + CO_2 \longrightarrow CO(NH_2)_2 + H_2O$. What is the greatest mass of urea that 17 tonnes of ammonia can give? (N = 14, H = 1, C = 12, O = 16)

(i) 8.5 tonnes (ii) 17 tonnes (iii) 30 tonnes (iv) 60 tonnes

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

Question 2 — 5 marks

Iron (Z = 26) and chromium (Z = 24) are transition metals of the fourth period.

a. State the Aufbau principle and Hund's rule of maximum multiplicity. **[2]**

b. Write the electronic configuration of the Fe^{3+} ion. **[1]**

c. By the Aufbau order, chromium should be [Ar] $4s^2\,3d^4$, but it is [Ar] $4s^1\,3d^5$. Explain why. Use the same idea to say why iron(II) compounds slowly turn into iron(III) compounds in air. **[2]**

OR

The electron affinities of the Group 16 elements, in kJ/mol (energy released), are: oxygen 141, sulphur 200, selenium 195, tellurium 190.

a. Define electron affinity. How does it generally change down a group? **[2]**

b. Calculate the energy released when 1.6 g of gaseous sulphur atoms each gain one electron. (S = 32) **[1]**

c. Explain why the values fall from sulphur to tellurium, and yet oxygen, the smallest atom of the group, releases the least energy of all four. **[2]**

Question 3 — 5 marks

Sujan copper-plates a key in his school laboratory. The key is one electrode and a strip of copper the other, both dipped in copper sulphate solution, and a current of 1.5 A is passed for 40 minutes. (Cu = 63.5)

a. State Faraday's first law of electrolysis. **[1]**

b. Calculate the mass of copper deposited on the key. **[2]**

c. Which electrode must the key be, and why? During the plating the copper strip gets thinner, but the blue color of the solution stays the same. Explain. **[2]**

Question 4 — 5 marks

How the atoms of a molecule are bonded decides its shape, and its shape and bonds decide how strongly the molecules hold one another.

a. Explain, with the ammonium ion as an example, how a coordinate covalent bond is formed. **[2]**

b. Use VSEPR theory to predict the shapes and bond angles of BF_3 and H_2O. **[2]**

c. Ethanol, CH_3CH_2OH, and methoxymethane, $CH_3–O–CH_3$, have the same molecular formula, C_2H_6O, and almost the same size. Yet ethanol is a liquid that boils at 78 °C, while methoxymethane is a gas that boils at −24 °C. Explain. **[1]**

OR

Pasang notices that a party balloon filled with hydrogen goes flat sooner than one blown up with air.

a. State Graham's law of diffusion, and explain why a lighter gas diffuses faster. **[2]**

b. A certain volume of oxygen takes 80 s to diffuse through a small hole. How long will the same volume of hydrogen take under the same conditions? (H = 1, O = 16) **[2]**

c. Explain why Pasang's hydrogen balloon goes flat sooner than the air-filled one. **[1]**

Question 5 — 5 marks

Hydrogen releases more energy for its mass than any other fuel. In a hydrogen–oxygen fuel cell it reacts with oxygen to give electricity and water.

a. What are isotopes? **[1]**

b. Heavy water, D_2O, and ordinary water, H_2O, have the same chemical properties but different physical properties. Why? **[1]**

c. Burning 1 g of hydrogen gives about 143 kJ, and 1 g of petrol about 50 kJ. What mass of petrol gives the same heat as 2.0 kg of hydrogen? **[1]**

d. Anjila argues that hydrogen fuel-cell buses would cut both Kathmandu's air pollution and Nepal's spending on imported fuel. Her friend replies that most of the world's hydrogen is made from natural gas, so the buses would help with neither. Judge both claims, with reasons. **[2]**

Question 6 — 5 marks

Patients with severe diarrhea are given oral rehydration solution (ORS), which contains both salt and glucose dissolved in clean water.

a. What are micronutrients and macronutrients? Give one example of each. **[2]**

b. A family has no ORS packet and gives a child with diarrhea plain salt water; another family, short of water, dissolves a 1-litre ORS packet in only a quarter of a litre. Explain why each drink rehydrates the child poorly. **[2]**

c. Every winter in Nepal some people are poisoned in closed rooms with a charcoal stove burning. Carbon monoxide binds to the iron of hemoglobin about 200 times more strongly than oxygen does, yet the first treatment is to give the patient pure oxygen to breathe. Explain why pure oxygen helps. **[1]**

Question 7 — 5 marks

Asmita wants to know whether an unknown organic compound contains nitrogen, sulphur or a halogen. She fuses it with sodium metal and makes the sodium extract (Lassaigne's extract).

