GCSE CHEMISTRY

Practice Paper 1 - 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, bonding, 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 [10 Marks]

A student sets up a computer simulation to model Rutherford's alpha particle scattering experiment. They record the path of 10,000 positive alpha particles fired at a thin gold foil:

- 9,880 alpha particles pass straight through the foil with no deflection.
- 118 alpha particles are deflected by small angles.
- 2 alpha particles bounce back towards the source.

(a) Explain how these simulation results provide evidence for the nuclear model of the atom. Link each conclusion to a specific observation from the data. **(3)**

(b) In 1932, James Chadwick discovered a new subatomic particle. State the name of this particle and explain why it was discovered much later than protons and electrons. **(2)**

Potassium is a Group 1 alkali metal and chlorine is a Group 7 halogen.

(c) Write the electronic configuration of:

(i) A potassium atom (atomic number = 19) **(1)**

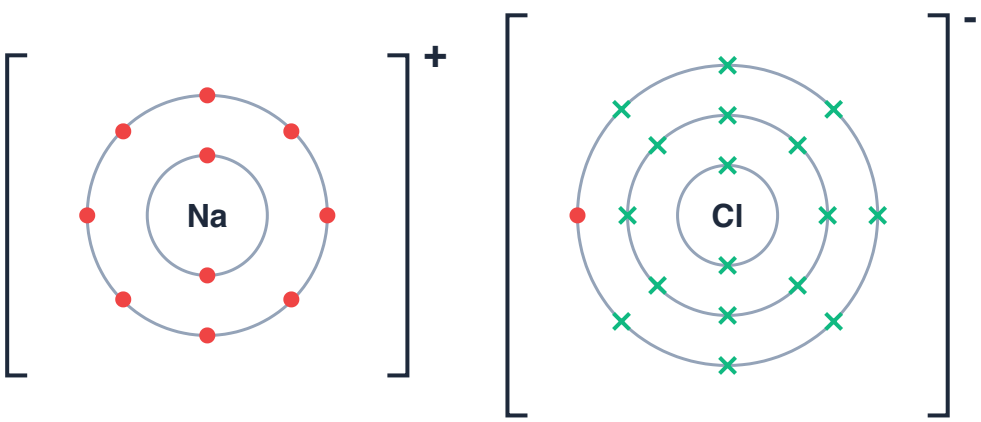
(ii) A chlorine atom (atomic number = 17) **(1)**

(d) Explain, in terms of electronic configurations, why potassium is more reactive than sodium (atomic number = 11). **(3)**

Question 2 (Synoptic Target B) [6 Marks]

Heated sodium metal reacts vigorously with chlorine gas to form the compound sodium chloride.

(a) Describe, in terms of electron transfer, how sodium atoms and chlorine atoms react to form sodium chloride. You must include the electronic configurations of the atoms and the resulting ions in your explanation. **(4)**



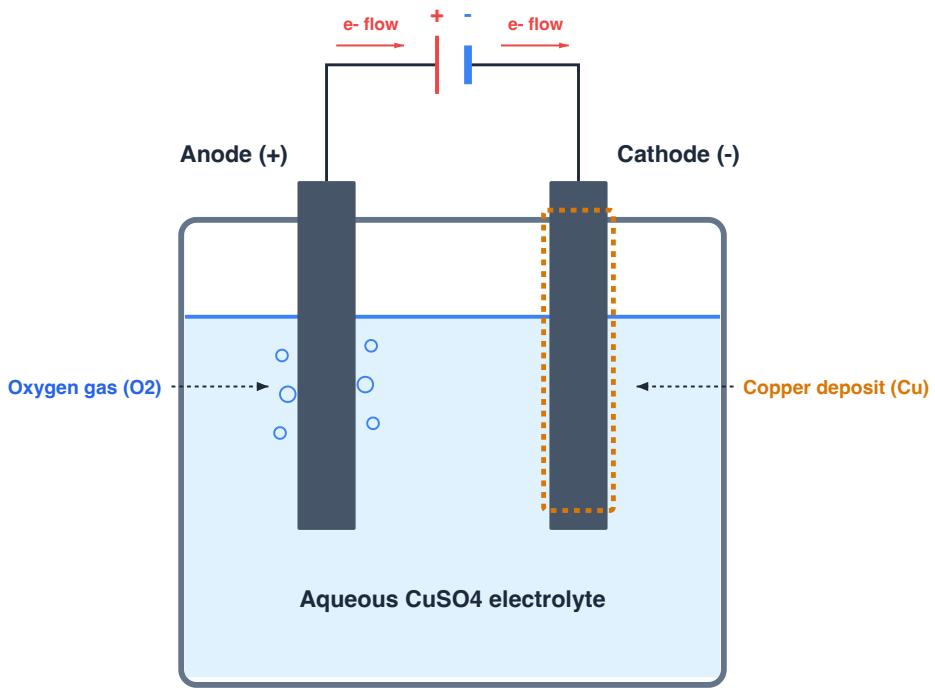
(b) Write the balanced chemical equation for the reaction of sodium metal with chlorine gas, including state symbols. **(2)**

