Questions are for both separate science and combined science students unless indicated in the question

Q1.

This question is about energy changes of reactions.

Zinc reacts with copper sulfate solution.

The word equation for the reaction is:

zinc + copper sulfate → zinc sulfate + copper

(a) What type of reaction is the reaction between zinc and copper sulfate solution?

Tick (✓) **one** box.

Combustion ☐

Decomposition ☐

Displacement ☐

(1)

(b) Calculate the percentage (%) by mass of copper in copper sulfate (CuSO4).

Give your answer to 3 significant figures.

Relative atomic mass (*Ar*): Cu = 63.5

Relative formula mass (*Mr*): $CuSO_4$ = 159.5

_____

_____

_____

_____

_____

Percentage by mass (3 significant figures) = _____ %

(3)

A student investigated the energy change in the reaction between zinc and copper sulfate solution.

This is the method used.

1. Measure 25 cm^3 of copper sulfate solution into a polystyrene cup.

2. Weigh 0.20 g of zinc powder.

3. Add the zinc powder to the copper sulfate solution.

4. Measure the highest temperature reached by the mixture.

5. Repeat steps 1 to 4 using different masses of zinc powder.

(c) Control variables are used to make an investigation a fair test.

Which is a control variable in the investigation?

Tick (✓) **one** box.

Highest temperature reached by the mixture ☐

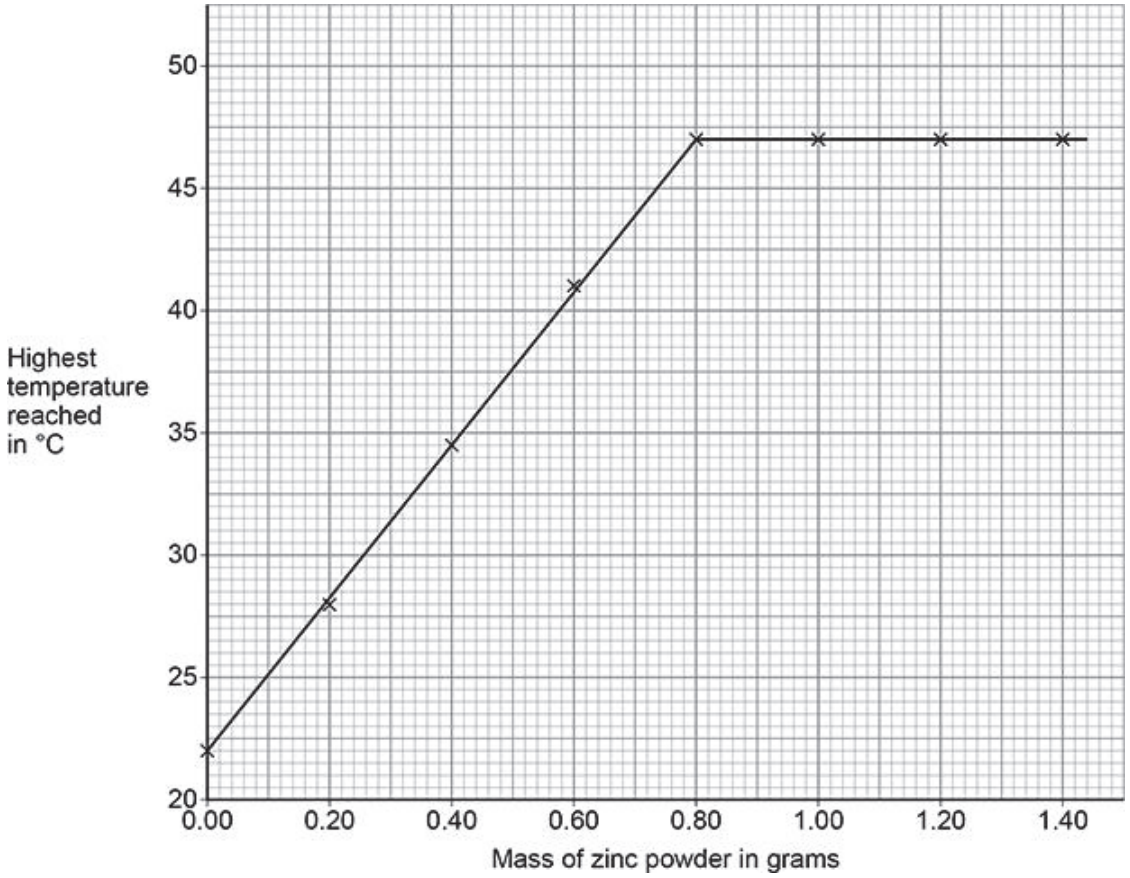
Mass of zinc powder ☐

Volume of copper sulfate solution ☐

(1)

Figure 1 shows the results.

