GCSE CHEMISTRY

Practice Paper 5 - Higher Tier (Unofficial)

Time Allowed: 1 hour 45 minutes
Total Marks: 100

INSTRUCTIONS TO STUDENTS

- Use black ink or black ball-point pen.
- Fill in the boxes at the top of this page with your details if required.
- Answer all questions in the spaces provided.
- Do all rough work in this book. Cross through any work you do not want to be marked.
- In all calculations, show clearly how you work out your answer.
- A Periodic Table is provided as a separate insert if required.
- Calculators may be used.

Information for Candidates

This practice paper is designed to support student revision for the GCSE Chemistry examinations. It contains questions covering atomic structure and the periodic table, bonding and properties, quantitative chemistry, chemical changes, and energy changes. The marks for individual questions and parts of questions are shown in round brackets.

Turn over →

Question 1 [16 Marks]

The periodic table is structured based on the properties and electronic configurations of the elements.

(a) Compare the physical and chemical properties of transition metals with Group 1 (alkali) metals. In your answer, you must give at least two physical and two chemical differences, and identify one industrial application of transition metals that Group 1 metals do not share. **(6)**

(b) Iron (atomic number = 26) and zinc (atomic number = 30) are transition metals.

(i) Write the electronic configuration (number of electrons in each shell) for an iron atom (Fe). **(2)**

(ii) Write the electronic configuration (number of electrons in each shell) for a zinc atom (Zn). **(2)**

(c) Explain the trends in boiling point and density down Group 0 (the noble gases). Your explanation should refer to the atomic structure, atomic size, and the nature of the forces between the atoms. **(6)**

GCSE CHEMISTRY

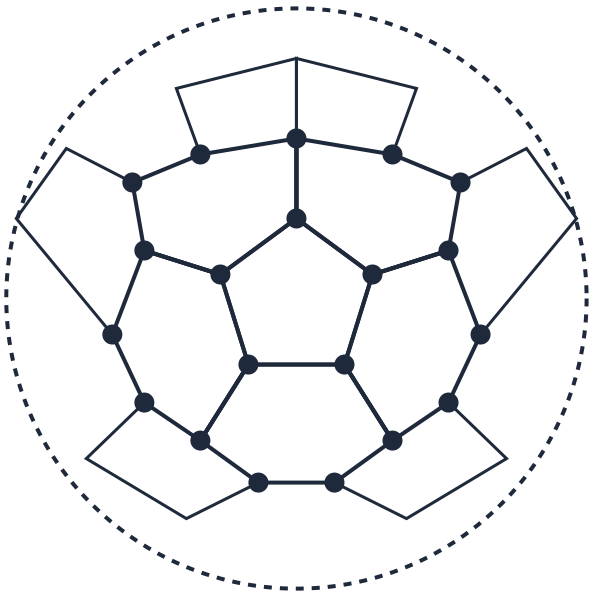
Practice Paper 5 - Higher Tier

Question 2 [22 Marks]

Carbon forms a variety of allotropes, including fullerenes and carbon nanotubes, which have unique structures and properties.

(a) Describe the structure and bonding in a carbon nanotube. Explain how this structure relates to its high tensile strength and high electrical conductivity. **(6)**

(b) Describe the structure of Fullerene C60. Explain why Fullerene C60 has a lower melting point than diamond, even though both substances are allotropes of carbon. **(6)**



(c) Compare the potential technological uses of carbon nanotubes and fullerenes, giving one specific application for each and explaining how the properties of the substance make it suitable for that application. **(4)**

(d) Pure copper is relatively soft and malleable. Brass is an alloy made of copper and zinc. Explain, in terms of structure and bonding, why brass is harder and less malleable than pure copper. **(6)**

Question 3 [25 Marks]

Magnesium reacts with aqueous copper(II) sulfate in a displacement reaction to form magnesium sulfate solution and copper metal. The balanced chemical equation is:

$Mg(s) + CuSO_4(aq) \rightarrow MgSO_4(aq) + Cu(s)$

(a) State two visual observations that would confirm that this displacement reaction is taking place. **(2)**

(b) A student reacts 3.00 g of magnesium ribbon with 16.0 g of copper(II) sulfate ($CuSO_4$) in solution. Show by calculation which reactant is the limiting reactant, and calculate the maximum theoretical mass of copper metal (Cu) that could be produced. Give your answer to 3 significant figures. **(6)**
Relative atomic masses (Ar): Mg = 24.3; S = 32.1; O = 16.0; Cu = 63.5

(c) A student carries out a titration to determine the concentration of a sodium carbonate (Na_2CO_3) solution. **(6)**

The student titrates 25.0 cm^3 of the sodium carbonate solution against 22.4 cm^3 of 0.150 mol/dm^3 hydrochloric acid (HCl) to reach the end point.

