

Foundation

Question number	Description	Marks	Page number
4.4.1 Reactivity of metals			
1	Conservation of mass , multiple choice on physical states and oxidation reaction, simplifying percentage into a ratio, advantages of recycling copper	10	6
5	Why mass is lost in heating copper carbonate, calculating mean in results table, identifying anomalous result, suggesting improvement to method to ensure reaction is complete, drawing line of best fit on graph, graph interpolation, extrapolation calculation using values from graph	10	10
6	Matching variable from a method, completing a bar graph, (4.5.1 reason why reaction is not endothermic, reaction profile multiple choice), placing metals in order of reactivity, describing method to find position of a metal in reactivity series	12	14
4.4.2 Reactions of acids			
3	Calculating total mass from masses in a table in mg and then converting to g, gas produced multiple choice when calcium carbonate and hydrochloric acid react, elements from symbol formula, multiple choice to improve accuracy in method, multiple choice on variables	8	19
3	Ions found in acid and meaning of aq multiple choice, suggesting pH of solution after hydrochloric is added, describing method to identify three solids using information a results table of observations and pH when added to water and solubility of the solids in water	9	23
5	Skills question in context of calcium carbonate reacting with hydrochloric acid - state symbol, reason for decrease in mass when reaction happens, range in results table, calculate mean from results table, identifying variables, sentence gap fill, graph interpolation.	8	25
5	(4.1.1 elements, symbol and number of atoms in a compound), completing word equation for reaction, type of substance multiple choice, drawing labelled diagram for producing copper	13	29

	sulphate crystals, matching equipment to measurement, calculate concentration in g/dm³ from mass dissolved in cm³		
6	Matching measurement to equipment, calculating a mean temperature increase, improving accuracy multiple choice, completing word equation for hydrochloric acid and sodium hydroxide, matching up pH and colour of universal indicator	9	33
4.4.3 Electrolysis			
2	(4.4.2 acid for making a salt multiple choice, ordering stages of making salt), naming products for each electrode, reading change in Y and X axes and then calculating gradient, electrolysis of aluminium gap fill	11	36
4	Reading volume of gas in an inverted measuring cylinder, graph interpretation multiple choice, completing table on products at anode and cathode for different electrolytes	8	40
4	Balancing aluminium extraction symbol equation, explain why aluminium ions move toward electrode, how many electron aluminium ions gain at cathode, word equation for carbon dioxide production at anode, why anodes need to be replaced, explain why ceramic anode needs to have high melting point and be unreactive	14	46
5	Matching variable to description, reason for anomalous result multiple choice, predicting result from trend in results table, electrolysis gap fill, reason solid copper sulphate doesn't conduct electricity,	8	51

Common content

Question number	Description	Marks	Page number
4.4.1 Reactivity of metals			
1	Reactivity of metals from diagram of reaction with acid, naming control variables for experiment, naming independent variable, giving prediction and reason, calculate concentration in g/dm³ from mass dissolved in cm³	9	53
2	(4.1.1 and 4.1.3 number of subatomic particles in an atom, difference between group one and transition metal), explaining why carbon can be used to extract nickel from nickel oxide, calculation atom economy for symbol equation	11	55

4.4.2 Reactions of acids			
1	Naming type of substance that will form salt when reacted with acid, formula of calcium nitrate from ions, describe method to produce dry crystals of magnesium sulphate (6 marks)	8	57
2	Ions in acids, complete word equation, naming and reading volume in burette, describe how to carry out titration to find which of two samples is more concentrated (6 marks)	11	59
2	(4.8.2 gas test for carbon dioxide), method for describing dry pure crystals of magnesium chloride (6 marks)	8	62
2	Giving state symbol, formula of nitric acid, colour of universal indicator with different chemicals, results table to show change in pH when nitric acid added to ammonia solution, calculate percentage by mass of oxygen in ammonium nitrate	8	63
3	Describe method to prepare pure crystals of copper sulphate	6	65
4.4.3 Electrolysis			
1	Gas produced at anode, multiple choice about cathode product, calculate mean from results table, calculate trial 2 in results table where trial 1 and 3 and mean are given, calculate mass of solute in given volume in cm³ from concentration in g/dm³	8	66

Higher

Question number	Description	Marks	Page number
4.4.1 Reactivity of metals			
5	Plotting bar graph, describe method to find position of unknown metal in reactivity series (4.5.1 reaction profile)	10	69
5	Extraction of copper from copper oxide (4.5.1 explaining how observation shows a reaction in exothermic), calculate the mass of product produced from mass of reactant, explain why steps from method result in residue of copper, ion equation multiple choice	10	72
6	Formula of products when calcium carbonate is heated, calculating A_r and naming unknown element in a compound , calculate gradient on line on graph and give unit, extrapolation of graph reading	12	74

8	Name product of a reaction, suggest how to separate unreacted iron from iron chloride solution, calculate mass of product produced in reaction from a given mass of one reactant , explain which species is reduced in symbol equation for reaction – include half equations.	10	77
8	Suggesting reason for step in method, explaining a step in method, determine mass of products from results table (conservation of mass), calculating number of moles of products to determine ratio and therefore which of two balanced equations is correct.	8	79

4.4.2 Reactions of acids

5	Calculating number of moles in a mass given in mg, writing balanced symbol equation, identifying dependent variable, suggesting changes to method to improve accuracy, selecting how to display results and reason	14	83
7	Interpreting information/results on tests on different solids, identify and explain answers (6 marks), calculating pH of a solution when volume is increased from 10cm^3 to 1000cm^3 when distilled water is added	8	86
7	Plotting results on a graph and drawing line of best fit, reading value from graph, resolution of temperature sensor in standard form, suggesting ways of increasing accuracy, describe and give reasons for how pH of solution changes as hydrochloric acid is added to sodium hydroxide, calculate concentration in g/dm^3 from mass dissolved in cm^3	16	89
8	Reason for adding excess copper oxide when reacting with sulphuric acid to make copper sulphate, suggesting and explaining two improvements to a method, Determine how many moles copper oxide is in excess from mass of copper oxide and the volume and concentration of sulphuric acid	10	93
9	Explain why acid can be strong and dilute, calculate pH of a solution, calculate mean result from titration and then use this to calculate unknown concentration of solution , explain why a pipette is used to measure volume of sulphuric acid into conical flask, calculate mass of solute in given volume in cm^3 from concentration in mol/dm^3	12	95

4.4.3 Electrolysis

5	Why electrolysis is used to extract some metals, substances contained in molten mixture used to extract aluminium, half equation at cathode and anode, suggesting why deposited mass was less than expected, reading value from graph and then extrapolation, reading value from graph, calculate gradient and units for line of best fit	14	98
5	Substance produced at anode when copper sulphate electrolysed, explain the extent which results in table support a given conclusion, calculate number of moles , change in investigation to increase mass of product multiple choice	11	102
6	Explain why electrolysis would not work with solid zinc chloride, (4.2.3 explain why graphite conducts electricity), describe change in apparatus diagram to correct an error, describe the trend in results from a graph, calculate number of moles of chlorine collected from reading volume of gas off graph answer in standard form	14	105
7	Explain why cryolite used in aluminium extraction, cathode multiple choice, anode half equation for oxygen, explain why anode needed to be replaced, calculate mass of product when given balanced symbol equation and mass of reactant , explain why sodium chloride electrolysis doesn't produce sodium, calculate volume of 150kg of chlorine	16	109
8	Calculate mass of product when given balanced symbol equation and mass of reactant , half equation for production of aluminium at cathode, explain why cryolite used when extracting aluminium, explain why electrolysis of aluminium oxide produces carbon dioxide, giving and explaining properties of ceramic anode.	16	112

0 1

A teacher extracted copper from copper oxide.

This is the method used.

1. Mix 1.30 g of zinc and 1.59 g of copper oxide.
2. Heat the mixture strongly.
3. When the mixture starts to glow, stop heating.
4. Let the glow spread through the mixture.
5. Leave the mixture to cool.

0 1 . 1

This reaction is exothermic.

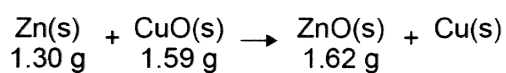
Which part of the method shows the reaction is exothermic?

[1 mark]

Tick **one** box.

Mix zinc and copper oxide	<input type="checkbox"/>
Heat the mixture	<input type="checkbox"/>
Let the glow spread	<input type="checkbox"/>
Leave to cool	<input type="checkbox"/>

The equation for the reaction between zinc and copper oxide is:



0 1 . 2

1.30 g of zinc fully reacted with 1.59 g of copper oxide to produce 1.62 g of zinc oxide.

What mass of copper was produced?

[1 mark]

Mass of copper produced = _____ g



0 1 . 3 What is the physical state of zinc oxide in the reaction?

[1 mark]

Tick **one** box.

Aqueous

☐

Gas

☐

Liquid

☐

Solid

☐

0 1 . 4 Which substance has been oxidised in the reaction?

[1 mark]

Tick **one** box.

Copper

☐

Copper oxide

☐

Zinc

☐

Zinc oxide

☐

0 1 . 5 What type of reaction takes place when zinc reacts with copper oxide?

[1 mark]

Tick **one** box.

Combustion

☐

Crystallisation

☐

Displacement

☐

Neutralisation

☐

Question 1 continues on the next page

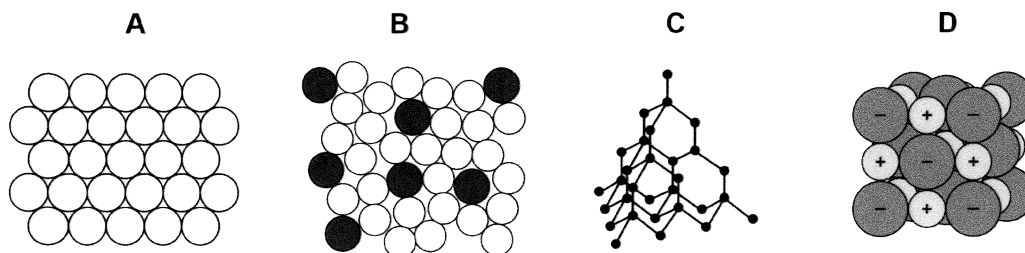
Turn over ►



Copper is a metal.

0 1 . 6 Which structure represents the arrangement of atoms in pure copper?

[1 mark]



Tick **one** box.

A	<input type="checkbox"/>
B	<input type="checkbox"/>
C	<input type="checkbox"/>
D	<input type="checkbox"/>

0 1 . 7 Copper is used in electrical wiring.

Give **one** reason why.

[1 mark]



0 1 . 8 In the UK, 40% of the copper we use is recycled copper.

The other 60% is copper obtained by mining.

What is the simplest ratio of recycled copper to copper obtained by mining?

[1 mark]

Tick **one** box.

2 : 3

☐

2 : 5

☐

4 : 10

☐

6 : 4

☐

0 1 . 9 What are **two** advantages of recycling copper?

[2 marks]

Tick **two** boxes.

Conserves copper ores

☐

Increase in greenhouse gases

☐

Less energy used

☐

More jobs for miners

☐

More space used at landfill

☐

10

Turn over for the next question

Turn over ►



0 5

A student investigated the mass of copper oxide produced by heating copper carbonate.

This is the method used.

1. Weigh an empty test tube.
2. Weigh 2.00 g of copper carbonate into the test tube.
3. Heat the copper carbonate until there appears to be no further change.
4. Re-weigh the test tube and copper oxide produced.
5. Subtract the mass of the empty tube to find the mass of copper oxide.
6. Repeat steps 1–5 twice.
7. Repeat steps 1–6 with different masses of copper carbonate.

