GCSE CHEMISTRY

Practice Paper 3 - 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, periodic table trends, structure and bonding, quantitative chemistry, chemical changes, electrolysis, and energy changes. The marks for individual questions and parts of questions are shown in round brackets.

Question 1 [16 Marks]

Early chemists attempted to classify elements by arranging them based on their properties.

(a) Compare Mendeleev's periodic table with John Newlands' octaves. Explain how Mendeleev overcame the problems of early periodic tables, and why his periodic table was eventually accepted by the scientific community. **(6)**

(b) Chlorine exists in nature as two isotopes: chlorine-35 and chlorine-37. The relative abundance of chlorine-35 is 75.77% and the relative abundance of chlorine-37 is 24.23%.
Calculate the relative atomic mass (Ar) of chlorine. Give your answer to 2 decimal places. Show your working clearly. **(4)**

(c) Oxygen has an atomic number of 8, and sulfur has an atomic number of 16. Write the electronic configuration of both oxygen and sulfur. Explain why both elements are placed in Group 6 of the modern periodic table. **(4)**

(d) State how the modern periodic table is ordered, and explain how this arrangement differs from early periodic tables before the discovery of subatomic particles. **(2)**

Question 2 [22 Marks]

Carbon dioxide is a simple molecular compound formed by covalent bonding.

(a) Draw a dot-and-cross diagram to show the covalent bonding in a molecule of carbon dioxide (CO_2). You should show only the outer-shell electrons. **(4)**

(b) Graphite and graphene are allotropes of carbon with different structures. Compare the structures of graphite and graphene. Describe how their bonding explains why graphite is used as a lubricant and how graphene is strong and conducts electricity. **(6)**

(c) Carbon dioxide (CO_2) has a low boiling point of -78 degrees Celsius and does not conduct electricity. Explain these physical properties in terms of structure and bonding. **(6)**

(d) Silicon dioxide (SiO_2) has a giant covalent structure. Compare the structure, bonding, and physical properties of carbon dioxide and silicon dioxide. Explain why their melting points are so different. **(6)**

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Question 3 [25 Marks]

Chemical calculations allow chemists to predict masses and concentrations of reactants and products.

(a) Ammonia (NH_3) is synthesised by reacting nitrogen gas with hydrogen gas as shown: **(8)**

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

A student reacts 56.0 g of nitrogen (N_2) with 15.0 g of hydrogen (H_2).
Show by calculation which reactant is the limiting reactant, and calculate the maximum theoretical mass of ammonia produced in grams.
Relative atomic masses (Ar): H = 1; N = 14

(b) A student carries out a titration to determine the concentration of a potassium hydroxide (KOH) solution. **(9)**
The student titrates 25.0 cm^3 of the potassium hydroxide solution against 18.5 cm^3 of a standard sulfuric acid (H_2SO_4) solution of concentration 0.125 mol/dm^3.
The equation for the reaction is:

$$H_2SO_4(aq) + 2KOH(aq) \rightarrow K_2SO_4(aq) + 2H_2O(l)$$

Calculate the concentration of the potassium hydroxide solution in mol/dm^3 and in g/dm^3. Give your answer to 3 significant figures.
Relative atomic masses (Ar): H = 1; O = 16; K = 39

(c) In the synthesis of ammonia reaction in part (a), the theoretical yield was calculated. In an actual laboratory experiment, the student obtained 51.0 g of ammonia.
Calculate the percentage yield of ammonia. Give your answer to 3 significant figures. **(3)**

(d) Calculate the volume, in dm3, occupied by 2.00 moles of nitrogen gas at room temperature and pressure (RTP). Assume 1 mole of any gas occupies 24.0 dm3 at RTP. **(2)**

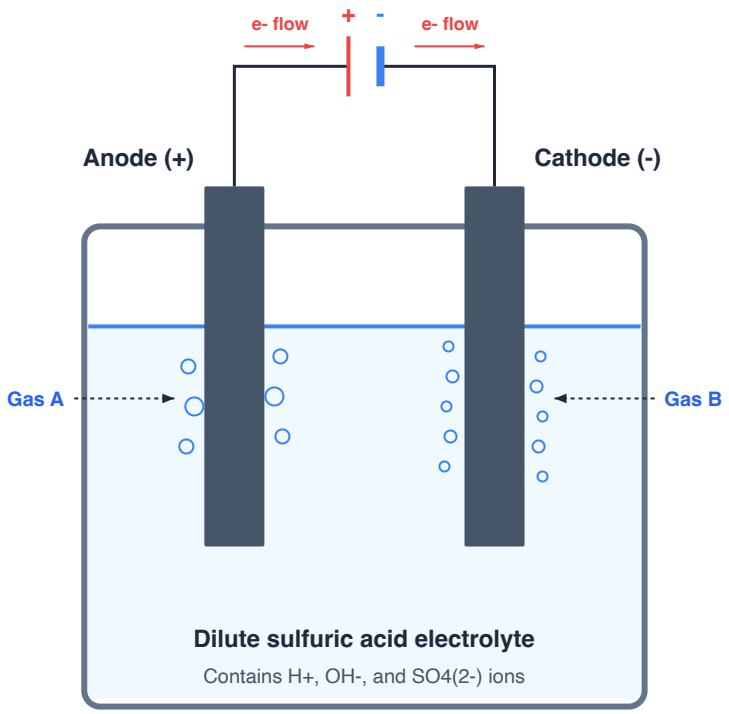
(e) Industrial chemical processes rarely achieve a 100% percentage yield. State three reasons why the actual yield of a chemical reaction is usually less than the theoretical maximum yield. **(3)**

Question 4 [23 Marks]

Electrolysis uses electrical energy to decompose liquid electrolytes.