Question 3 (Synoptic Target A) [8 Marks]

A student sets up an electrolysis experiment using carbon electrodes. They test the electrical conductivity of two samples: Sample X (solid copper(II) sulfate) and Sample Y (aqueous copper(II) sulfate).

(a) State which sample, X or Y, will conduct electricity. Explain this difference in conductivity by referring to the structure and bonding of copper(II) sulfate. **(3)**

During the electrolysis of aqueous copper(II) sulfate, chemical changes occur at the electrodes as shown in the diagram.



(b) During the electrolysis:

(i) Explain why copper metal forms at the negative electrode (cathode). Write a half-equation for this process. **(3)**

(ii) Describe the chemical change at the positive electrode (anode) and write a half-equation for this process. **(2)**

Question 4 [14 Marks]

Carbon exists as different allotropes, including diamond and graphite. Both have giant covalent structures but exhibit very different physical properties.

(a) Compare the structure and bonding of diamond and graphite, and explain how these structures relate to their hardness and electrical conductivity. **(6)**

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A student is given a table of physical properties for three unidentified substances, A, B, and C:

Substance	Melting Point / °C	Boiling Point / °C	Electrical Conductivity as Solid	Electrical Conductivity as Liquid	Solubility in Water
Substance A	1610	2230	Does not conduct	Does not conduct	Insoluble
Substance B	801	1413	Does not conduct	Conducts	Soluble
Substance C	-182	-161	Does not conduct	Does not conduct	Insoluble

The student claims that Substance A is a metal, Substance B is a simple molecular compound, and Substance C is a giant covalent structure.

(b) Evaluate the student's claims using the data in the table. For each substance, state whether the claim is correct or incorrect, and explain why by analyzing the physical properties. **(6)**

Nanoparticles of titanium dioxide are used in some modern sunscreens.

(c) (i) Explain why nanoparticles have different properties compared to bulk materials like titanium dioxide powder. **(1)**

(ii) State one potential risk of using nanoparticles in consumer cosmetics. **(1)**

Question 5 [12 Marks]

(a) State what is meant by the term **limiting reactant**. **(1)**

(b) A student prepared a sample of copper(II) carbonate precipitate. After filtering the reaction mixture, the student washed the precipitate with distilled water and dried it. Explain why the actual yield of the dried copper(II) carbonate might be: **(2)**

1. Lower than the calculated theoretical maximum yield.
2. Higher than the calculated theoretical maximum yield.

(c) Iron can be produced by reducing iron(III) oxide with carbon. The balanced equation for the reaction is: **(5)**

$$2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(s) + 3CO_2(g)$$

A student reacts 24.0 g of iron(III) oxide (Fe_2O_3) with 5.40 g of carbon (C).
Show by calculation which reactant is the limiting reactant, and calculate the maximum theoretical yield of iron (Fe) in grams.
Relative atomic masses (Ar): C = 12; O = 16; Fe = 56

(d) Calculate the percentage atom economy for the reaction to produce iron. Give your answer to 3 significant figures. **(3)**

Equation: $2Fe_2O_3(s) + 3C(s) \rightarrow 4Fe(s) + 3CO_2(g)$

Relative atomic masses (Ar): C = 12; O = 16; Fe = 56

(e) State one reason why chemical companies aim to use reactions with a high atom economy. **(1)**

Question 6 [13 Marks]

(a) State two conditions that must be kept constant for 1 mole of any gas to occupy a volume of 24.0 dm3. **(2)**

(b) When carrying out a titration, a student performs a rough titration first before carrying out further runs to obtain concordant titres.

