

IGCSE Chemistry 0620 Paper 4 (Extended) Mock Paper (10 questions, 75 marks)

IGCSE (Year 10-11) Chemistry | 時限：75 分鐘 | 總分：75 分 | 共 10 題

All questions (75 marks) — Questions 1 to 10

Answer ALL questions. Write your answers in the spaces provided and show all working in calculations.

1. 25.0 g of pure calcium carbonate (CaCO_3 , $\text{Mr} = 100$) is heated and decomposes: $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$. (a) Calculate the number of moles of CaCO_3 . (b) Calculate the volume of CO_2 formed at room temperature and pressure (1 mol of gas = 24.0 dm^3). (c) Calculate the mass of CaO formed ($\text{Mr}(\text{CaO}) = 56$).

答案：(a) $n = 25.0 / 100 = 0.250 \text{ mol}$. [2] (b) The mole ratio is 1:1, so $\text{CO}_2 = 0.250 \text{ mol}$ and volume = $0.250 \times 24.0 = 6.00 \text{ dm}^3$. [2] (c) $\text{CaO} = 0.250 \text{ mol}$, mass = $0.250 \times 56 = 14.0 \text{ g}$. [2]

2. Aqueous copper(II) sulfate is electrolysed using copper electrodes. A current of 2.0 A flows for 30.0 minutes (1 faraday = 96,500 C). (a) Calculate the quantity of charge passed in coulombs. (b) Calculate the number of moles of electrons. (c) Calculate the mass of copper deposited at the cathode ($\text{Cu} = 63.5$). (d) Calculate the volume of oxygen released at the anode at room temperature and pressure, in cm^3 .

答案：(a) $Q = I \times t = 2.0 \times 1,800 = 3600 \text{ C}$. [2] (b) $n(e^-) = 3600 / 96,500 = 0.0373 \text{ mol}$. [2] (c) $\text{Cu}^{2+} + 2e^- \rightarrow \text{Cu}$, so $n(\text{Cu}) = 0.0373 / 2 = 0.0187 \text{ mol}$ and mass = $0.0187 \times 63.5 = 1.18 \text{ g}$. [2] (d) $4\text{OH}^- \rightarrow \text{O}_2 + 2\text{H}_2\text{O} + 4e^-$, so $n(\text{O}_2) = 0.0373 / 4 = 0.0093 \text{ mol}$ and volume = $0.0093 \times 24,000 = 224 \text{ cm}^3$. [2]

3. Marble chips are added to excess dilute hydrochloric acid and the volume of carbon dioxide collected is measured: 0 s: 0 cm^3 , 20 s: 48 cm^3 , 40 s: 90 cm^3 , 60 s: 120 cm^3 (reaction complete). (a) Calculate the average rate over the first 20 s in cm^3/s . (b) Calculate the average rate between 20 s and 40 s in cm^3/s . (c) Explain why the rate decreases with time. (d) Suggest two ways to increase the initial rate without changing the amounts of reactants used.

答案：(a) Rate = $48 / 20 = 2.4 \text{ cm}^3/\text{s}$. [2] (b) Rate = $(90 - 48) / 20 = 2.1 \text{ cm}^3/\text{s}$. [2] (c) As the reaction proceeds the concentration of the acid falls, so there are fewer collisions between reacting particles per unit time and the rate decreases. [2] (d) Raise the temperature; grind the marble into a finer powder to increase the surface area (also: use more concentrated acid). [2]

4. 25.0 cm^3 of 0.100 mol/dm^3 sodium hydroxide solution is titrated with hydrochloric acid of unknown concentration; 20.0 cm^3 of the acid is needed to reach the end-point. (a) Calculate the number of moles of NaOH . (b) Calculate the concentration of the acid in mol/dm^3 . (c) Calculate the mass of HCl in that 20.0 cm^3 of acid ($\text{Mr} = 36.5$). (d) Name a suitable indicator and state the colour change at the end-point.

答案：(a) $n(\text{NaOH}) = 25.0 / 1000 \times 0.100 = 2.50 \times 10^{-3} \text{ mol}$. [2] (b) $\text{NaOH} + \text{HCl} \rightarrow \text{NaCl} + \text{H}_2\text{O}$, ratio 1:1, so $c(\text{HCl}) = 2.50 \times 10^{-3} / 0.0200 = 0.125 \text{ mol/dm}^3$. [2] (c) Mass = $2.50 \times 10^{-3} \times 36.5 = 0.0913 \text{ g}$. [2] (d) Phenolphthalein, pink to colourless (methyl orange would go yellow to orange). [2]

5. 1.00 g of ethanol is burned and the heat released raises the temperature of 200 g of water by 12.0 ° C (specific heat capacity of water = 4.2 J/(g · ° C), Mr(C₂H₅OH) = 46). (a) Calculate the heat absorbed by the water in kJ. (b) Calculate the number of moles of ethanol. (c) Calculate the enthalpy of combustion ΔH in kJ/mol. (d) Explain why the experimental value is lower than the data book value of 1,370 kJ/mol.

