

## C5 Chemical Changes Homework task 1

**Q1.** A student investigated the reactivity of metals with hydrochloric acid. This is the method used.

1. Measure 50 cm<sup>3</sup> of hydrochloric acid into a polystyrene cup.
2. Measure the temperature of the hydrochloric acid.
3. Add one spatula of metal powder to the hydrochloric acid and stir.
4. Measure the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1 to 5 three more times.
7. Repeat steps 1 to 6 with different metals.

The table below shows the student's results.

Metal	Temperature increase in °C				Mean temperature increase in °C
	Trial 1	Trial 2	Trial 3	Trial 4	
Cobalt	6	7	5	9	7
Magnesium	54	50	37	55	X
Zinc	18	16	18	20	18

- (a) Calculate the mean temperature increase **X** for magnesium in the table above. Do **not** include the anomalous result in your calculation.

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$$X = \underline{\hspace{2cm}} \text{ °C}$$

(2)

- (b) Determine the order of reactivity for the metals cobalt, magnesium and zinc. Use the table above.

Most reactive \_\_\_\_\_

\_\_\_\_\_

Least reactive \_\_\_\_\_

(1)

- (c) The range of measurements either side of the mean shows the uncertainty in the mean temperature increase. Complete the sentence. Use the table above.

The mean temperature increase for zinc is  $18 \pm \underline{\hspace{2cm}}$  °C

(1)

(d) What type of variable is the volume of hydrochloric acid in this investigation? Tick (✓) **one** box.

Control

Dependent

Independent

(1)

(e) Suggest **one** way of improving **step 3** in the method to give results which are more repeatable.

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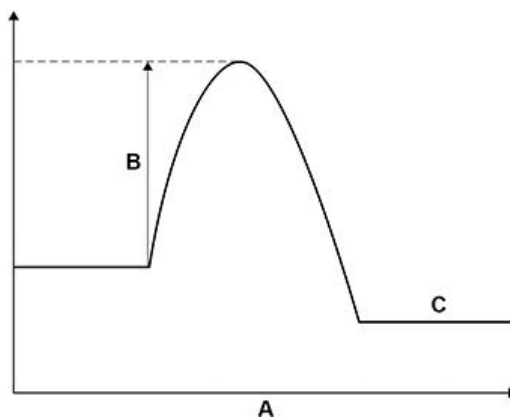
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(1)

(f) The figure below shows a reaction profile for the reaction of magnesium with hydrochloric acid.



What do labels **A**, **B** and **C** represent on the figure above? Choose answers from the box.

activation energy	energy	overall energy change
products	progress of reaction	reactants

**A** \_\_\_\_\_

**B** \_\_\_\_\_

**C** \_\_\_\_\_

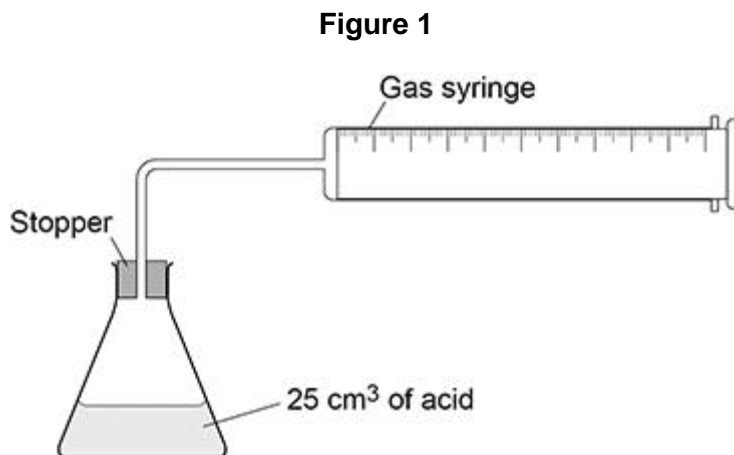
(3)

(Total 9 marks)

**Q2.** This question is about metal carbonates.

A student investigated the reaction of copper carbonate with an acid.

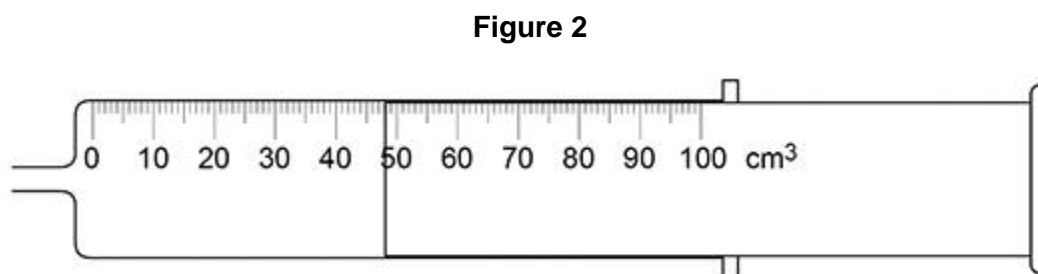
**Figure 1** shows the apparatus.



This is the method used.