The balanced equation for the reaction is:

$$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$$

Calculate the concentration of the sodium carbonate solution in mol/dm^3 and in g/dm^3. Give your answers to 3 significant figures.

Relative atomic masses (Ar): H = 1.0; C = 12.0; O = 16.0; Na = 23.0

(d) In the displacement reaction described in part (b), the student actually obtained 5.08 g of copper. Calculate the percentage yield of copper. Give your answer to 3 significant figures. **(3)**

(e) The student used a volumetric pipette with an uncertainty of +/- 0.06 cm3 to measure the 25.0 cm3 of sodium carbonate solution. Calculate the percentage uncertainty of this measurement. **(2)**

(f) Calculate the percentage atom economy for the reaction to produce sodium chloride (NaCl) as the desired product in the titration reaction. Give your answer to 3 significant figures. **(6)**

Equation: $Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + H_2O(l) + CO_2(g)$

Relative atomic masses (Ar): H = 1.0; C = 12.0; O = 16.0; Na = 23.0; Cl = 35.5

Question 4 [23 Marks]

Electrolysis can be used to decompose ionic compounds when they are molten or in aqueous solution.

(a) A student electrolyses aqueous copper(II) chloride ($CuCl_2$) using inert graphite electrodes.

(i) Write the balanced ionic half-equation, including state symbols, for the reaction that occurs at the anode (positive electrode). **(2)**

(ii) Write the balanced ionic half-equation, including state symbols, for the reaction that occurs at the cathode (negative electrode). **(2)**

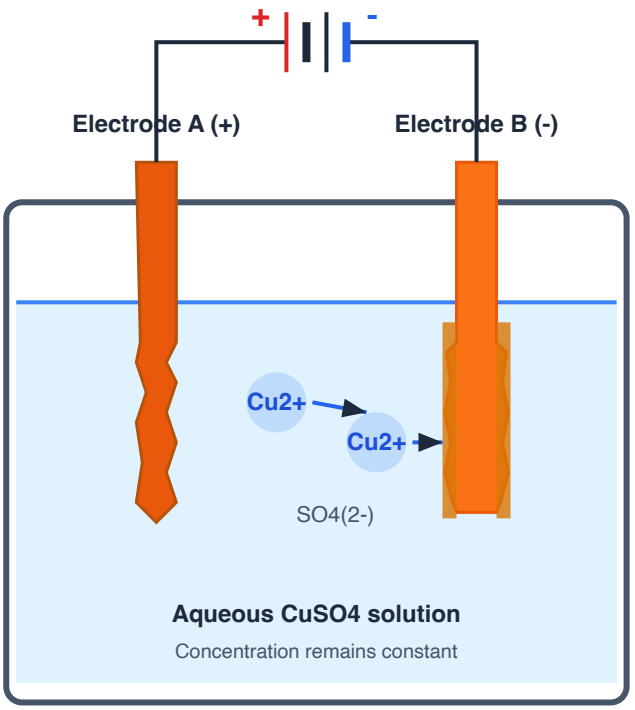
(iii) Explain why copper metal is deposited at the cathode rather than hydrogen gas, and why chlorine gas is produced at the anode rather than oxygen gas. Refer to the reactivity series of metals and the rules of selective discharge in aqueous solutions. **(4)**

(b) Acids release hydrogen ions (H+) when dissolved in water. The concentration of H+ ions determines the pH of a solution.

(i) Hydrochloric acid (HCl) is a strong acid, whereas ethanoic acid (CH3COOH) is a weak acid. Explain what is meant by 'strong acid' and 'weak acid' in terms of dissociation or ionisation. **(2)**

(ii) Show mathematically how a decrease of 1.0 unit on the pH scale corresponds to a tenfold increase in the concentration of hydrogen ions [H+] in the solution. You must include a base-10 logarithm explanation in your answer. **(4)**

A student investigates the mass changes at the electrodes during the active electrolysis of copper(II) sulfate solution using copper electrodes.



