All questions are for separate science students only

Q1.

A student produced a salt by reacting copper carbonate with sulfuric acid.

This is the method used.

1. Measure 50 cm^3 of sulfuric acid into a beaker.
2. Add copper carbonate powder.
3. Stir the mixture.
4. Repeat steps 2 and 3 until copper carbonate is in excess.
5. Filter the mixture.
6. Warm the filtrate gently until crystals start to appear.
7. Leave the solution to cool and crystallise.

(a) Complete the word equation for the reaction.

copper carbonate + sulfuric acid → _____ + _____ + carbon dioxide

(2)

(b) Give **one** observation the student could make during **Step 4** which shows that the copper carbonate is in excess.

_____

_____

(1)

(c) Give **one** reason for filtering the mixture in **Step 5**.

_____

_____

(1)

(d) Name the equipment that can be used to warm the filtrate **gently** in **Step 6**.

_____

_____

(1)

(e) The maximum theoretical mass of the salt that could be produced using 50 cm^3 of the sulfuric acid is 12.5 g.

The percentage yield of the salt is 92.8%.

Calculate the mass of salt actually produced. **(chemistry only)**

Use the equation:

$$\% \text{ yield} = \frac{\text{mass of salt actually produced}}{\text{maximum theoretical mass of salt that could be produced}} \times 100$$

_____

_____

_____

_____

_____

Mass of salt actually produced = _____ g

(3)

(f) Some salts can be produced by reacting sulfuric acid with a metal.

Neither copper nor sodium is used to produce a salt with sulfuric acid.

Give **one** reason why each metal is **not** used.

Copper _____

_____

Sodium _____

_____

(2)

(Total 10 marks)

Q2.

This question is about displacement reactions.

Iron is extracted from iron oxide by a displacement reaction with carbon.

(a) Balance the equation for the reaction.

$$Fe_2O_3 + 3\ C \rightarrow \_\_\_\_\_Fe + \_\_\_\_\_CO$$

(2)

(b) Iron oxide is reduced in this reaction.

How does the equation show that iron oxide is reduced?

_____

_____

(1)

(c) Calculate the relative formula mass (M_r) of Fe_2O_3

Relative atomic masses (A_r): O = 16 Fe = 56

_____

_____

_____

M_r = _____

(2)

(d) Copper oxide reacts with hydrogen to produce copper.

The equation for the reaction is:

$$CuO + H_2 \rightarrow Cu + H_2O$$

Calculate the percentage atom economy for obtaining copper from this reaction.
(chemistry only)

Use the equation:

$$\text{Percentage atom economy} = \frac{A_r \text{ of Cu}}{M_r \text{ of } H_2 + M_r \text{ of CuO}} \times 100$$

Relative atomic mass (A_r): Cu = 63.5
Relative formula masses (M_r): H_2 = 2 CuO = 79.5

_____

_____

_____

Percentage atom economy = _____ %

(2)

A student investigated the reactivity of four different metals, **A**, **B**, **C** and **D**.

The student:

- added each metal to aqueous solutions of each of the metal sulfates
- observed whether a reaction took place.

(e) Give **one** observation that would show a reaction took place.

_____

_____

(1)

(f) The table below shows the results.

	Metal sulfate solution			
Metal	**A sulfate**	**B sulfate**	**C sulfate**	**D sulfate**
A	×	×	✓	×
B	✓	×	✓	×
C	×	×	×	×
D	✓	✓	✓	×

✓ shows that a displacement reaction took place.
× shows that a displacement reaction did not take place.

Write metals **A**, **B**, **C** and **D** in order of reactivity.

Give a reason for your order of reactivity.

Most reactive _____

_____

_____

Least reactive _____

Reason _____

_____

(2)

(Total 10 marks)

Q3.