Table 4 shows the student's results.

Table 4

Mass of copper carbonate in g	Mass of copper oxide in g			
	Trial 1	Trial 2	Trial 3	Mean
2.00	1.29	1.27	1.31	1.29
4.00	2.89	2.57	2.59	2.58
6.00	3.85	3.90	3.87	3.87
8.00	5.12	5.15	5.09	X
10.00	6.42	6.45	6.45	6.44

The equation for the reaction is:

**0 5 . 1**

Complete the sentence.

[1 mark]

The state symbol shows carbon dioxide is a _____.



0 5 . 2 Why do the contents of the test tube lose mass in the investigation?

[1 mark]

0 5 . 3 Calculate the mean mass **X** in **Table 4**.

[1 mark]

X = _____ g

0 5 . 4 One of the results in **Table 4** is anomalous.

Which result is anomalous?

[1 mark]

Mass of copper carbonate _____ g Trial _____

0 5 . 5 Suggest how the investigation could be improved to make sure the reaction is complete.

[2 marks]

Turn over ►



Another student repeated the investigation using magnesium carbonate instead of copper carbonate.

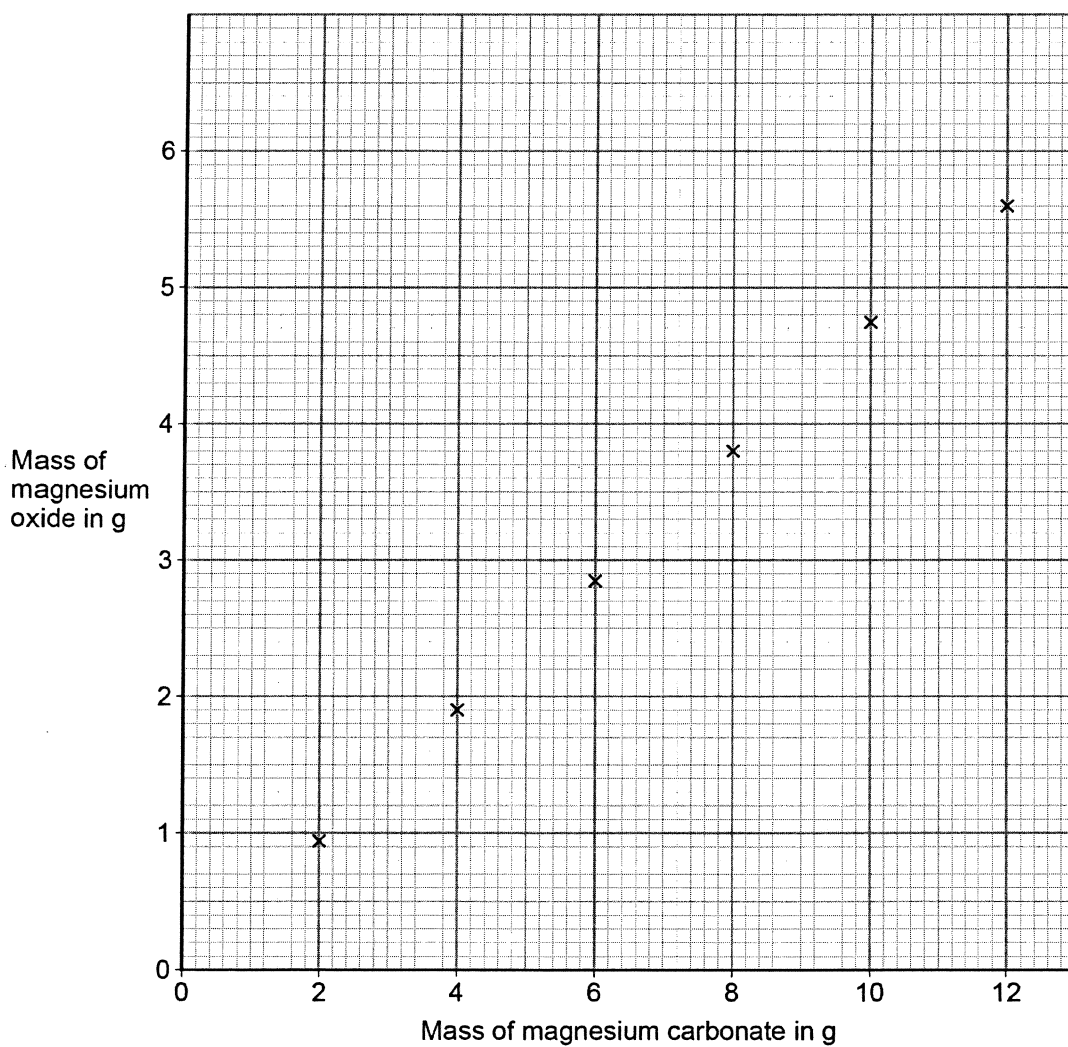
Do not write
outside the
box

The word equation for the reaction is:



Figure 8 shows the results of the investigation.

Figure 8



0 5 . 6Draw a line of best fit on **Figure 8**.**[1 mark]****0 5 . 7**

Determine the mass of magnesium oxide produced by 8.4 g of magnesium carbonate.

Use **Figure 8**.**[1 mark]**

Mass = _____ g

0 5 . 8

Calculate the mass of magnesium oxide produced when 168 g of magnesium carbonate is heated.

Use your answer to Question **05.7****[2 marks]**

Mass of magnesium oxide produced = _____ g

Turn over for the next question

10

Turn over ►



0 6

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

This is the method used.

1. Measure 50 cm³ of the copper sulfate solution into a polystyrene cup.
2. Record the starting temperature of the copper sulfate solution.
3. Add the metal and stir the solution.
4. Record the highest temperature the mixture reaches.
5. Calculate the temperature increase for the reaction.
6. Repeat steps 1-5 with different metals.

0 6

1

Draw **one** line from each type of variable to the name of the variable in the investigation.

[2 marks]

Type of variable

Name of variable in the
investigation

Concentration of solution

Dependent variable

Particle size of solid

Temperature change

Independent variable

Type of metal

Volume of solution



0 6 . 2 The student used a polystyrene cup and **not** a glass beaker.

Why did this make the investigation more accurate?

[1 mark]

Tick **one** box.

Glass is breakable

☐

Glass is transparent

☐

Polystyrene is a better insulator

☐

Polystyrene is less dense

☐

Question 6 continues on the next page

Turn over ►



Table 5 shows the student's results.

Do not write
outside the
box

Table 5

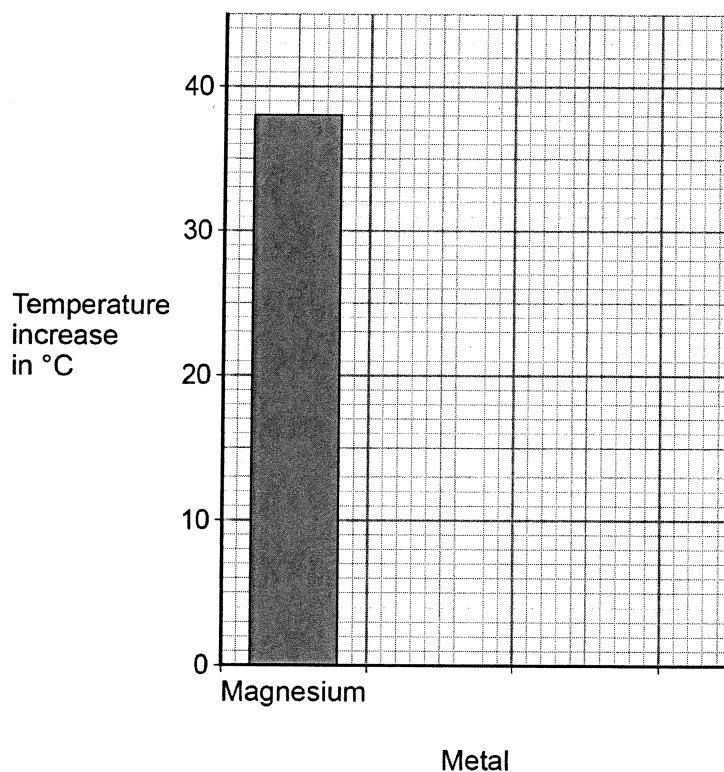
Metal	Temperature increase in °C
Magnesium	38
Nickel	8
Zinc	16

0 6 3 Complete Figure 9.

Use data from Table 5.

[2 marks]

Figure 9



- 06.4** The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

- 06.5** The temperature increase depends on the reactivity of the metal.

Write the metals magnesium, nickel and zinc in order of reactivity.

Use **Table 5**.

[1 mark]

Most reactive _____

Least reactive _____

- 06.6** Y is an unknown metal.

Describe a method to find the position of Y in the reactivity series in Question **06.5**

[3 marks]

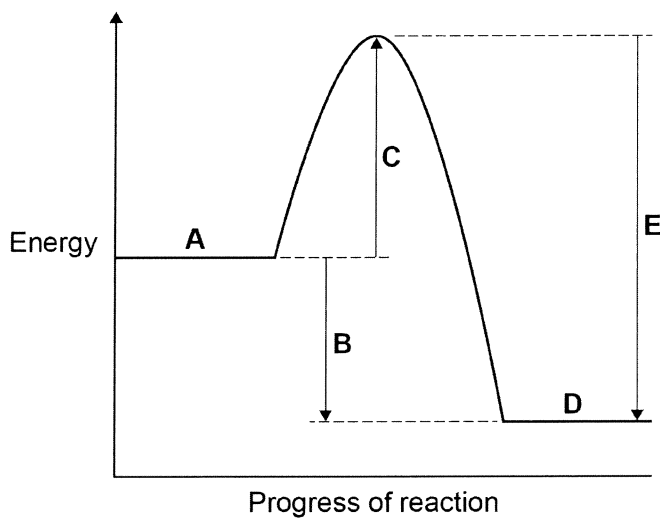
Turn over ►



Figure 10 shows the reaction profile for the reaction between zinc and copper sulfate solution.

*Do not write
outside the
box*

Figure 10



0 6 . 7 Which letter represents the products of the reaction?

[1 mark]

Tick **one** box.

A		B		C		D		E	
----------	--	----------	--	----------	--	----------	--	----------	--

0 6 . 8 Which letter represents the activation energy?

[1 mark]

Tick **one** box.

A		B		C		D		E	
----------	--	----------	--	----------	--	----------	--	----------	--



0 3

Table 3 shows the mass of each ingredient in an indigestion tablet.

Table 3

Ingredient	Mass in milligrams
Calcium carbonate	522
Magnesium carbonate	68
Sodium hydrogencarbonate	64
Other substances	146

0 3 . 1

Calculate the mass of the indigestion tablet in grams.

[2 marks]

Mass of tablet in milligrams = _____

Mass of tablet in grams = _____

0 3 . 2

Calcium carbonate in the indigestion tablet reacts with hydrochloric acid in the stomach.

Which gas is produced?

[1 mark]

Tick (✓) **one** box.

Carbon dioxide

☐

Chlorine

☐

Hydrogen

☐

Oxygen

☐

0 3 . 3Sodium hydrogencarbonate has the chemical formula NaHCO_3

How many different elements are in sodium hydrogencarbonate?

[1 mark]Tick (✓) **one** box.