Figure 1



(d) What is the minimum mass of zinc powder needed to react with all the copper sulfate solution?

Use **Figure 1**.

Minimum mass of zinc powder = _____ g

(1)

(e) What is the maximum temperature change in the reaction between zinc powder and 25 cm^3 of copper sulfate solution?

Use **Figure 1**.

_____

_____

_____

Maximum temperature change = _____ °C

(2)

(f) 25 cm^3 of copper sulfate solution contained 6.75 g of copper sulfate.

Calculate the concentration of the solution in g/dm^3.

You should:

- calculate the volume of the solution in dm^3 (1000 cm^3 = 1 dm^3)
- use the equation:

$$\text{concentration of solution in g/dm}^3 = \frac{\text{mass of copper sulfate in grams}}{\text{volume of solution in dm}^3}$$

_____

_____

Volume of solution = _____ dm^3

_____

_____

_____

Concentration of solution = _____ g/dm^3

(3)

Another student investigated the energy change of the reaction between sodium hydrogencarbonate and hydrochloric acid.

This is the method used.

1. Measure 25 cm^3 of hydrochloric acid.

2. Weigh 1.0 g of sodium hydrogencarbonate.

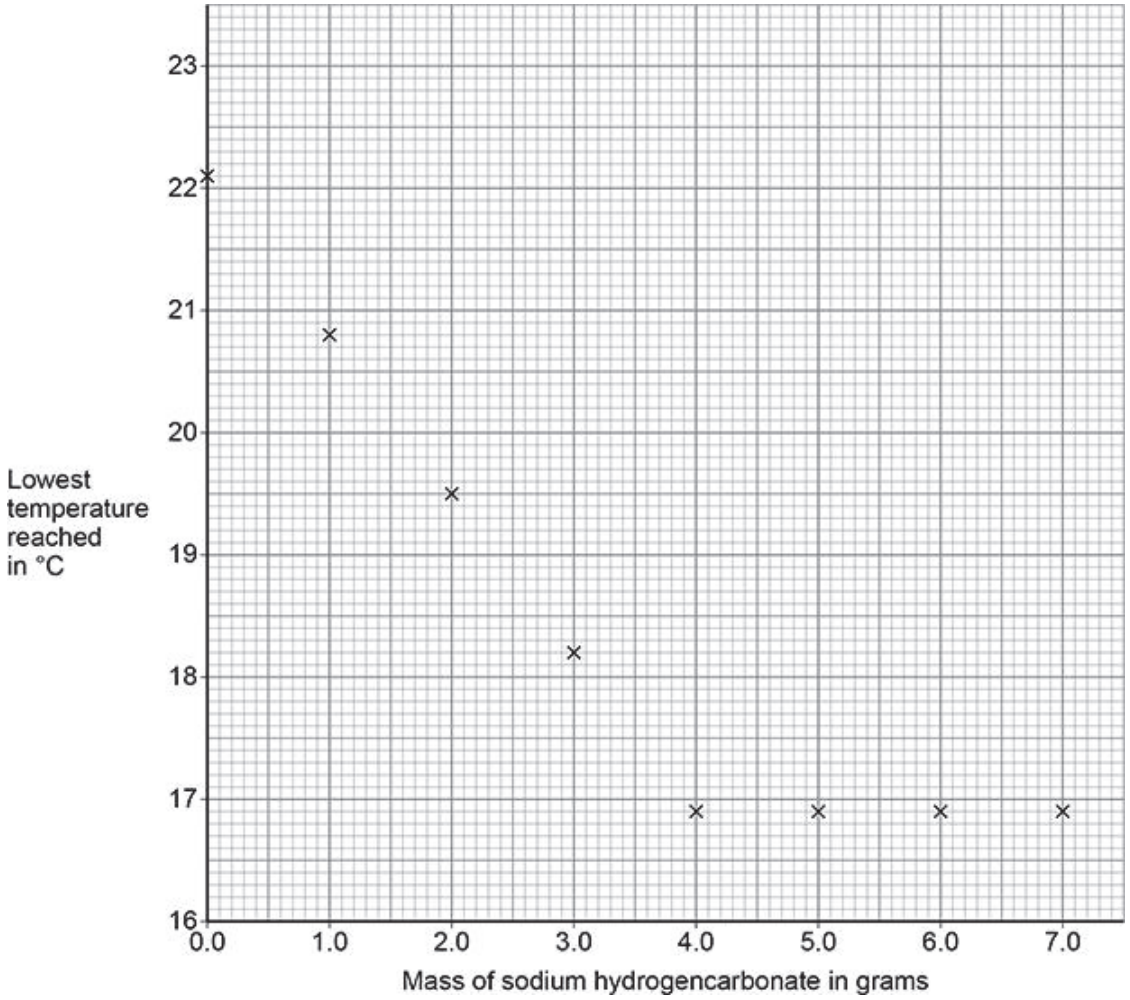
3. Add the sample of sodium hydrogencarbonate to the hydrochloric acid.