(i) Explain the purpose of performing a rough titration first. **(1)**

(ii) Explain what is meant by the term **concordant titres** in terms of experimental precision. **(1)**

(c) A student carries out a titration to find the concentration of a sodium hydroxide (NaOH) solution. **(6)**
The student titrates 25.0 cm3 of the sodium hydroxide solution against a standard solution of sulfuric acid (H2SO4) of concentration 0.0500 mol/dm3.
The mean volume of sulfuric acid required to neutralise the sodium hydroxide is 20.0 cm3.
The balanced equation for the reaction is:

H2SO4(aq) + 2NaOH(aq) → Na2SO4(aq) + 2H2O(l)

Calculate the concentration of the sodium hydroxide solution in g/dm3. Give your answer to 3 significant figures.
Relative atomic masses (Ar): H = 1; O = 16; Na = 23; S = 32

(d) A student reacts 0.243 g of magnesium ribbon with an excess of dilute hydrochloric acid to produce hydrogen gas. **(3)**
The equation for the reaction is:

Mg(s) + 2HCl(aq) → MgCl2(aq) + H2(g)

Calculate the volume of hydrogen gas produced in cm3 at room temperature and pressure (RTP).
Assume 1 mole of gas occupies 24.0 dm3 at RTP.
Relative atomic mass (Ar): Mg = 24.3

Question 7 [9 Marks]

(a) Iron is extracted from iron(III) oxide in a blast furnace by heating with carbon. Aluminium is extracted from aluminium oxide using electrolysis. Explain why carbon can be used to extract iron but cannot be used to extract aluminium. **(2)**

A student adds zinc powder to copper(II) sulfate solution. A displacement reaction occurs.

(b) (i) Write a balanced ionic equation for this reaction. Include state symbols. **(2)**

(ii) State which species is oxidised and explain this in terms of electron transfer. **(1)**

Dilute hydrochloric acid and dilute ethanoic acid are both acids.

(c) (i) Explain the difference between a strong acid (such as hydrochloric acid) and a weak acid (such as ethanoic acid) in terms of their ionization in aqueous solution. **(2)**

(c) (ii) The concentration of hydrogen ions in an acid determines its pH. The mathematical relationship between pH and hydrogen ion concentration is given by: **(2)**

$$pH = -\log_{10}[H^+]$$

Using this equation, prove that decreasing the pH of an acid by exactly 1 unit (for example, from pH 3 to pH 2) corresponds to a tenfold (10 times) increase in the concentration of hydrogen ions.

Question 8 [8 Marks]

A student carries out an experiment to prepare a pure, dry sample of copper(II) sulfate crystals. They add copper(II) oxide to dilute sulfuric acid.

(a) The student heats the dilute sulfuric acid gently in a beaker before adding the copper(II) oxide. State why the acid is warmed. **(1)**

(b) The copper(II) oxide is added until it is in excess.

(i) Describe what the student would observe when the copper(II) oxide is in excess. **(1)**

(ii) Explain why it is necessary to add an excess of copper(II) oxide. **(1)**

(c) Describe the remaining steps the student must take to obtain a pure, dry sample of copper(II) sulfate crystals from the mixture. **(3)**

(d) The theoretical yield of copper(II) sulfate crystals for this experiment was calculated to be 5.0 g. The student obtained a mass of 4.2 g of dry crystals. Suggest two reasons why the actual yield was lower than the theoretical yield. **(2)**

Question 9 [6 Marks]

A student investigates the electrolysis of aqueous sodium chloride (brine) using inert carbon electrodes.