3

☐

4

☐

5

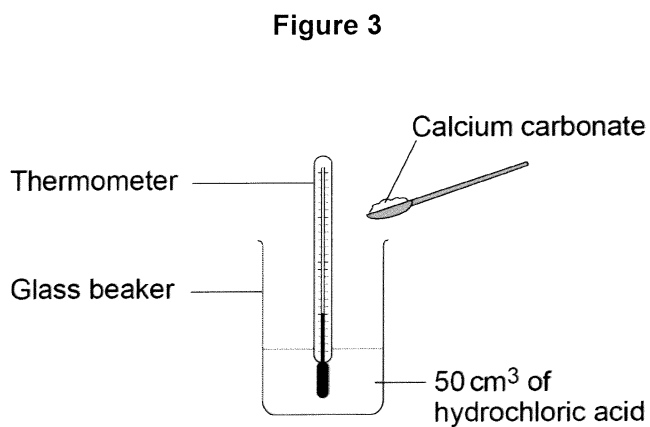
☐

6

☐**Question 3 continues on the next page****Turn over ►**

A student investigated the temperature change when different masses of calcium carbonate were reacted with 50 cm³ of hydrochloric acid.

Figure 3 shows the apparatus used.



This is the method used.

1. Add 50 cm³ of hydrochloric acid to a glass beaker.
2. Record the temperature of the hydrochloric acid.
3. Add 1 g of calcium carbonate to the hydrochloric acid.
4. Stir the mixture.
5. Record the highest temperature of the mixture.
6. Repeat steps 1–5 with different masses of calcium carbonate.

0 3 . 4

Which **two** changes would increase the accuracy of the results?**[2 marks]**Tick (✓) **two** boxes.

Add a lid to the top of the glass beaker

☐

Add indicator to the hydrochloric acid

☐Use 100 cm³ of hydrochloric acid☐

Use a polystyrene cup instead of the glass beaker

☐

Use a thermometer with intervals of 5 °C instead of 1 °C

☐

0 3 . 5

The student added different masses of calcium carbonate to the hydrochloric acid.

Which **two** terms describe the mass of calcium carbonate in this investigation?**[2 marks]**Tick (✓) **two** boxes.

Categoric variable

☐

Continuous variable

☐

Control variable

☐

Dependent variable

☐

Independent variable

☐

Turn over ►



0 3

This question is about acids and bases.

0 3**1**

Which ion is found in all acids?

[1 mark]Tick **one** box. Cl^- ☐ H^+ ☐ Na^+ ☐ OH^- ☐**0 3****2**

Zinc nitrate can be produced by reacting an acid and a metal oxide.

Name the acid and the metal oxide used to produce zinc nitrate.

[2 marks]

Acid _____

Metal oxide _____

0 3**3**In an equation, zinc nitrate is written as $\text{Zn}(\text{NO}_3)_2(\text{aq})$.

What does (aq) mean?

[1 mark]Tick **one** box.

Dissolved in water

☐

Insoluble

☐

Not all reacted

☐

Reactant

☐**0 3****4**

The pH of a solution is 8

Some hydrochloric acid is added to the solution.

Suggest the pH of the solution after mixing.

[1 mark]

pH = _____

Turn over ►

0 3 . 5

Table 2 shows the solubility of three solids in water at room temperature.

Table 2

Solid	The mass of the solid that dissolves in 100 cm ³ of water
Phosphorus oxide	50 g
Silicon dioxide	0 g
Sodium hydroxide	100 g

A teacher labelled these three solids **A**, **B** and **C**.

She gave a student the information shown in **Table 3**

Table 3

Solid	Observation when added to water	pH of the solid in water
A	colourless solution	14
B	colourless solution	2
C	solid does not dissolve	7

Describe a method that could be used to identify each of the three solids **A**, **B** and **C**.

You must use an indicator in the method.

Use information in **Table 2** and **Table 3**

[4 marks]



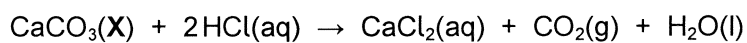
0	5
---	---

A student investigated the reaction between lumps of calcium carbonate and dilute hydrochloric acid.

This is the method used.

1. Pour 100 cm³ of dilute hydrochloric acid into a conical flask.
2. Place the conical flask on a balance.
3. Add 2 g of calcium carbonate lumps to the conical flask.
4. Wait until the calcium carbonate stops reacting.
5. Record the decrease in mass of the conical flask and contents.
6. Repeat steps 1 to 5 three more times.

The equation for the reaction is:



0	5
---	---

1

What is the state symbol **X** in the equation?

[1 mark]

Tick (✓) **one** box.

aq

☐

g

☐

l

☐

s

☐

Table 2 shows the student's results.

Table 2

	Result 1	Result 2	Result 3	Result 4
Decrease in mass of the conical flask and contents in g	0.84	0.79	0.86	0.47

0 5 . 2 Why does the mass of the conical flask and contents decrease during the reaction? **[1 mark]**

Tick (✓) **one** box.

A gas escapes.

☐

A new solution is made.

☐

The dilute hydrochloric acid is used up.

☐

The calcium carbonate lumps decrease in size.

☐

0 5 . 3 What is the range of the four results in **Table 2**? **[1 mark]**

From _____ g to _____ g

0 5 . 4 Calculate the mean decrease in mass of the conical flask and contents.

Do **not** include the anomalous result.

Use **Table 2**.

[2 marks]

Mean decrease in mass = _____ g

Turn over ►

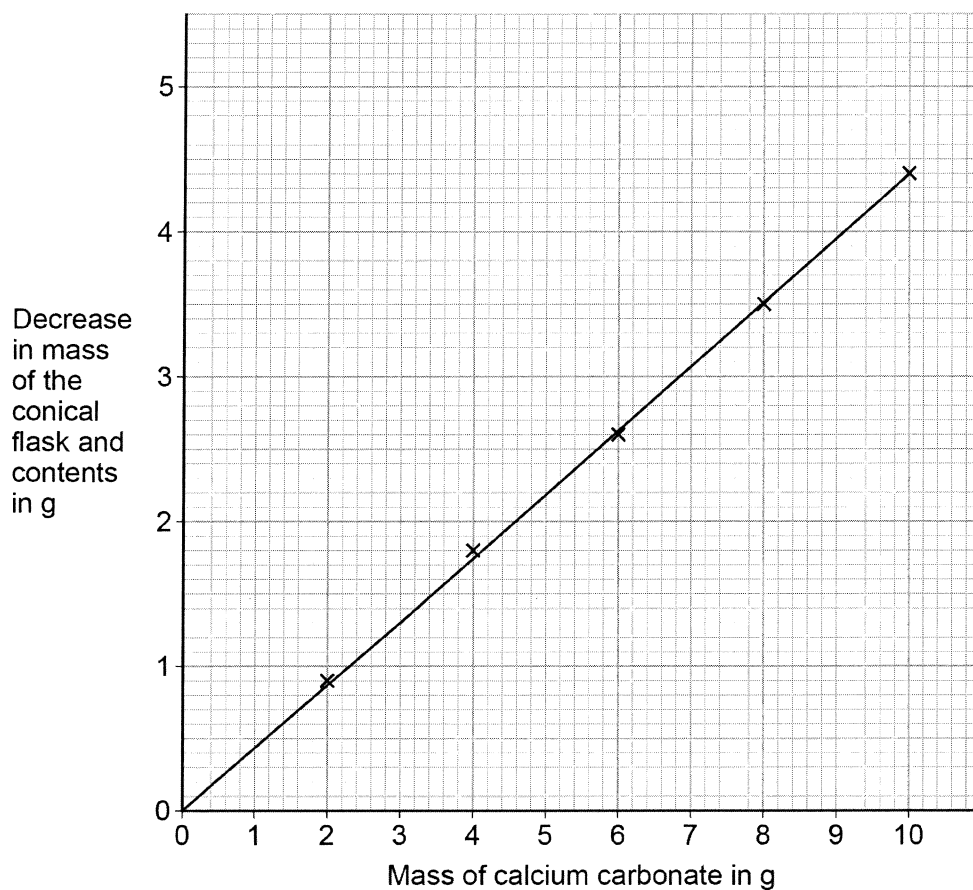


A teacher demonstrated the investigation.

The teacher used different masses of calcium carbonate.

Figure 8 shows the teacher's results.

Figure 8



0 5 . 5 What type of variable is the mass of calcium carbonate?

[1 mark]

Tick (✓) **one** box.

Control

☐

Dependent

☐

Independent

☐

Use **Figure 8** to answer Questions **05.6** and **05.7**

0 5 . 6 Complete the sentence.

[1 mark]

As the mass of calcium carbonate used increases, the decrease in mass of the conical flask and contents _____.

0 5 . 7 What is the decrease in mass of the conical flask and contents when a 3 g sample of calcium carbonate is used?

[1 mark]

Decrease in mass = _____ g

8

Turn over for the next question

Turn over ►



0 5

This question is about copper sulfate.

0 5 . 1

The formula of copper sulfate is CuSO_4 **Table 5** shows information about the atoms in copper sulfate.Complete **Table 5**.**[3 marks]****Table 5**

Element	Symbol	Relative number of atoms in CuSO_4
	Cu	
Sulfur		
		4

Copper oxide and sulfuric acid react to produce copper sulfate and water.

0 5 . 2

Complete the word equation for this reaction.

[1 mark]

_____ + _____ \longrightarrow _____ + water

0 5 . 3

What type of substance is copper oxide?

[1 mark]Tick (✓) **one** box.

A base

☐

A metal

☐

A salt

☐

An acid

☐**Question 5 continues on the next page****Turn over ►**

A student planned to make blue copper sulfate crystals.

This is the method the student used.

1. Add 25 cm³ of dilute sulfuric acid to a conical flask.
2. Gently warm the dilute sulfuric acid.
3. Add 2 g of black copper oxide to the dilute sulfuric acid.
4. Stir the mixture.
5. Evaporate some of the water from the mixture using an electric heater.
6. Leave the mixture to cool.

Not all the copper oxide reacted. The student did not remove the excess copper oxide.

0 5 . 4 What would the product look like after step 6?

[1 mark]

Tick (✓) **one** box.

Black powder only

☐

Blue crystals and black powder

☐

Blue crystals only

☐

Blue solution only

☐

0 5 . 5 The student should have filtered the mixture after step 4.

Draw a diagram of the apparatus the student could use.

You should label:

- the pieces of equipment used
- where the excess copper oxide collects.

[3 marks]

Question 5 continues on the next page

Turn over ►



0 5 . 6

What equipment should the student use to measure:

- 2 g of copper oxide
- 25 cm³ of dilute sulfuric acid?

Draw **one** line from each measurement to the most suitable piece of equipment.**[2 marks]****Measurement****Equipment**

	Balance
2 g of copper oxide	Beaker
	Measuring cylinder
25 cm ³ of dilute sulfuric acid	Metre rule
	Thermometer

0 5 . 7

1 g of copper sulfate is dissolved in water to make 25 cm³ of copper sulfate solution.Calculate the concentration of the copper sulfate solution in g/dm³**[2 marks]**

Concentration = _____ g/dm³

13



0 6

A teacher demonstrated the temperature change when hydrochloric acid is added to sodium hydroxide.

This is the method used.

1. Add 25.0 cm^3 of sodium hydroxide solution to a polystyrene cup.
2. Measure the temperature of the sodium hydroxide solution.
3. Add 25.0 cm^3 of hydrochloric acid to the sodium hydroxide solution.
4. Stir the solution.
5. Measure the maximum temperature of the solution.

0 6**1**

Draw **one** line from each measurement to the most suitable piece of equipment to use to make the measurement.

[2 marks]**Measurement****Equipment**

	balance
Temperature of solution	beaker
	measuring cylinder
Volume of hydrochloric acid	metre rule
	thermometer



0 6 . 2 The teacher did the experiment four times.

Table 1 shows the teacher's results.