4. Measure the lowest temperature reached by the mixture.

5. Repeat steps 1 to 4 using different masses of sodium hydrogencarbonate.

Figure 2 shows the results.

Figure 2



(g) Draw **two** straight lines of best fit on **Figure 2**.

The lines should cross.

(2)

(h) Which statement describes the energy change in the reaction shown in **Figure 2**?

Tick (✓) **one** box.

Energy is **transferred to** the surroundings so the reaction is **endothermic**. ☐

Energy is **transferred to** the surroundings so the reaction is **exothermic**. ☐

Energy is **taken in from** the surroundings so the reaction is **endothermic**. ☐

Energy is **taken in from** the surroundings so the reaction is **exothermic**. ☐

(1)

(Total 14 marks)

Q2.

This question is about electrolysis and the extraction of metals.

(a) Why can some molten substances be electrolysed?

Tick (✓) **one** box.

Electrons can move through the molten substance to the electrodes. ☐

Ions can move through the molten substance to the electrodes. ☐

Protons can move through the molten substance to the electrodes. ☐

(1)

(b) The table below shows the products of the electrolysis of some molten compounds.

Complete below table.

Molten compound	**Product at negative electrode**	**Product at positive electrode**
Lead chloride	_____	Chlorine
Potassium iodide	Potassium	_____
_____	Zinc	Bromine

(3)

Aluminium is extracted by electrolysing molten aluminium oxide.

(c) Balance the equation for the reaction.

Choose numbers from the box.

2	**3**	**4**	**5**

$$2\ Al_2O_3 \rightarrow \_\_\_Al + \_\_\_O_2$$

(2)

(d) Calculate the relative formula mass (M_r) of aluminium oxide (Al_2O_3).

Relative atomic masses (A_r): O = 16 Al = 27

_____

_____

_____

Relative formula mass (M_r) = _____

(2)

(e) The figure below shows part of the reactivity series of metals.

The non-metal carbon has been included.

Metals can be extracted from their compounds by:

- electrolysis
- reduction with carbon.

Electrolysis is more expensive than reduction with carbon.

Predict one metal that would be extracted by each method.

Use the figure above.

Extracted by electrolysis _____

Extracted by carbon reduction _____

(2)

(Total 10 marks)

Q3.

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) (HT 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)

Q4.

This question is about the periodic table.

Sodium and potassium are in Group 1 of the periodic table.

(a) Give **one** similarity and **one** difference between the electronic structures of sodium and potassium.

Similarity _____

_____

Difference _____

_____

(2)

Group 1 elements react with water.

(b) Give **two** observations made when potassium reacts with water.

1 _____

_____

2 _____

_____

(2)

(c) Potassium hydroxide solution is produced when potassium reacts with water.

What is the colour of universal indicator when added to potassium hydroxide solution?

Give **one** reason for your answer.