1. Pour 25 cm<sup>3</sup> of the acid into a conical flask.
2. Weigh 0.10 g of copper carbonate.
3. Remove the stopper and add the copper carbonate to the flask.
4. Quickly replace the stopper.
5. Record the maximum volume of gas collected in the gas syringe.
6. Repeat steps 1 to 5 with different masses of copper carbonate.

(a) **Figure 2** shows the gas syringe during the experiment.



What is the reading on the gas syringe?

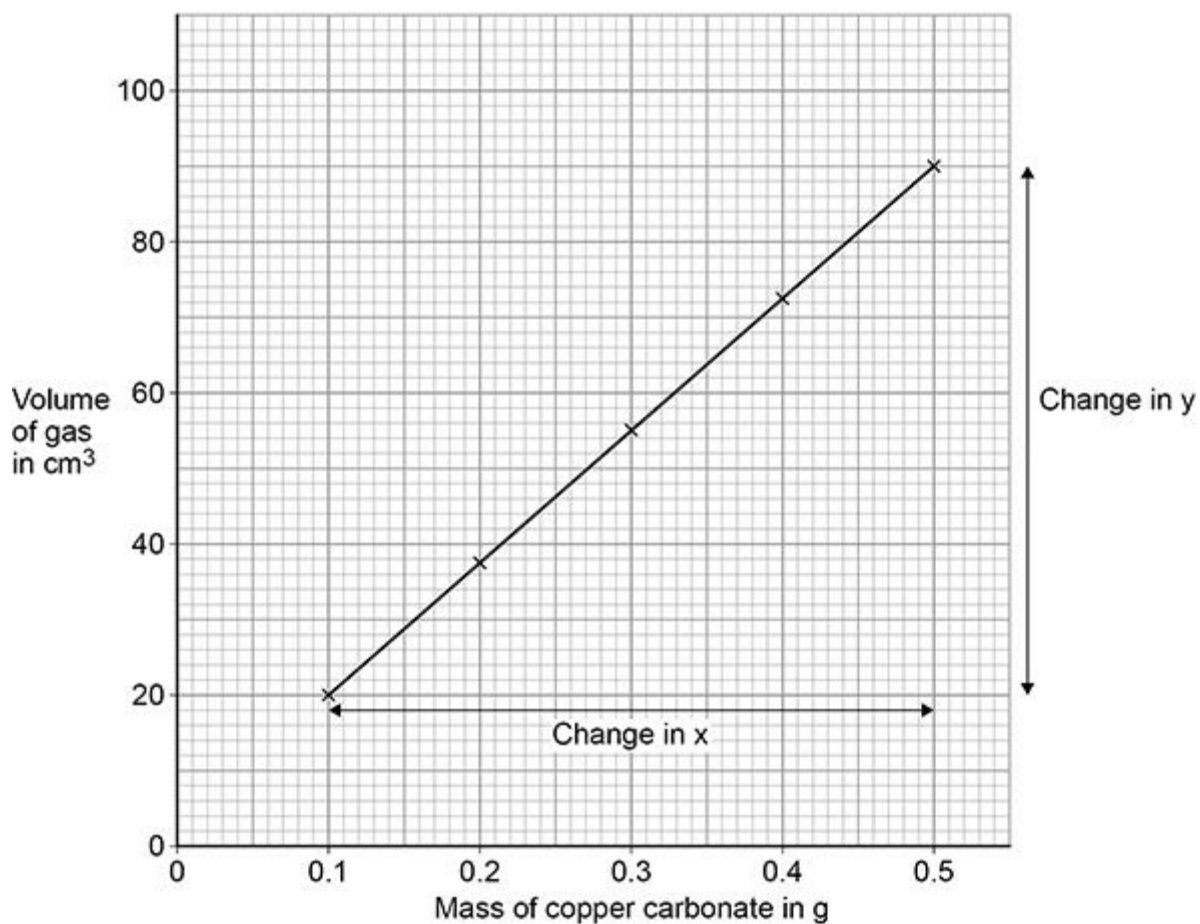
\_\_\_\_\_ cm<sup>3</sup>

(1)

(b) The student plotted the results on a graph.

Figure 3 shows the student's graph.

Figure 3



Determine the gradient of the line of best fit.

You should:

- calculate the values of the change in y and the change in x
- calculate the gradient of the line of best fit.

Change in y = \_\_\_\_\_ cm<sup>3</sup>

Change in x = \_\_\_\_\_ g

Gradient \_\_\_\_\_

Gradient = \_\_\_\_\_ cm<sup>3</sup>/g

(4)

- (c) Copper chloride was produced in the reaction. Which acid reacts with copper carbonate to produce copper chloride? Tick (✓) **one** box.

Hydrochloric acid

Nitric acid

Sulfuric acid

(1)

- (d) The reaction between copper carbonate and the acid produced a gas. What was the gas?

Tick (✓) **one** box.

Carbon dioxide

Chlorine

Hydrogen

Oxygen

(1)

A different student produced a pure, dry sample of copper chloride using the same reaction. This is the method used.