答案 : (a) $q = 200 \times 4.2 \times 12.0 = 10080 \text{ J} = 10.08 \text{ kJ}$. [2] (b) $n(\text{C}_2\text{H}_5\text{OH}) = 1.00 / 46 = 0.0217 \text{ mol}$. [2] (c) $\Delta H = -10.08 / 0.0217 = -463.7 \text{ kJ/mol}$. [2] (d) Some heat is lost to the surroundings and used to heat the apparatus rather than the water, and combustion may be incomplete, so the measured value is too low. [1]

6. Consider ethanol (C₂H₅OH) and ethanoic acid (CH₃COOH). (a) Name the homologous series each belongs to and the functional group each contains. (b) Write the equation, with conditions, for making ethanol by fermentation of glucose. (c) Ethanol reacts with ethanoic acid with concentrated sulfuric acid as catalyst: name the product and give its molar mass. (d) Describe a chemical test to distinguish an alkene from an alkane, including the observation.

答案 : (a) Ethanol is an alcohol (functional group –OH, hydroxyl); ethanoic acid is a carboxylic acid (functional group –COOH, carboxyl). [2] (b) $\text{C}_6\text{H}_{12}\text{O}_6 \rightarrow 2\text{C}_2\text{H}_5\text{OH} + 2\text{CO}_2$; conditions: yeast (enzymes), about 25 – 35 ° C, absence of air. [2] (c) Ethyl ethanoate, CH₃COOC₂H₅, Mr = 60 + 46 – 18 = 88. [2] (d) Add bromine water and shake: an alkene decolourises the orange-brown bromine water (addition reaction) while an alkane gives no reaction and the colour stays. [2]

7. 2.4 g of magnesium burns in oxygen to form magnesium oxide (Ar(Mg) = 24, Mr(MgO) = 40). (a) Calculate the number of moles of magnesium. (b) Calculate the mass of MgO formed. (c) State the type of bonding in MgO and explain why molten MgO conducts electricity.

答案 : (a) $n(\text{Mg}) = 2.4 / 24 = 0.10 \text{ mol}$. [2] (b) $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$, ratio 1:1, so mass = $0.10 \times 40 = 4.0 \text{ g}$. [3] (c) MgO is ionic: each magnesium atom loses two electrons to form Mg²⁺ and each oxygen atom gains two electrons to form O²⁻, held in a giant ionic lattice by electrostatic attraction; when molten the ions are free to move and carry charge, so it conducts. [2]

8. Dry air is about 21% oxygen and 78% nitrogen by volume. A sample of 250 cm³ of dry air is taken. (a) Calculate the volume of oxygen in cm³. (b) Calculate the volume of nitrogen in cm³. (c) Give the test for carbon dioxide and its observation. (d) Name two air pollutants and their main sources.

答案 : (a) $250 \times 21\% = 52.5 \text{ cm}^3$. [2] (b) $250 \times 78\% = 195.0 \text{ cm}^3$. [2] (c) Bubble the gas through limewater (calcium hydroxide solution): the limewater turns milky/cloudy. [2] (d) Carbon monoxide from car exhaust and incomplete combustion; sulfur dioxide from burning sulfur-containing fuels (power stations, industry); oxides of nitrogen from high-temperature combustion in engines. (any two) [2]

9. In a blast furnace, iron(III) oxide is reduced by carbon monoxide: $\text{Fe}_2\text{O}_3 + 3\text{CO} \rightarrow 2\text{Fe} + 3\text{CO}_2$ ($\text{Mr}(\text{Fe}_2\text{O}_3) = 160$, $\text{Ar}(\text{Fe}) = 56$). (a) State the change in oxidation number of iron in this reaction. (b) Calculate the mass of iron, in tonnes, that can be extracted from 100 tonnes of ore containing 80% Fe_2O_3 . (c) State two functions of coke in the blast furnace.

答案：(a) Iron is +3 in Fe_2O_3 and 0 in Fe, so it is reduced (oxidation number falls from +3 to 0). [2] (b) Pure $\text{Fe}_2\text{O}_3 = 100 \times 80\% = 80$ tonnes; 160 tonnes of Fe_2O_3 gives $2 \times 56 = 112$ tonnes of iron, so iron = $80 \times 112 / 160 = 56$ tonnes. [3] (c) Coke burns to provide heat, and the CO_2 formed reacts with more coke to produce CO, which acts as the reducing agent. [2]

10. The Haber process: $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$ ($\text{Mr}(\text{N}_2) = 28$, $\text{Mr}(\text{NH}_3) = 17$). (a) State the temperature, pressure and catalyst used industrially. (b) Calculate the mass of ammonia, in g, obtained from 28 g of nitrogen reacting completely. (c) Calculate the percentage by mass of nitrogen in ammonium nitrate (NH_4NO_3 , $\text{Mr} = 80$). (d) Explain how the overuse of nitrogenous fertilisers causes water pollution.

答案：(a) About 450°C , about 200 atm, iron catalyst (with oxide promoters). [3] (b) $n(\text{N}_2) = 28 / 28 = 1$ mol; ratio 1:2, so $n(\text{NH}_3) = 2$ mol and mass = $2 \times 17 = 34$ g. [2] (c) Percentage of nitrogen = $28 / 80 \times 100\% = 35\%$. [1] (d) Fertilisers dissolve in rain and are washed into rivers and lakes, raising the nitrate concentration; algae grow rapidly (eutrophication), and when they die bacteria decompose them and use up the dissolved oxygen, so fish die from lack of oxygen. [2]