Table 1

Experiment	Maximum temperature rise in °C
1	6.1
2	7.8
3	6.1
4	6.4

Calculate the mean maximum temperature rise.

Do **not** use the anomalous result in your calculation.

[2 marks]

Mean maximum temperature rise = _____ °C

0 6 . 3 How could the accuracy of the experiment be improved?

[1 mark]

Tick **one** box.

Add 20.0 cm³ of hydrochloric acid

☐

Use a lid on the polystyrene cup

☐

Use a metal beaker

☐

Use a thermometer with a resolution of 1 °C

☐

Question 6 continues on the next page

Turn over ►



The reaction between hydrochloric acid and sodium hydroxide is a neutralisation reaction.

The reaction produces a salt and one other product.

0 6 . 4 Complete the word equation for the reaction.

[2 marks]

hydrochloric acid + sodium hydroxide \rightarrow _____ + _____

0 6 . 5 Universal indicator is used to measure the pH of solutions.

Hydrochloric acid is pH 1

Sodium hydroxide is pH 13

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

[2 marks]

pH	Colour of universal indicator
	green
1	orange
	purple
13	red
	yellow



0 2

This question is about salts and electrolysis.

A student wants to make copper chloride crystals.

The student adds excess copper oxide to some hot acid.

The student stirs the mixture.

0 2 . 1

Which acid should the student use?

[1 mark]

Tick (✓) **one** box.

Hydrochloric acid

☐

Nitric acid

☐

Sulfuric acid

☐**0 2 . 2**

Suggest how the student would know that excess copper oxide has been added.

[1 mark]

Question 2 continues on the next page

Turn over ►

0 2 . 3

There are four more stages, **A**, **B**, **C** and **D**, to make copper chloride crystals.

The stages **A**, **B**, **C** and **D** are not in the correct order.

Stage **A** Partially evaporate by heating with a water bath

Stage **B** Filter the mixture into an evaporating basin

Stage **C** Leave to crystallise

Stage **D** Remove and dry the crystals

Put stages **A**, **B**, **C** and **D** in the correct order.

[2 marks]

First stage _____

Second stage _____

Third stage _____

Fourth stage _____

0 2 . 4

Molten copper chloride can be electrolysed.

State the product at each electrode when molten copper chloride is electrolysed.

[2 marks]

Negative electrode _____

Positive electrode _____

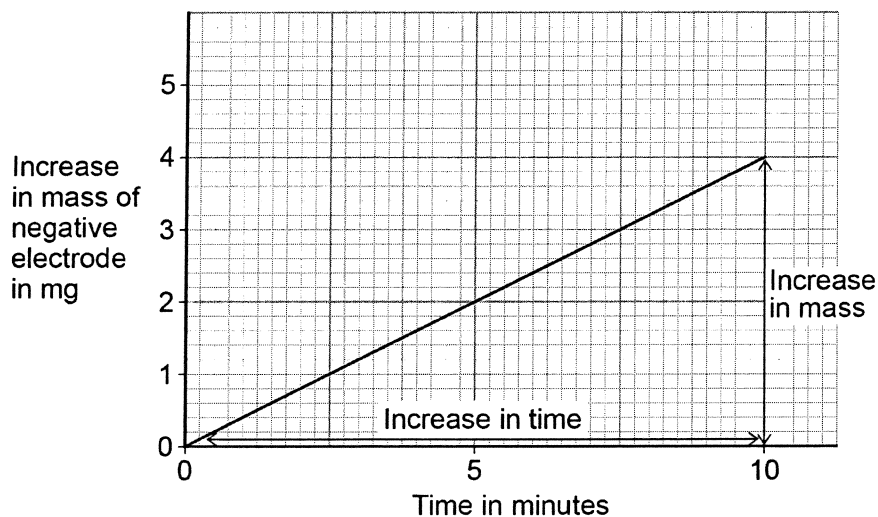


0 2 . 5

A solution of copper chloride is electrolysed.

Figure 3 shows a graph of the increase in mass of the negative electrode.

This increase is shown over a time of 10 minutes.

Figure 3Calculate the gradient of the line in **Figure 3**.

Use the equation:

$$\text{Gradient} = \frac{\text{increase in mass in mg}}{\text{increase in time in minutes}}$$

[3 marks]

Increase in mass _____

Increase in time _____

Gradient _____

Gradient = _____ mg per minute

Turn over ►

0 2 . 6

Aluminium is produced by electrolysis of a molten mixture.

Complete the sentence.

Choose the answers from the box.

[2 marks]

carbon

chloride

cryolite

oxide

sulfate

water

The molten mixture contains _____ and
aluminium _____.

11

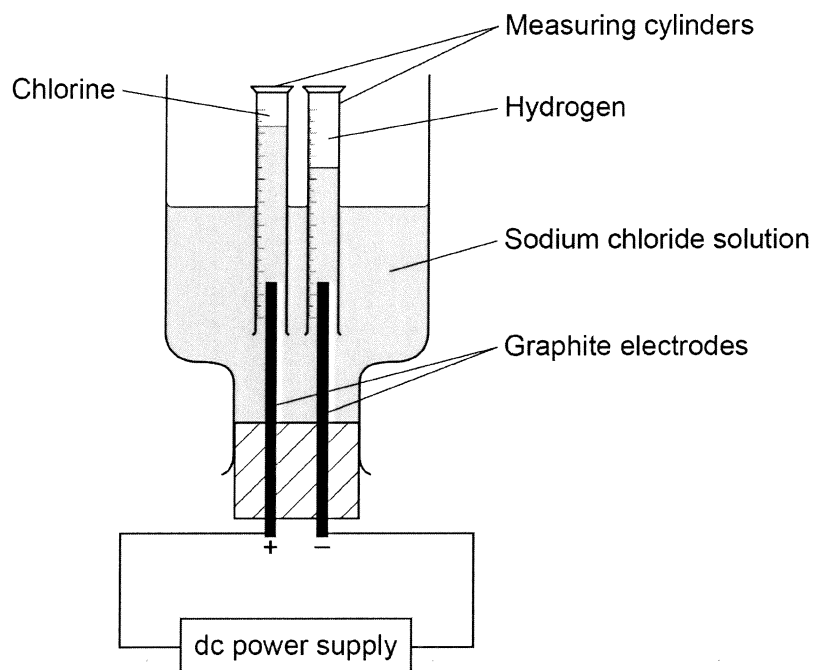
0	4
---	---

A student investigated the electrolysis of sodium chloride solution.

*Do not write
outside the
box*

Figure 4 shows the apparatus.

Figure 4



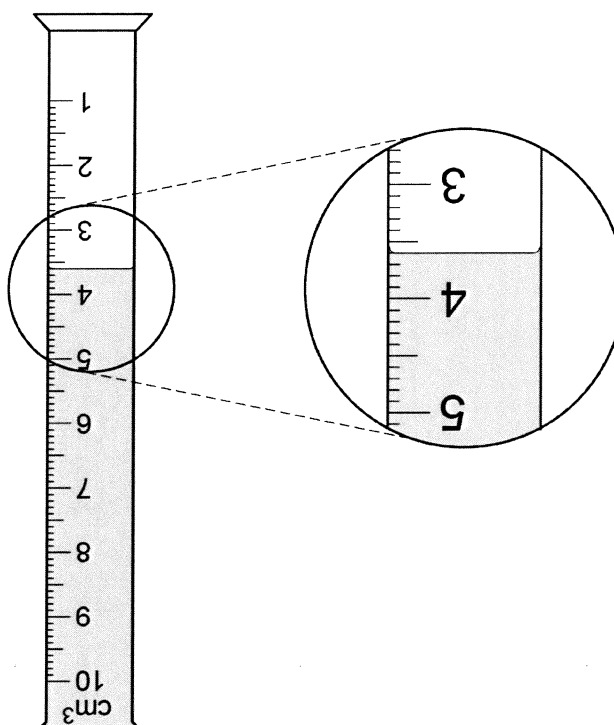
The student measured the volume of gas collected in each measuring cylinder every minute for 20 minutes.



0 4 . 1

Figure 5 shows the volume of hydrogen gas collected in the measuring cylinder after 8 minutes.

Figure 5



What is the volume of hydrogen gas collected?

[1 mark]

Volume = _____ cm³

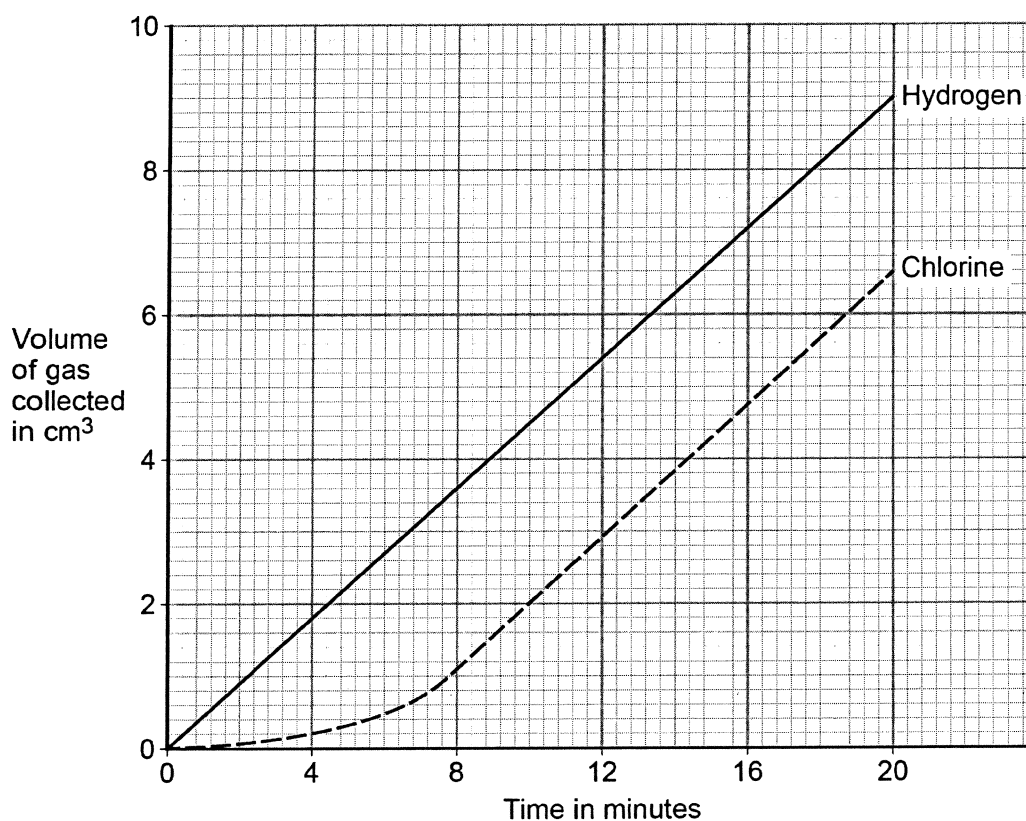
Question 4 continues on the next page

Turn over ►



Figure 6 shows the results of the investigation.

Figure 6



0 4 . 2

Which of the lines on **Figure 6** show that the volume of gas collected is directly proportional to the time?

[1 mark]

Tick **one** box.

Both lines

☐

Chlorine line only

☐

Hydrogen line only

☐

Neither line

☐


0 4 . 3

Which of the lines on **Figure 6** show a positive correlation between the volume of gas collected and time?

[1 mark]Tick **one** box.