1. Add excess copper carbonate to the acid.
2. Filter the mixture.
3. Heat the solution gently until crystals start to form.
4. Leave for 24 hours.
5. Remove the crystals.
6. Rinse with water and dry the crystals.

- (e) Why was the solution heated gently in **step 3**? Tick (✓) **one** box.

To evaporate acid

To evaporate copper carbonate

To evaporate water

(1)

(f) How should the solution be heated gently in **step 3**?

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(1)

(Total 9 marks)

**Q3.** This question is about chemical reactions and electricity.

- (a) Electrolysis and chemical cells both involve chemical reactions and electricity. Explain the difference between the processes in electrolysis and in a chemical cell.

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(2)

- (b) A teacher demonstrates the electrolysis of molten lead bromide. Bromine is produced at the positive electrode. Complete the half equation for the production of bromine. You should balance the half equation.



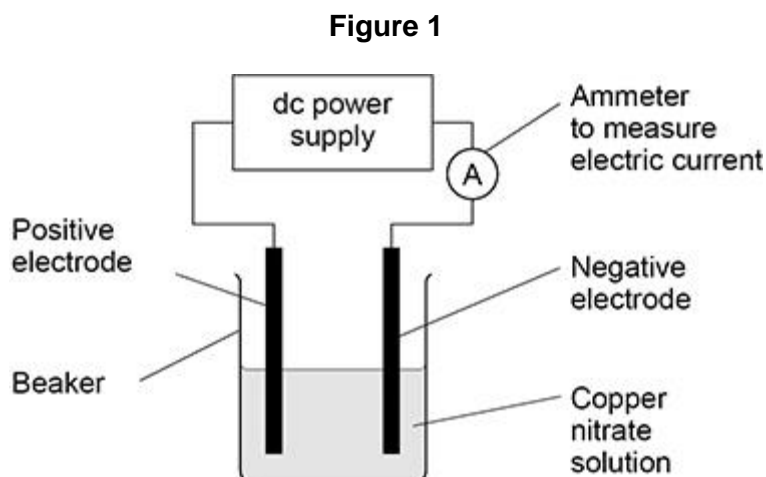
(2)

- (c) Two aqueous salt solutions are electrolysed using inert electrodes. Complete the table below to show the product at each electrode.

Salt solution	Product at positive electrode	Product at negative electrode
Copper nitrate		copper
Potassium iodide		

(3)

Some students investigated the electrolysis of copper nitrate solution using inert electrodes. **Figure 1** shows the apparatus.



The students investigated how the mass of copper produced at the negative electrode varied with:

- time
- current.





A student correctly concluded that the total mass of copper produced is directly proportional both to the time and to the current.

- (e) How do the results in **Figure 2** support the conclusion that the total mass of copper produced is directly proportional to the time?

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(1)

- (f) How do the results in **Figure 2** support the conclusion that the total mass of copper produced is directly proportional to the current?

Use data from **Figure 2** in your answer.

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(1)

- (g) Copper nitrate solution is blue.

Suggest why the blue colour of the copper nitrate solution fades during the electrolysis.

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(1)

- (h) Determine the number of atoms of copper produced when copper nitrate solution is electrolysed for 20 minutes at a current of 0.6 A

Give your answer to 3 significant figures.

Use **Figure 2**.

Relative atomic mass ( $A_r$ ): Cu = 63.5

The Avogadro constant =  $6.02 \times 10^{23}$  per mole

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Number of atoms (3 significant figures) = \_\_\_\_\_

(3)

(Total 17 marks)

**Q4.** Cells contain chemicals which react to produce electricity.

(a) Why can a rechargeable cell be recharged?

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(1)

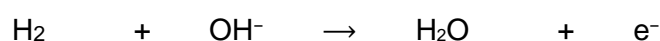
(b) Give **two** factors that affect the voltage produced by a cell.

1. \_\_\_\_\_

2. \_\_\_\_\_

(2)

(c) Balance the half-equation for the reaction occurring at an electrode in one type of hydrogen fuel cell.



(1)

(d) Why is the fuel cell in Question (c) described as an alkaline fuel cell?

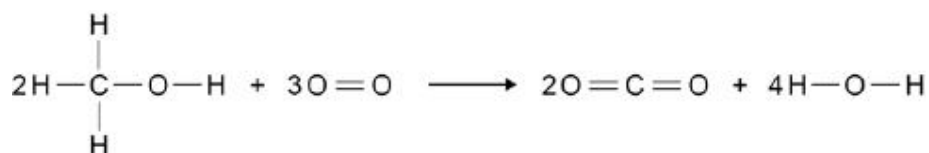
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(1)

(e) Another type of fuel cell uses methanol instead of hydrogen. The diagram represents the reaction in this fuel cell.



The table shows the bond energies for the reaction.

	C-H	C-O	O-H		O=O	C=O
Bond energy in kJ / mol	412	360	464		498	805

Calculate the overall energy change for the reaction. Use the diagram and table above.

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Overall energy change = \_\_\_\_\_ kJ / mol

(3)

(Total 8 marks)