Colour of universal indicator _____

Reason _____

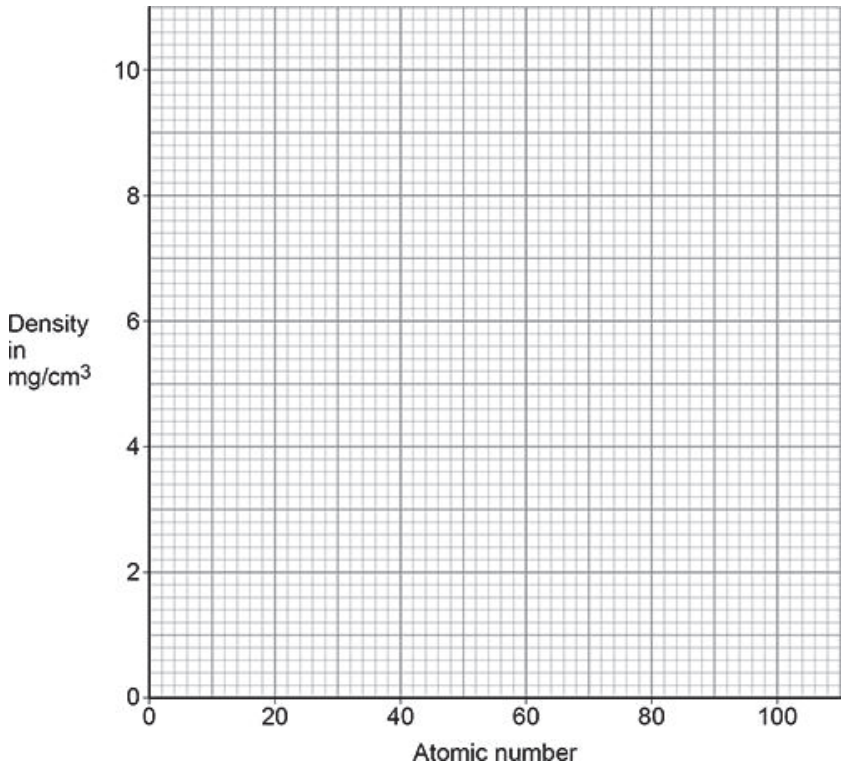
_____

(2)

The table below shows the densities of some of the elements in Group 0 of the periodic table.

Element	Atomic number	Density in mg/cm^3
Helium	2	0.2
Neon	10	0.8
Argon	18	1.6
Krypton	36	**X**
Xenon	54	5.4
Radon	86	9.1

(d) Plot the data from the table above on the figure below.



(2)

(e) Estimate the density (**X**) of krypton.

Use the figure and table above.

_____

_____

Density = _____ mg/cm^3

(1)

(f) The elements in Group 7 are called the halogens.

A more reactive halogen can displace a less reactive halogen from a solution of its salt.

Which combination of solutions will produce a reaction when mixed?

Tick (✓) **one** box.

Chlorine and potassium fluoride ☐

Chlorine and potassium bromide ☐

Bromine and potassium fluoride ☐

Bromine and potassium chloride ☐

(1)

(g) Which of the following describes the trends going down Group 7?

Tick (✓) **one** box.

Relative molecular mass decreases and boiling point decreases. ☐

Relative molecular mass decreases and boiling point increases. ☐

Relative molecular mass increases and boiling point decreases. ☐

Relative molecular mass increases and boiling point increases. ☐

(1)

(Total 11 marks)

Q5.

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) (HT 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)

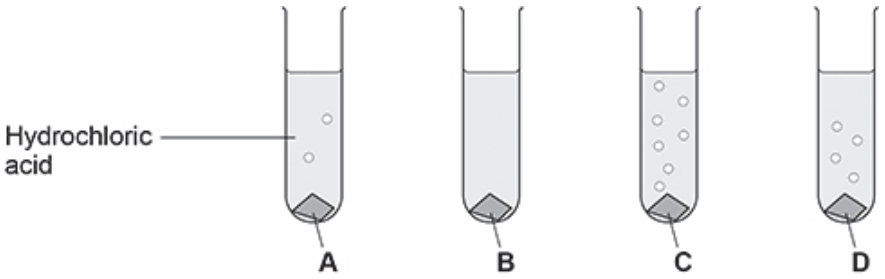
Q6.

This question is about acids.

A student added four metals, **A**, **B**, **C** and **D** to hydrochloric acid.

Figure 1 shows the rate of bubbling in each tube.

Figure 1



Use **Figure 1** to answer parts (a) and (b).

(a) Which metal is copper?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(b) Which metal is the most reactive?

Tick (✓) **one** box.

A ☐ **B** ☐ **C** ☐ **D** ☐

(1)

(c) A metal oxide reacts with an acid to produce zinc sulfate and water.

Name the metal oxide and the acid used in this reaction.

Name of metal oxide _____

Name of acid _____

(2)

(d) Universal indicator is used to measure the pH of a solution.

Draw **one** line from each pH to the colour of universal indicator in a solution with that pH.

pH	Colour of universal indicator
	Blue
1	Green
	Purple
7	Red
	Yellow

(2)

A student reacts an acid with an alkali in a titration.

(e) What is the type of reaction when an acid reacts with an alkali?

Tick (✓) **one** box.

- Combustion ☐
- Decomposition ☐
- Neutralisation ☐

(1)

(f) **Figure 2** shows a piece of equipment used to measure the volume of the acid in the titration.

Figure 2

What is the name of this piece of equipment? **(chemistry only)**

Tick (✓) **one** box.

Burette ☐

Pipette ☐

Syringe ☐

Tube ☐

(1)

(Total 8 marks)