Both lines

☐

Chlorine line only

☐

Hydrogen line only

☐

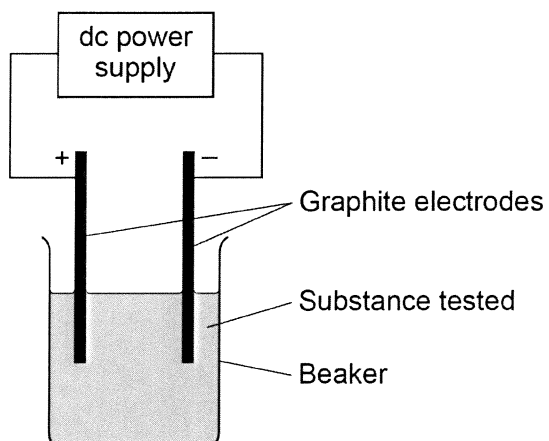
Neither line

☐**Question 4 continues on the next page****Turn over ►**

A teacher demonstrates the electrolysis of different substances using graphite electrodes.

Figure 7 shows the apparatus used.

Figure 7



0 4 . 4 Why can graphite conduct electricity?

[1 mark]

Tick **one** box.

Graphite exists in layers of atoms.

☐

Graphite has a giant structure.

☐

Graphite has a high melting point.

☐

Graphite has delocalised electrons.

☐


0 4 . 5

The teacher demonstrates the electrolysis of:

- molten zinc chloride
- potassium bromide solution.

Complete **Table 3** to predict the products.

Choose answers from the box.

[4 marks]

chlorine bromine hydrogen oxygen potassium zinc

Table 3

Substance electrolysed	Product at cathode (negative electrode)	Product at anode (positive electrode)
Molten zinc chloride		
Potassium bromide solution		

Turn over for the next question

8

Turn over ►



0 4

The country Iceland is a major producer of aluminium.

Aluminium is extracted from aluminium oxide using electrolysis.

Electrolysis requires a large amount of electricity.

Iceland generates all of its electricity from renewable resources.

0 4 . 1

Which of the following is a renewable resource?

[1 mark]

Tick (✓) **one** box.

Coal

☐

Crude oil

☐

Hydroelectricity

☐

Nuclear fuel

☐**0 4 . 2**

Why is aluminium produced in Iceland?

[1 mark]

Tick (✓) **one** box.

Conserves aluminium ore

☐

Plentiful supply of cheap electricity

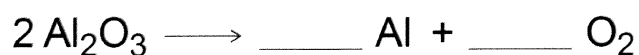
☐

Uses up non-renewable resources

☐**0 4 . 3**

Aluminium is extracted from aluminium oxide.

Complete the balanced equation for the reaction.

[2 marks]

0 4 . 4 What type of reaction takes place when oxygen is removed from aluminium oxide? **[1 mark]**

Tick (✓) **one** box.

Combustion

☐

Neutralisation

☐

Reduction

☐

0 4 . 5 During electrolysis, aluminium ions (Al^{3+}) move towards the negative electrode.

Explain why aluminium ions move towards the negative electrode.

[2 marks]

0 4 . 6 At the negative electrode, an aluminium ion (Al^{3+}) gains electrons to become an aluminium atom.

How many electrons does each aluminium ion gain?

[1 mark]

Number of electrons = _____

0 4 . 7 The positive electrode is made of carbon.

Oxygen is produced at the positive electrode.

The oxygen reacts with the carbon.

Complete the word equation for the reaction.

[1 mark]

carbon + oxygen \longrightarrow _____

Turn over ►



0 4 . 8

Why do the positive electrodes need to be replaced regularly?

[1 mark]

0 4 . 9

A ceramic material can be used as the positive electrode in the electrolysis of aluminium oxide.

The ceramic material has the following properties:

- high melting point
- unreactive.

Explain why each property is important when the ceramic material is used in the electrolysis of aluminium oxide.

[4 marks]

High melting point

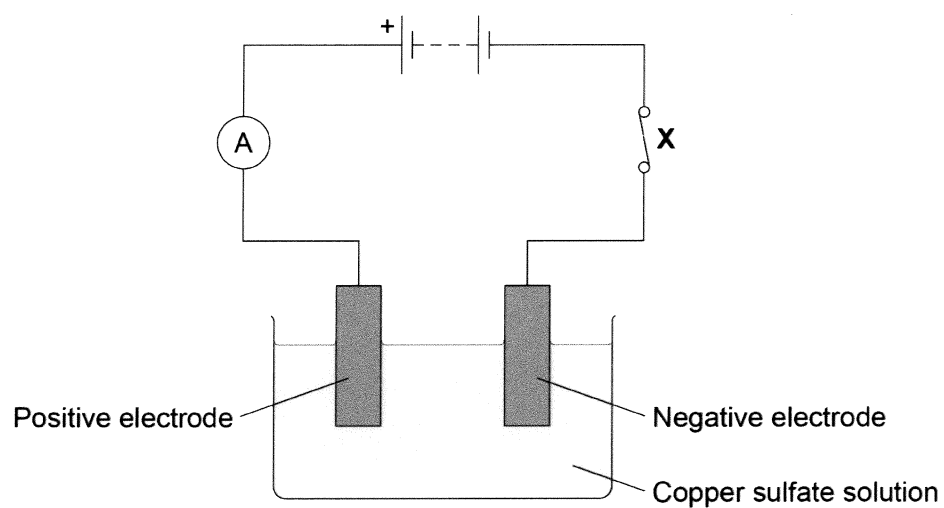
Unreactive



0 5

Figure 9 shows the apparatus used to pass a current through copper sulfate solution.

Figure 9



0 5 . 1

What is the name of component X in Figure 9?

[1 mark]

Tick **one** box.

Ammeter

☐

Battery

☐

Fuse

☐

Switch

☐

0 5 . 2 What is the name of the process happening in **Figure 9**?

[1 mark]

Tick **one** box.

Combustion

☐

Crystallisation

☐

Distillation

☐

Electrolysis

☐

A student investigated how the concentration of copper sulfate solution affects the mass of copper deposited on the negative electrode.

0 5 . 3 What are the independent and dependent variables in this investigation?

Draw **one** line from each type of variable to the correct description.

[2 marks]

Type of variable

Description

Independent variable

Dependent variable

Concentration of
copper sulfate solution

Distance between
electrodes

Mass of copper
deposited

Time circuit is switched
on for

Question 5 continues on the next page

Turn over ►



Table 5 shows the student's results.

Table 5

Concentration of copper sulfate solution in g/dm^3	Mass of copper deposited in grams
30	0.04
60	0.08
90	0.12
120	0.07
150	0.20

0 5 . 4 The result for the concentration of 120 g/dm^3 is anomalous.

What may have caused the anomalous result?

[1 mark]

Tick **one** box.

Some copper fell off the electrode

☐

The circuit was switched on for too much time

☐

The concentration of the solution was too high

☐

0 5 . 5 Predict the expected mass of copper deposited for the concentration of 120 g/dm^3

Use Table 5.

[1 mark]

Mass of copper = _____ g



0 5 . 6 During the investigation copper ions move to the negative electrode.

Complete the sentence.

Choose the answer from the box.

[1 mark]

a negative charge

a positive charge

no charge

Copper ions move to the negative electrode because copper ions have

_____.

0 5 . 7 Solid copper sulfate does **not** conduct electricity.

What is the reason for this?

[1 mark]

Tick **one** box.

The charge on the ions is too high

☐

The ions are too big

☐

The ions are too small

☐

The ions cannot move

☐

Question 5 continues on the next page

8

Turn over ►

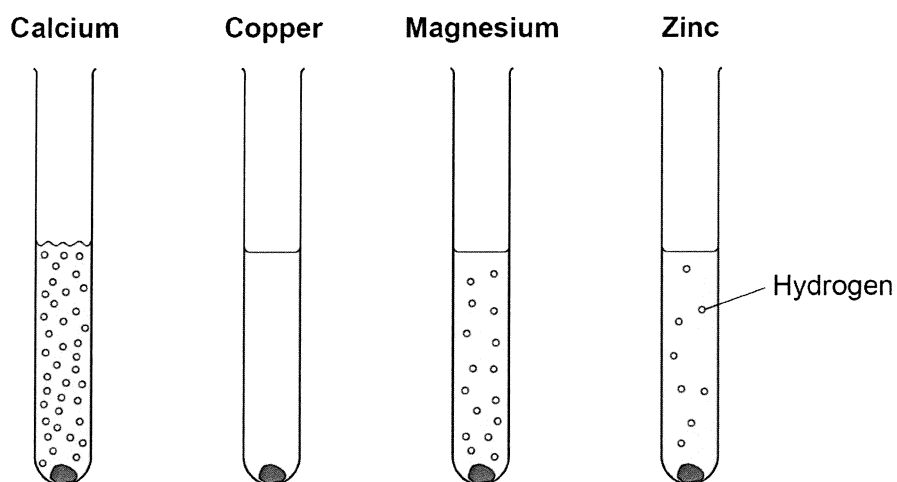


0 1

This question is about reactions of metals.

Figure 1 shows what happens when calcium, copper, magnesium and zinc are added to hydrochloric acid.

Figure 1



0 1

1

What is the order of decreasing reactivity of these four metals?

[1 mark]

Tick (✓) **one** box.

Zn Ca Cu Mg

☐

Ca Cu Mg Zn

☐

Cu Zn Ca Mg

☐

Ca Mg Zn Cu

☐


A student wants to make a fair comparison of the reactivity of the metals with hydrochloric acid.

0 1 . 2 Name **two** variables that must be kept constant.

[2 marks]

1 _____

2 _____

0 1 . 3 What is the independent variable in this reaction?

[1 mark]

0 1 . 4 Predict the reactivity of beryllium compared with magnesium.

Give a reason for your answer.

Use the periodic table.

[2 marks]

Reason _____

0 1 . 5 A solution of hydrochloric acid contains 3.2 g of hydrogen chloride in 50 cm³

Calculate the concentration of hydrogen chloride in g per dm³

[3 marks]

Concentration = _____ g per dm³

Turn over ►



0 2

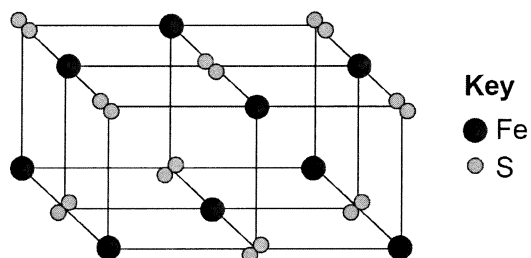
This question is about metals and metal compounds.

0 2 . 1

Iron pyrites is an ionic compound.

Figure 1 shows a structure for iron pyrites.

Figure 1



Determine the formula of iron pyrites.

Use Figure 1.

[1 mark]

0 2 . 2

An atom of iron is represented as ${}^{56}_{26}\text{Fe}$

Give the number of protons, neutrons and electrons in this atom of iron.

[3 marks]

Number of protons _____

Number of neutrons _____

Number of electrons _____

0 2 . 3

Iron is a transition metal.

Sodium is a Group 1 metal.

Give **two** differences between the properties of iron and sodium.

[2 marks]

1 _____

2 _____



Nickel is extracted from nickel oxide by reduction with carbon.

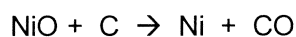
0 2 . 4

Explain why carbon can be used to extract nickel from nickel oxide.

[2 marks]

0 2 . 5

An equation for the reaction is:



Calculate the percentage atom economy for the reaction to produce nickel.

Relative atomic masses (A_r): C = 12 Ni = 59

Relative formula mass (M_r): NiO = 75

Give your answer to 3 significant figures.

[3 marks]

Percentage atom economy = _____ %

Turn over ►



Give **one** other type of substance that can react with an acid to form a soluble salt.

Calcium nitrate contains the ions Ca^{2+} and NO_3^-

[1 mark]

Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.