(a) Name the product formed at the negative electrode (cathode) and write a balanced half-equation to represent its formation. **(2)**

(b) A gas is produced at the positive electrode (anode).

(i) Identify this gas and explain why it is formed in preference to hydroxide ions. **(2)**

(ii) Write a balanced half-equation for the discharge of chloride ions at the anode. **(2)**

Question 10 [14 Marks]

(a) Define the term **activation energy**. **(1)**

(b) When a solid is dissolved in water in an insulated cup, the temperature of the water rises. State whether this process is exothermic or endothermic, and explain this in terms of energy transfer between the reacting chemicals and the water. **(2)**

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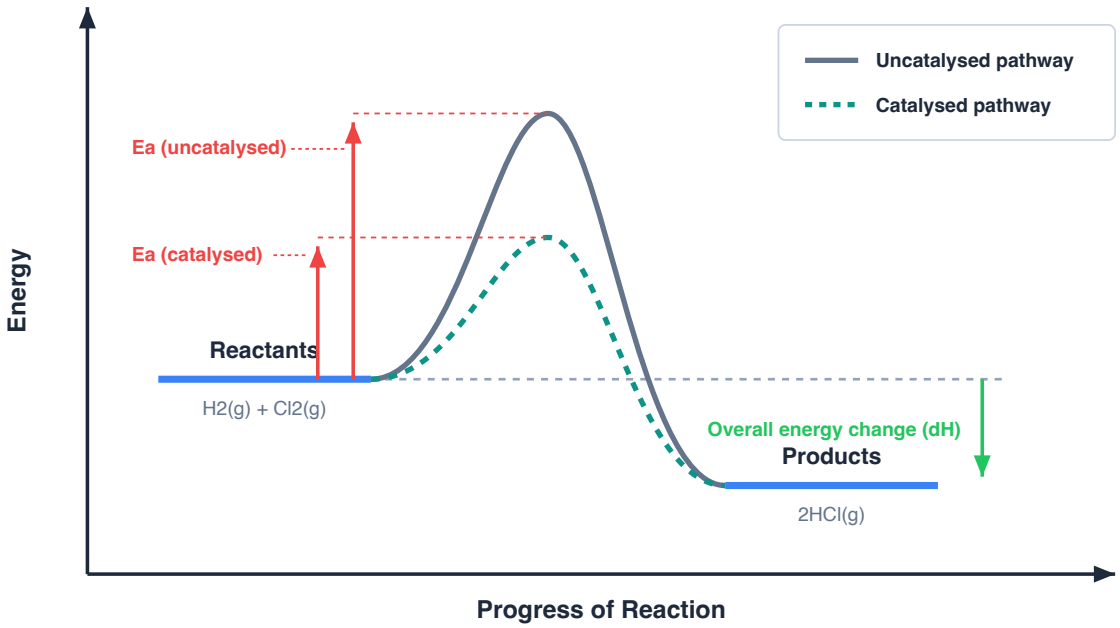
(c) A student wants to measure the temperature change when different masses of ammonium chloride are dissolved in water. Describe how the student could carry out this investigation to obtain valid results, mentioning a key piece of apparatus used to reduce heat loss to the surroundings. **(2)**

(d) Explain how a catalyst increases the rate of a chemical reaction. **(2)**

(e) Describe how the activation energy and the overall energy change of an exothermic reaction are represented on an energy profile diagram. In your answer, refer to the relative energy levels of the reactants and products. **(3)**



The reaction between hydrogen gas and chlorine gas is represented by the following equation:

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

The table below lists the bond energies for the bonds involved in this reaction:

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

(f) Use the values in the table to answer the following questions.

(i) Calculate the energy required to break all the bonds in the reactants. **(1)**

(ii) Calculate the energy released when the bonds in the products are formed. **(1)**

(iii) Calculate the overall energy change for the reaction and state whether the reaction is exothermic or endothermic. **(2)**

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Periodic Table

END OF QUESTION PAPER

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

Group 1 Group 2

* Lanthanides

** Actinides