a. Why is the organic compound fused with sodium? **[1]**

b. The extract, made acidic with dilute nitric acid and boiled, gives a white precipitate with silver nitrate that dissolves easily in dilute ammonia. Which halogen is present? Write the equations for its conversion into the sodium salt during fusion and for the formation of the precipitate. **[2]**

c. Asmita tests a second compound. Its extract, made acidic with dilute nitric acid but **not** boiled, gives a white precipitate with silver nitrate. A fresh portion, boiled with dilute nitric acid before the silver nitrate is added, gives no precipitate. What do these results show about the elements in the second compound? Explain. **[2]**

Question 8 — 5 marks

Alkanes can be made from the sodium salts of carboxylic acids in two different ways.

a. What is decarboxylation? Name the reagent used to decarboxylate the sodium salt of a carboxylic acid. **[2]**

b. Write the equations for making ethane (i) by heating sodium propanoate with soda lime and (ii) by Kolbe's electrolysis of sodium ethanoate. **[2]**

c. Cetane, hexadecane, $CH_3(CH_2)_{14}CH_3$, is the standard of a good diesel fuel, with cetane number 100. Would it make a good petrol? Give a reason. **[1]**

Question 9 — 5 marks

Yangchen's uncle grows vegetables near a pond in Chitwan. Each season he spreads 100 kg of an NPK fertilizer marked 20 : 20 : 10 and, to be sure, 50 kg of urea as well. After the monsoon the pond turns green and its fish die.

a. What do the numbers 20 : 20 : 10 on the sack mean? **[1]**

b. Explain any two characteristics of a good fertilizer. **[2]**

c. His crop needs about 25 kg of nitrogen in a season. Calculate the nitrogen he adds (urea is 46% nitrogen), and use your answer to explain why the pond turned green and its fish died. **[2]**

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

Question 10 — 8 marks

Prapti analyzes the acid of vinegar in her school laboratory. It contains 40.0% carbon, 6.7% hydrogen and 53.3% oxygen by mass, and its vapor density is 30. (C = 12, H = 1, O = 16)

a. How does an empirical formula differ from a molecular formula? **[1]**

b. Calculate the empirical formula of the acid. **[2]**

c. Find its molecular formula. **[2]**

d. When 6.0 g of the acid burns completely, the carbon dioxide formed measures 4.48 L at STP. Prapti's partner says that the oxygen used, measured at 27 °C and 1 atm, must also be 4.48 L, "because the equation uses as many moles of oxygen as of carbon dioxide". Write the balanced equation for the combustion, and judge the claim with a calculation. **[3]**

Question 11 — 8 marks

Zinc is extracted from zinc blende, ZnS, an ore that holds only a few percent of the mineral mixed with rock.

a. Explain how froth flotation concentrates a sulphide ore like zinc blende. **[3]**

b. The concentrated zinc blende is roasted, not calcined. Why? **[1]**

c. Write the balanced equations for the roasting of zinc blende and for the reduction of the product with coke. **[2]**

d. Sodium can't be extracted by reducing its compounds with coke, nor by electrolyzing an aqueous solution of sodium chloride. Explain both, and say how it is extracted. **[2]**

OR

In many villages of Nepal, lime (*chuna*) is made by heating limestone in a kiln. Quicklime is then slaked with water to make the whitewash used on walls.

a. Write the equations for making quicklime from limestone and for slaking it. Why does the kiln have to be very hot, and why does a heap of quicklime get hot when water is poured on it? **[3]**

b. Carbon dioxide bubbled through a clear solution of slaked lime (limewater) turns it milky. Why? **[1]**

c. Write the balanced equations for making (i) bleaching powder from slaked lime and (ii) plaster of Paris from gypsum. **[2]**

d. A farmer spreads agricultural lime on acidic soil. Why does this help? His neighbor mixes the lime with ammonium sulphate fertilizer before spreading it. Is that wise? Give a reason. **[2]**

Question 12 — 8 marks

Organic reactions happen when covalent bonds break and new ones form. Methane reacts with chlorine in sunlight, and the strength of an acid like ethanoic acid changes when atoms are swapped in its molecule.

a. Explain homolytic and heterolytic fission of a covalent bond, with one example of each. **[3]**

b. Write the equations for the initiation step and the two propagation steps of the reaction of methane with chlorine in sunlight. **[2]**

c. Chloroethanoic acid, $ClCH_2COOH$, is a stronger acid than ethanoic acid, CH_3COOH, and methanoic acid, HCOOH, is stronger than ethanoic acid. Explain both with the inductive effect. **[2]**

d. Toluene, $C_6H_5CH_3$, is nitrated faster than benzene, and the nitro group goes mainly to the ortho and para positions. Why? **[1]**