*Do not write
outside the
box*

Turn over for the next question

8

Turn over ►



0 2

This question is about acids and alkalis.

0 2 . 1

Which ion do all acids produce in aqueous solution?

[1 mark]Tick (✓) **one** box. H^+ ☐ H^- ☐ O^{2-} ☐ OH^- ☐**0 2 . 2**

Calcium hydroxide solution reacts with an acid to form calcium chloride.

Complete the word equation for the reaction.

[2 marks]

calcium hydroxide + _____ acid → calcium chloride + _____

Question 2 continues on the next page

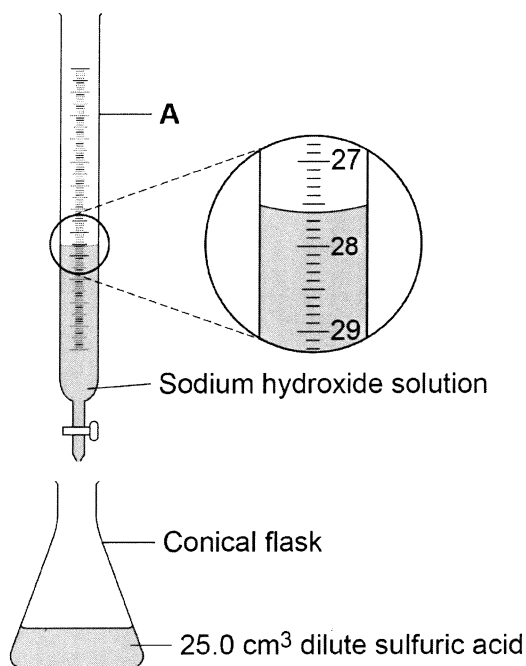
Turn over ►



A student investigates the volume of sodium hydroxide solution that reacts with 25.0 cm^3 of dilute sulfuric acid.

Figure 2 shows the apparatus the student uses.

Figure 2



Use **Figure 2** to answer Questions **02.3** and **02.4**

0 2 . 3 Name apparatus **A**.

[1 mark]

0 2 . 4 What is the reading on apparatus **A**?

[1 mark]

_____ cm^3



Do not write
outside the
box

0	2	.	5
---	---	---	---

The higher the concentration of a sample of dilute sulfuric acid, the greater the volume of sodium hydroxide needed to neutralise the acid.

The student tested two samples of dilute sulfuric acid, **P** and **Q**.

Describe how the student could use titrations to find which sample, **P** or **Q**, is more concentrated.

[6 marks]

This image shows a single page of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page, leaving small margins at the top and bottom. There is no handwriting or other markings on the paper.

11

Turn over ►



0	2
---	---

When a metal carbonate reacts with an acid, a salt, carbon dioxide and water are produced.

0	2	.	1
---	---	---	---

Describe how you would test for carbon dioxide gas.

Give the result of the test.

[2 marks]

Test _____

Result _____

0	2	.	2
---	---	---	---

Describe how to make pure dry crystals of magnesium chloride from magnesium carbonate and a dilute acid.

In your method you should name the apparatus and reagents you plan to use.

[6 marks]

Turn over ►



0 2

This question is about salts.

Ammonium nitrate solution is produced when ammonia gas reacts with nitric acid.

0 2 . 1

Give the state symbol for ammonium nitrate solution.

[1 mark]

0 2 . 2

What is the formula of nitric acid?

[1 mark]Tick (✓) **one** box.

HCl

☐HNO₃☐H₂SO₄☐NH₄OH☐**0 2 . 3**

Ammonia gas dissolves in water to produce ammonia solution.

Ammonia solution contains hydroxide ions, OH⁻

A student adds universal indicator to solutions of nitric acid and ammonia.

What colour is observed in each solution?

[2 marks]

Colour in nitric acid

Colour in ammonia solution



0 2 . 4

The student gradually added nitric acid to ammonia solution.

Which row, **A**, **B**, **C** or **D**, shows the change in pH as the nitric acid is added until in excess?**[1 mark]**Tick (✓) **one** box.

	pH of ammonia solution at start	pH after addition of excess nitric acid	
A	10	7	<input type="checkbox"/>
B	2	10	<input type="checkbox"/>
C	7	1	<input type="checkbox"/>
D	10	2	<input type="checkbox"/>

0 2 . 5

Calculate the percentage by mass of oxygen in ammonium nitrate (NH_4NO_3).Relative atomic masses (A_r): H = 1 N = 14 O = 16Relative formula mass (M_r): $\text{NH}_4\text{NO}_3 = 80$ **[3 marks]**

Percentage by mass of oxygen = _____ %

8

Question 2 continues on the next page

Turn over ►



The student's method is:

- The method contains several errors and does not produce copper sulfate crystals.

[6 marks]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

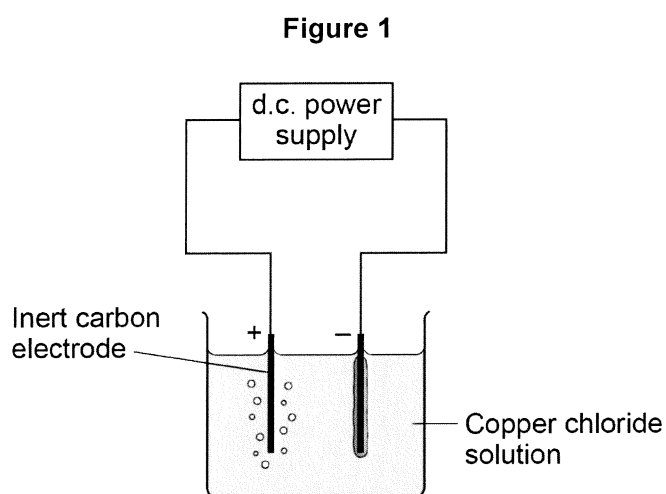
E

0 1

This question is about electrolysis.

A student investigates the mass of copper produced during electrolysis of copper chloride solution.

Figure 1 shows the apparatus.



0 1 . 1

Which gas is produced at the positive electrode (anode)?

[1 mark]

Tick **one** box.

carbon dioxide

☐

chlorine

☐

hydrogen

☐

oxygen

☐

0 1 . 2 Copper is produced at the negative electrode (cathode).

What does this tell you about the reactivity of copper?

[1 mark]

Tick **one** box.

Copper is less reactive than hydrogen

☐

Copper is less reactive than oxygen

☐

Copper is more reactive than carbon

☐

Copper is more reactive than chlorine

☐

Table 1 shows the student's results.

Table 1

	Total mass of copper produced in mg			
Time in mins	Experiment 1	Experiment 2	Experiment 3	Mean
1	0.60	0.58	0.62	0.60
2	1.17	1.22	1.21	1.20
4	2.40	2.41	2.39	2.40
5	3.02	X	3.01	3.06

0 1 . 3 Determine the **mean** mass of copper produced after 3 minutes.

[1 mark]

Mass = _____ mg

Question 1 continues on the next page

Turn over ►



0 1 . 4

Calculate the mass **X** of copper produced in **Experiment 2** after 5 minutes.Use **Table 1** on page 3**[2 marks]**

Mass **X** = _____ mg

0 1 . 5

The copper chloride solution used in the investigation contained 300 grams per dm^3 of solid CuCl_2 dissolved in 1 dm^3 of water.The student used 50 cm^3 of copper chloride solution in each experiment.

Calculate the mass of solid copper chloride used in each experiment.

[3 marks]

Mass = _____ g



0 5

A student investigated the temperature change in displacement reactions between metals and copper sulfate solution.

Table 2 shows the student's results.

Table 2

Metal	Temperature increase in °C
Copper	0
Iron	13
Magnesium	43
Zinc	17

Do not write
outside the
box

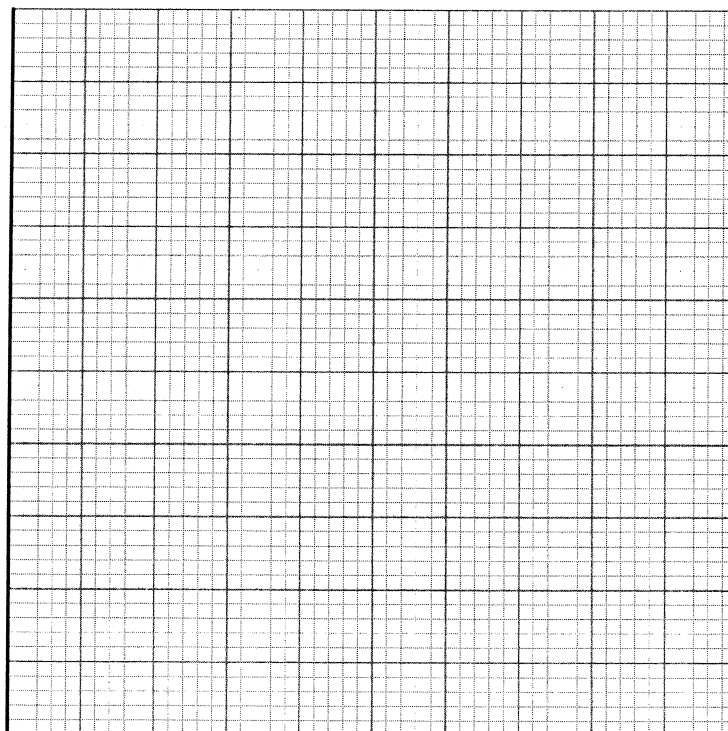
0 5 . 1

Plot the data from **Table 2** on **Figure 4** as a bar chart.

[2 marks]

Figure 4

Temperature
increase
in °C



Metal



0 5 . 2

The student concluded that the reactions between the metals and copper sulfate solution are endothermic.

Give **one** reason why this conclusion is **not** correct.

[1 mark]

0 5 . 3

The temperature change depends on the reactivity of the metal.

The student's results are used to place copper, iron, magnesium and zinc in order of their reactivity.

Describe a method to find the position of an unknown metal in this reactivity series.

Your method should give valid results.

[4 marks]

Question 5 continues on the next page

Turn over ►



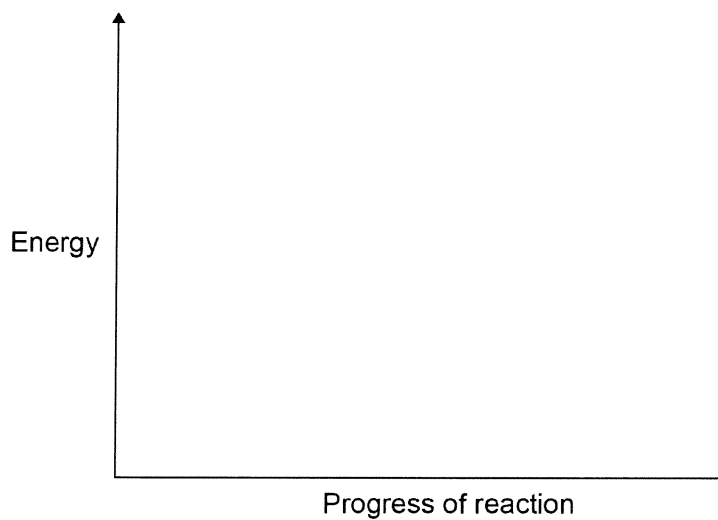
0 5 . 4

Draw a fully labelled reaction profile for the reaction between zinc and copper sulfate solution on **Figure 5**.

Do not write
outside the
box

[3 marks]

Figure 5



10



0 5

A teacher demonstrated the extraction of copper from copper oxide.

This is the method used.