(a) A student sets up an electrolysis cell containing dilute sulfuric acid (H2SO4) using inert platinum electrodes, as shown in the diagram below. **(8)**

Explain the chemical reactions taking place at each electrode. Identify the products formed, explain which ions migrate to each electrode, and write the balanced half-equations for the reactions at the anode and the cathode.



(b) Required Practical 3: A student investigates the electrolysis of brine (aqueous sodium chloride, NaCl) using carbon electrodes. **(6)**

Describe the product formed at the anode and the product formed at the cathode. Explain why these specific products form instead of sodium metal and oxygen gas, and state which useful substance is left in the solution.

(c) Acid strength refers to the degree of ionisation of acid molecules in solution. A student has a solution of hydrochloric acid of pH 2.00, and a solution of a weak acid of pH 5.00. **(6)**

Show by calculation the difference in hydrogen ion concentration [H+] between these two solutions. Explain what is meant by a strong acid and a weak acid, referring to how they ionise in water.

(d) Required Practical 1: A student prepares a pure sample of copper(II) chloride crystals by reacting copper(II) oxide with dilute hydrochloric acid. **(3)**

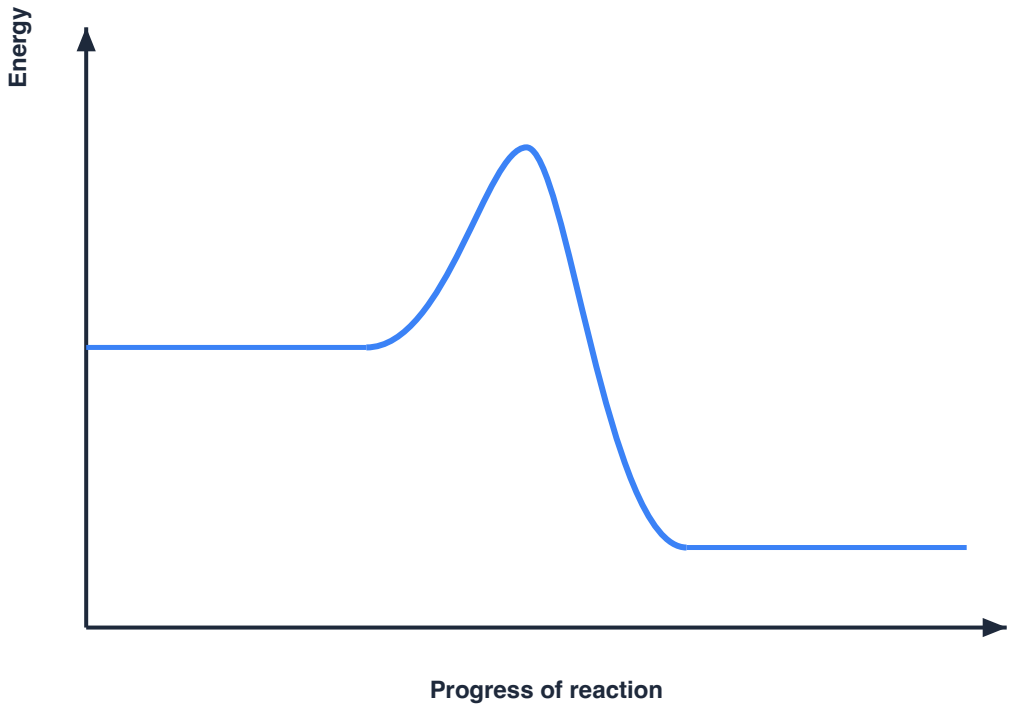
Write the balanced chemical equation for this reaction. Describe the filtration and crystallisation steps required to obtain dry, pure copper(II) chloride crystals from the reaction mixture.

Question 5 [14 Marks]

The reaction between magnesium ribbon and hydrochloric acid is highly exothermic.

$$Mg(s) + 2HCl(aq) \rightarrow MgCl_2(aq) + H_2(g)$$

(a) Complete the energy profile diagram below for this reaction. Label the reactants and products, and show arrows for the activation energy (Ea) and the overall energy change (ΔH). Explain why this reaction is exothermic by referring to the diagram. **(6)**



(b) Hydrogen gas reacts with chlorine gas to produce hydrogen chloride gas: **(8)**

$$H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$$

The table below shows the relevant bond energies:

Bond	Bond Energy / kJ/mol
H-H	436
Cl-Cl	242
H-Cl	431

Calculate the overall energy change for the reaction in kJ/mol. Explain whether this reaction is endothermic or exothermic, referring to the energy required to break bonds and the energy released when new bonds are formed.

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Insert

Periodic Table

END OF QUESTION PAPER

Group 1			
H	Hydrogen	1	1
Li	Lithium	7	3
Na	Sodium	23	11
K	Potassium	39	19
Rb	Rubidium	85.5	37
Cs	Cesium	133	55
Fr	Francium	223	87

Group 2			
Be	Beryllium	9	4
Mg	Magnesium	24	12
Ca	Calcium	40	20
Sr	Strontium	88	38
Ba	Barium	137	56
Ra	Radium	226	88

Sc	Scandium	45	21
Y	Yttrium	89	39
La*	Lanthanum	139	57
Ac**	Actinium	227	89

* Lanthanides

** Actinides

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