(c) (i) Explain the changes in mass observed at each electrode during this electrolysis. Link your explanation to the chemical reactions happening at the surfaces of the copper anode and the copper cathode. **(5)**

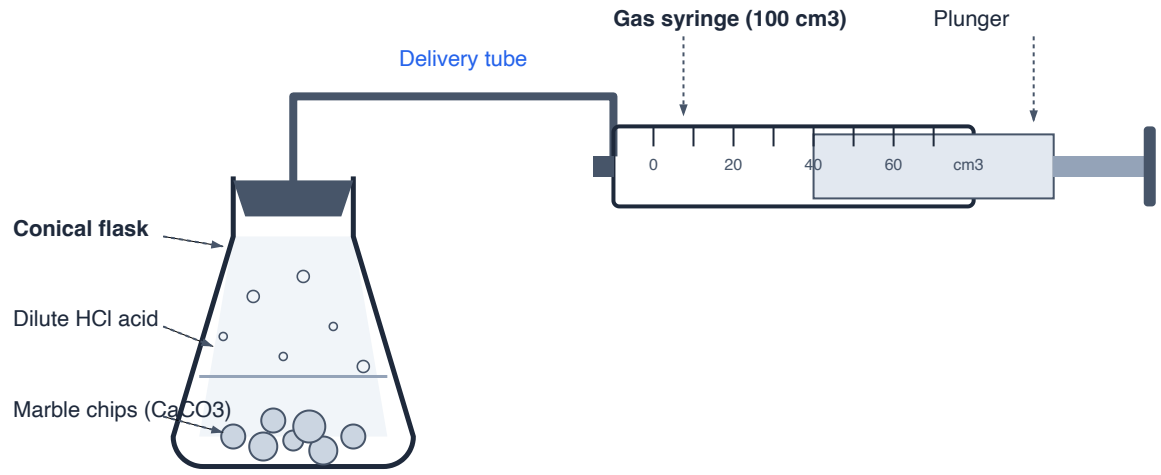
(ii) Write the balanced ionic half-equations, including state symbols, for the oxidation and reduction processes occurring at the electrodes in this experiment. **(4)**

Question 5 [14 Marks]

A student investigates the rate of reaction between calcium carbonate (marble chips) and dilute hydrochloric acid. The equation for the reaction is:

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

(a) The student sets up the apparatus as shown in the diagram to measure the volume of carbon dioxide gas produced over time. Explain how and why the rate of reaction changes over time from the start of the reaction until it completely stops. Refer to particles and collision theory in your answer. **(5)**



(b) The student recorded the volume of carbon dioxide gas collected at regular intervals: **(4)**

- At 0 seconds: 0 cm3
- At 10 seconds: 22 cm3
- At 20 seconds: 38 cm3
- At 30 seconds: 48 cm3
- At 40 seconds: 54 cm3
- At 50 seconds: 57 cm3
- At 60 seconds: 57 cm3

Calculate the mean rate of reaction during the first 20 seconds of the reaction. Show your working and state the units.

(c) In a second investigation, the student compares the energy released per gram by the combustion of different alcohols (methanol, ethanol, propanol) using a copper calorimeter setup. Explain why the temperature rise recorded in this simple calorimeter experiment is always significantly lower than the theoretical temperature rise calculated from standard combustion data. Suggest two modifications to the setup that would improve the accuracy of these results. **(3)**

(d) Write the balanced chemical symbol equation for the complete combustion of ethanol (C_2H_5OH). **(2)**

GCSE CHEMISTRY

Insert

Periodic Tabl[illegible]

END OF QUESTION PAPER

Group	Symbol	Relative atomic mass	Atomic number	Name
Group 1	H	1	1	Hydrogen
Group 1	Li	7	3	Lithium
Group 1	Na	23	11	Sodium
Group 1	K	39	19	Potassium
Group 1	Rb	85.5	37	Rubidium
Group 1	Cs	133	55	Cesium
Group 1	Fr	223	87	Francium
Group 2	Be	9	4	Beryllium
Group 2	Mg	24	12	Magnesium
Group 2	Ca	40	20	Calcium
Group 2	Sr	88	38	Strontium
Group 2	Ba	137	56	Barium
Group 2	Ra	226	88	Radium
	Sc	45	21	Scandium
	Y	89	39	Yttrium
	La*	139	57	Lanthanum
	Ac**	227	89	Actinium

* Lanthanides

** Actinides