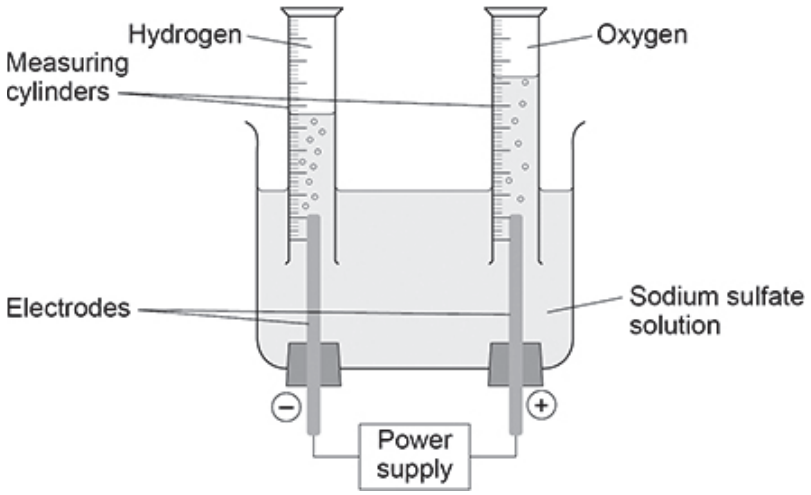
This question is about electrolysis.

Ionic compounds decompose when they are electrolysed.

A student electrolyses sodium sulfate solution.

Figure 1 shows the apparatus used.

Figure 1



(a) Sodium sulfate solution contains:

- hydrogen ions
- hydroxide ions
- sodium ions
- sulfate ions.

Oxygen is produced at the positive electrode.

Which ions are discharged at the positive electrode to produce oxygen?

Tick (✓) **one** box.

Hydrogen ions ☐

Hydroxide ions ☐

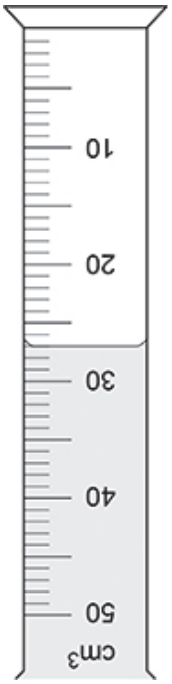
Sodium ions ☐

Sulfate ions ☐

(1)

(b) **Figure 2** shows one of the measuring cylinders during the electrolysis.

Figure 2



What is the volume of gas in the measuring cylinder?

Volume of gas = _____ cm^3

(1)

(c) Ionic compounds can be electrolysed when molten or dissolved in water.

Why can ionic compounds **not** be electrolysed when solid?

You should answer in terms of ions.

_____

_____

(1)

(d) The table below shows the products of electrolysis of two molten compounds.

Molten compound	**Product at negative electrode**	**Product at positive electrode**
Potassium iodide	Potassium	_____
Zinc bromide	_____	Bromine

Complete the table above.

(2)

(e) The electrolysis of molten sodium chloride is used to extract sodium metal.

Why is sodium metal extracted by electrolysis instead of by reduction with carbon?

Tick (✓) **one** box.

Carbon conducts electricity. ☐

Carbon is less reactive than sodium. ☐

Carbon reduction uses more energy. ☐

(1)

(f) What is the state symbol for molten sodium chloride?

Tick (✓) **one** box.

(aq) ☐ (g) ☐ (l) ☐ (s) ☐

(1)

(g) Titanium can be produced from titanium oxide by electrolysis.

The equation for the reaction is:

$$TiO_2 \rightarrow Ti + O_2$$

Calculate the percentage atom economy for the production of titanium from titanium oxide by electrolysis. **(chemistry only)**

Use the equation:

$$\text{Percentage atom economy} = \frac{\text{Relative atomic mass of desired product}}{\text{Relative formula mass of reactant}} \times 100$$

Relative atomic mass (A_r): Ti = 48

Relative formula mass (M_r): TiO_2 = 80

_____

_____

_____

_____

Percentage atom economy = _____ %

(2)

(Total 9 marks)