1. Mix 1.30 g of zinc and 1.59 g of copper oxide.
2. Heat the mixture strongly.
3. When the mixture starts to glow, stop heating.
4. Let the glow spread through the mixture.
5. Leave the mixture to cool.
6. Add hydrochloric acid to the cooled mixture.
7. Filter the mixture obtained in step 6.

0 5 . 1

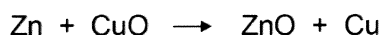
A student concluded that an exothermic reaction had taken place.

Explain how an observation made during the demonstration shows this.

[2 marks]

0 5 . 2

The equation for the reaction between zinc and copper oxide is:



1.59 g of copper oxide reacted.

Calculate the mass of copper produced.

Relative atomic masses (A_r): Cu = 63.5 O = 16 Zn = 65

[3 marks]

Mass of copper produced = _____ g



0 5 . 3

Explain why steps 6 and 7 result in only copper being obtained as the residue.

[4 marks]

0 5 . 4

The ionic equation for the reaction is:



Which statement about the reaction between zinc and copper ions is correct?

[1 mark]Tick **one** box.

Copper ions have been oxidised because the copper ions have gained electrons.

☐

Copper ions have been oxidised because the copper ions have lost electrons.

☐

Zinc has been oxidised because the zinc atoms have gained electrons.

☐

Zinc has been oxidised because the zinc atoms have lost electrons.

☐

10

Turn over for the next question**Turn over ►**

0 6

Group 2 metal carbonates thermally decompose to produce a metal oxide and a gas.

0 6 . 1Give the formula of each product when calcium carbonate (CaCO_3) is heated.**[2 marks]**

and

0 6 . 2The relative formula mass (M_r) of a Group 2 metal carbonate is 197Relative atomic masses (A_r): C = 12 O = 16Calculate the relative atomic mass (A_r) of the Group 2 metal in the metal carbonate.

Name the Group 2 metal.

[3 marks]

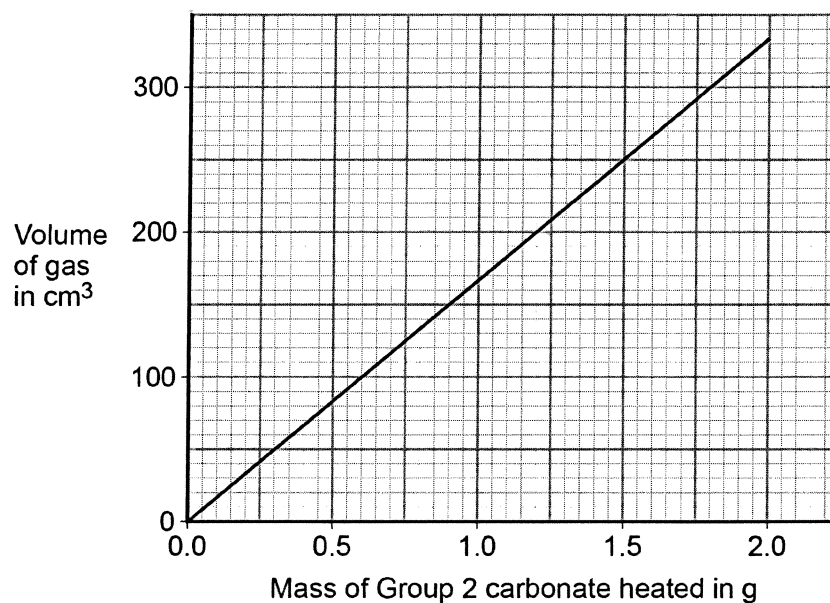
Relative atomic mass (A_r) =

Metal

Question 6 continues on the next page**Turn over ►**

Figure 8 shows the volume of gas produced when a different Group 2 carbonate, **W**, is heated.

Figure 8



0 6 . 3 Calculate the gradient of the line in **Figure 8**

Give the unit.

[3 marks]

Gradient _____

Unit _____



24 dm³ of gas is produced when one mole of a Group 2 carbonate is heated.

Use Figure 8

[4 marks]

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.Relative formula mass (M_r) = _____

12

Turn over for the next question

Turn over ►



0 8

This question is about iron.

Iron reacts with dilute hydrochloric acid to produce iron chloride solution and one other product.

0 8 . 1

Name the other product.

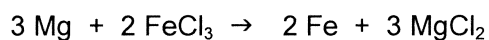
[1 mark]

0 8 . 2

Suggest how any unreacted iron can be separated from the mixture.

[1 mark]

Magnesium reacts with iron chloride solution.

**0 8 . 3**

0.120 g of magnesium reacts with excess iron chloride solution.

Relative atomic masses (A_r): Mg = 24 Fe = 56

Calculate the mass of iron produced, in mg

[5 marks]

Mass of iron = _____ mg

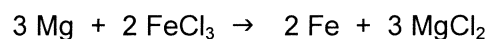
Question 8 continues on the next page

Turn over ►



0	8	.	4
---	---	---	---

Explain which species is reduced in the reaction between magnesium and iron chloride.



Your answer should include the half equation for the reduction.

[3 marks]

10

END OF QUESTIONS

Copyright information

For confidentiality purposes, from the November 2015 examination series, acknowledgements of third party copyright material will be published in a separate booklet rather than including them on the examination paper or support materials. This booklet is published after each examination series and is available for free download from www.aqa.org.uk after the live examination series.

Permission to reproduce all copyright material has been applied for. In some cases, efforts to contact copyright-holders may have been unsuccessful and AQA will be happy to rectify any omissions of acknowledgements. If you have any queries please contact the Copyright Team, AQA, Stag Hill House, Guildford, GU2 7XJ.

Copyright © 2018 AQA and its licensors. All rights reserved.



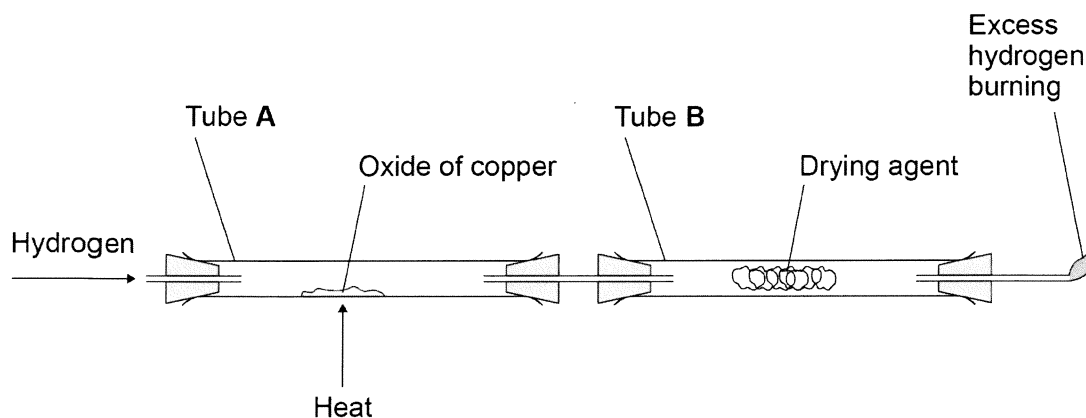
0	8
---	---

Copper forms two oxides, Cu_2O and CuO

A teacher investigated an oxide of copper.

Figure 10 shows the apparatus.

Figure 10



This is the method used.

1. Weigh empty tube **A**.
2. Add some of the oxide of copper to tube **A**.
3. Weigh tube **A** and the oxide of copper.
4. Weigh tube **B** and drying agent.
5. Pass hydrogen through the apparatus and light the flame at the end.
6. Heat tube **A** for 2 minutes.
7. Reweigh tube **A** and contents.
8. Repeat steps 5 to 7 until the mass no longer changes.
9. Reweigh tube **B** and contents.
10. Repeat steps 1 to 9 with different masses of the oxide of copper.



0 8 . 1 Suggest **one** reason why step 8 is needed.

[1 mark]

0 8 . 2 Explain why the excess hydrogen must be burned off.

[2 marks]

Question 8 continues on the next page

Turn over ►



Figure 10 is repeated here.

Figure 10

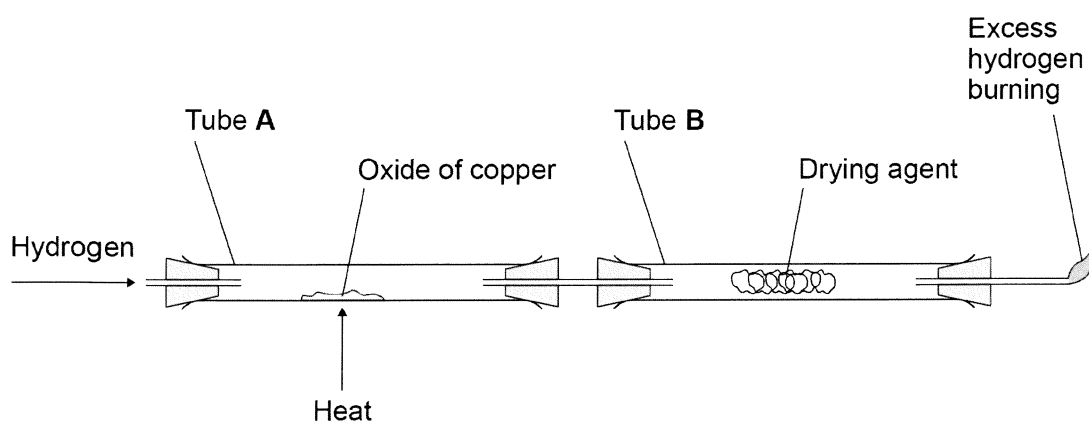


Table 5 shows the teacher's results.

Table 5

	Mass in g
Tube A empty	105.72
Tube A and oxide of copper before heating	115.47
Tube A and contents after 2 minutes	114.62
Tube A and contents after 4 minutes	114.38
Tube A and contents after 6 minutes	114.38
Tube B and contents at start	120.93
Tube B and contents at end	123.38

When an oxide of copper is heated in a stream of hydrogen, the word equation for the reaction is:



0 8 . 3 Determine the mass of copper and the mass of water produced in this experiment.

Use Table 5.

[2 marks]

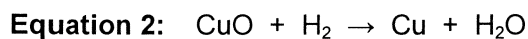
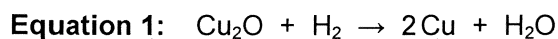
Mass of copper = _____ g

Mass of water = _____ g

0 8 . 4 The teacher repeated the experiment with a different sample of the oxide of copper.

The teacher found that the oxide of copper produced 2.54 g of copper and 0.72 g of water.

Two possible equations for the reaction are:



Determine which is the correct equation for the reaction in the teacher's experiment.

Relative atomic masses (A_r): H = 1 O = 16 Cu = 63.5

[3 marks]

8

Turn over for the next question

Turn over ►



0 5

One type of indigestion tablet contains:

- calcium carbonate
- magnesium carbonate
- non-active ingredients.

0 5 . 1

Peppermint oil is one of the non-active ingredients in the tablet.

Suggest why peppermint oil is used in the tablet.

[1 mark]

0 5 . 2

In one indigestion tablet the mass of magnesium carbonate is 64.0 mg

Calculate the number of moles of magnesium carbonate in this indigestion tablet.

Give your answer to 3 significant figures.

Relative formula mass (M_r) of magnesium carbonate = 84**[3 marks]**

Number of moles = _____

0 5 . 3Magnesium carbonate (MgCO_3) in the tablet reacts with hydrochloric acid (HCl) in the stomach.

Write a balanced chemical equation for the reaction.

[3 marks]_____ + _____ \longrightarrow _____ + _____ + _____

Question 5 continues on the next page

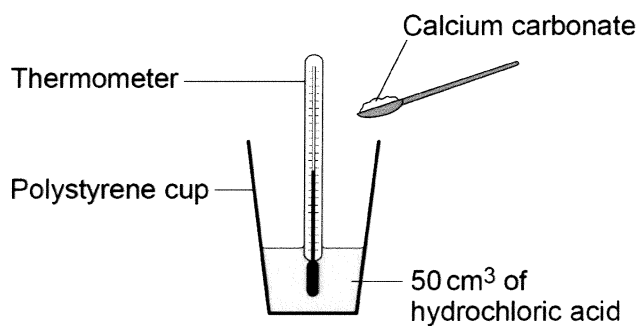
Turn over ►



A student investigated the temperature change when different masses of calcium carbonate were reacted with hydrochloric acid.

Figure 7 shows the apparatus used.

Figure 7



This is the method used.

1. Add 50 cm³ of hydrochloric acid to a polystyrene cup.
2. Record the temperature of the hydrochloric acid.
3. Add 1 g of calcium carbonate to the hydrochloric acid.
4. Stir the mixture.
5. Record the highest temperature of the mixture.
6. Repeat steps 1–5 with different masses of calcium carbonate.

0 5 . 4

What was the dependent variable in this investigation?

[1 mark]



0 5 . 5 Suggest **two** changes to the investigation that would improve the accuracy of the results.

Give a reason why each change would improve the accuracy.

[4 marks]

Change 1 _____

Reason _____

Change 2 _____

Reason _____

0 5 . 6 How should the results of the investigation be displayed?

Give a reason for your answer.

[2 marks]

Tick (✓) **one** box.

Bar chart

☐

Histogram

☐

Line graph

☐

Pie chart

☐

Reason _____

14

Turn over for the next question

Turn over ►



07

A scientist does two tests on four white solids. The solids are labelled **A**, **B**, **C** and **D**.

Test 1 Adds the sample of the solid to distilled water and stirs.

Test 2 Measures the pH of the solution after **Test 1**

Table 2 shows the results.

Table 2

Solid	Appearance after stirring	pH
A	colourless solution, no solid	14
B	colourless solution, no solid	3
C	colourless solution, solid remains	9
D	colourless liquid, solid remains	7

These four solids are:

- magnesium oxide
- phosphorus oxide
- silicon dioxide
- sodium oxide.

Table 3 shows the solubility of these four solids in water.

Table 3

Solid	Solubility in grams per 100 cm ³ of water
Magnesium oxide	0.01
Phosphorus oxide	52
Silicon dioxide	0
Sodium oxide	109

Do not write
outside the
box



Explain your answers.

This image shows a single sheet of white paper with horizontal blue or grey ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Turn over ►



0 7 . 2 10 cm³ of solution **B** is added to a beaker.

Distilled water is added to the beaker until the final volume in the beaker is 1000 cm³

The pH of the solution is measured before and after distilled water is added.

Table 4 shows the results.

Table 4

Volume of solution in beaker	pH of solution B
10 cm ³	3
1000 cm ³	X

Calculate the value of **X**.

[2 marks]

X = _____



0 7

A teacher demonstrated the temperature change when hydrochloric acid is added to sodium hydroxide solution.

This is the method used.

1. Measure 25 cm³ of sodium hydroxide solution using a measuring cylinder.
2. Add the sodium hydroxide solution to a polystyrene cup.
3. Record the temperature of the sodium hydroxide solution.
4. Add 5 cm³ of hydrochloric acid from a burette to the sodium hydroxide solution.
5. Stir the solution.
6. Record the temperature of the solution.
7. Repeat steps 4–6 until 50 cm³ of hydrochloric acid in total is added.

Table 1 shows some of the teacher's results.

Table 1

Volume of hydrochloric acid added in cm ³	Temperature in °C
0	21.30
5	24.25
10	26.15
15	27.05
20	27.70

0 7 . 1

Figure 4 shows the results when 30 cm³ to 50 cm³ of hydrochloric acid was added to sodium hydroxide solution.

A line of best fit has been drawn through these results.

Complete **Figure 4**.

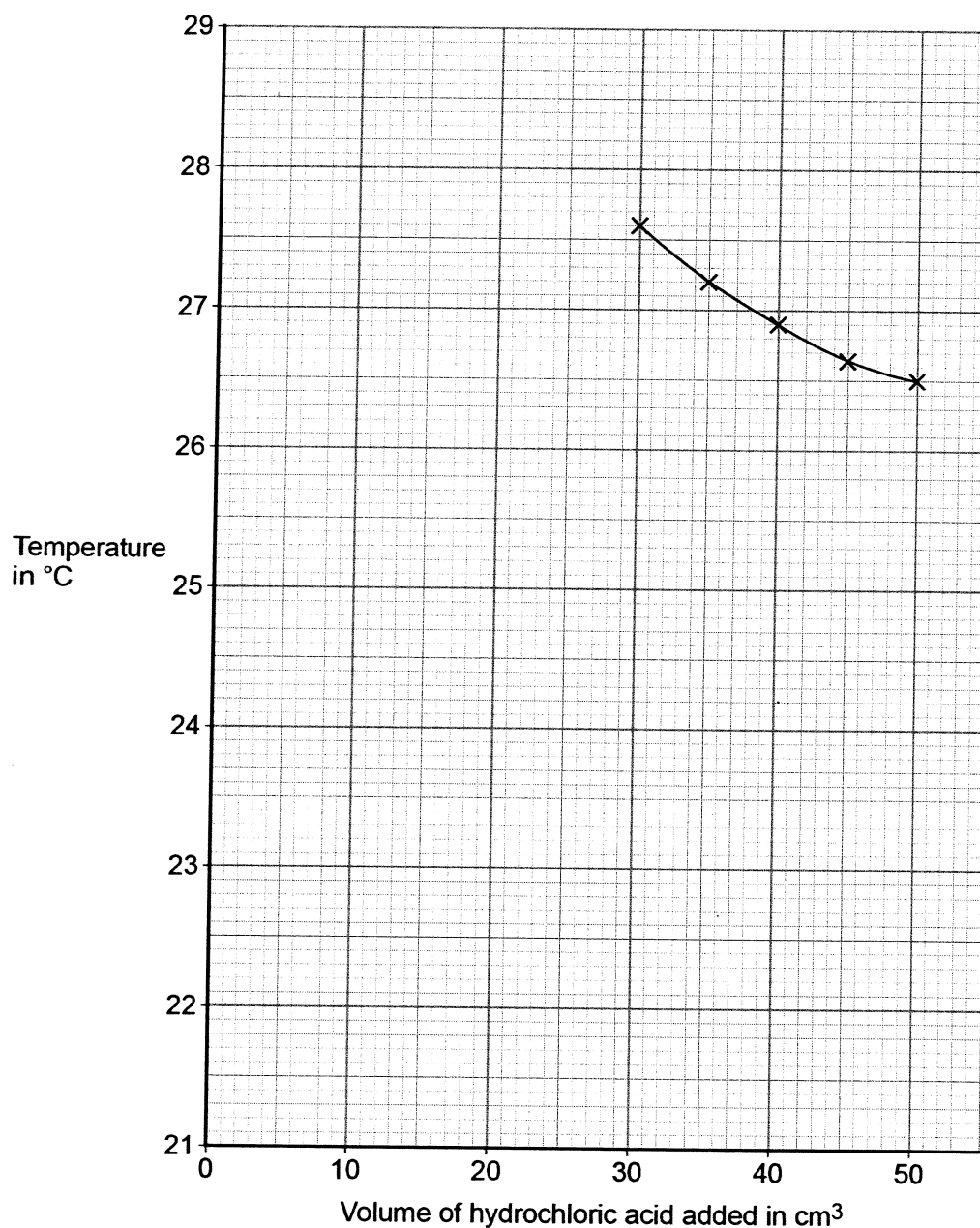
You should:

- plot the data from **Table 1** on **Figure 4**
- draw a line of best fit through these results
- continue both lines of best fit until the lines meet.

[4 marks]



Figure 4



0 7 . 2 Estimate the maximum temperature reached in the reaction.

Use Figure 4.

[1 mark]

Maximum temperature = _____ °C

Question 7 continues on the next page

Turn over ►



07.3

The teacher used a temperature sensor to measure the temperature of the reaction mixture.

What is the resolution of the temperature sensor?

[1 mark]

Tick **one** box.

$1 \times 10^{-1} \text{ }^{\circ}\text{C}$

☐

$1 \times 10^{-2} \text{ }^{\circ}\text{C}$

☐

$1 \times 10^{-3} \text{ }^{\circ}\text{C}$

☐

$1 \times 10^{-4} \text{ }^{\circ}\text{C}$

☐

07.4

Suggest **two** ways of improving the accuracy of the results.

[2 marks]

1

2



07.5

The pH of the solution changes as hydrochloric acid is gradually added to sodium hydroxide solution, until hydrochloric acid is in excess.

Describe how the pH of the solution changes.

Give reasons for these changes.

You should refer to the pH value of the solution at different stages in the procedure.

[6 marks]

07.6

In a different demonstration the teacher used a 25 cm³ solution containing 1.4 g of sodium hydroxide.

Calculate the concentration of the sodium hydroxide solution in g/dm³

[2 marks]

Concentration of sodium hydroxide solution = _____ g/dm³

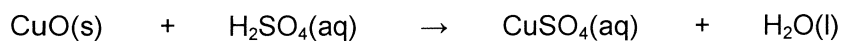
16

Turn over ►

0 8

A student planned to make copper sulfate crystals from excess copper oxide and dilute sulfuric acid.

The equation for the reaction is:

**0 8****. 1**

Why is it necessary to add excess copper oxide?

[1 mark]

0 8**. 2**

This is the method used.

1. Add 25 cm³ of dilute sulfuric acid to a conical flask.
2. Gently warm the dilute sulfuric acid.
3. Add excess copper oxide to the dilute sulfuric acid.
4. Stir the mixture.
5. Heat to evaporate all the water from the mixture.

Suggest **two** improvements to the method.

Explain why each improvement is needed.

[4 marks]

1

2



0 8 . 3

The student used:

- 2 g of copper oxide (in excess)
- 25 cm³ of a solution of dilute sulfuric acid with a concentration of 49 g/dm³

Determine by how many moles the copper oxide (CuO) was in excess.

Relative atomic masses (A_r): Cu = 63.5 O = 16Relative formula mass (M_r) of sulfuric acid = 98**[5 marks]**

Number of moles in excess = _____

10

Turn over for the next question

Turn over ►



0	9
---	---

This question is about acids and alkalis.

0	9	.	1
---	---	---	---

Dilute hydrochloric acid is a strong acid.

Explain why an acid can be described as both strong and dilute.

[2 marks]

0	9	.	2
---	---	---	---

A $1.0 \times 10^{-3} \text{ mol/dm}^3$ solution of hydrochloric acid has a pH of 3.0

What is the pH of a $1.0 \times 10^{-5} \text{ mol/dm}^3$ solution of hydrochloric acid?

[1 mark]

pH = _____

Question 9 continues on the next page

Turn over ►



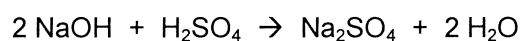
A student titrated 25.0 cm³ portions of dilute sulfuric acid with a 0.105 mol/dm³ sodium hydroxide solution.

0 9 . 3 Table 4 shows the student's results.

Table 4

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of sodium hydroxide solution in cm ³	23.50	21.10	22.10	22.15	22.15

The equation for the reaction is:



Calculate the concentration of the sulfuric acid in mol/dm³

Use only the student's concordant results.

Concordant results are those within 0.10 cm³ of each other.

[5 marks]

Concentration of sulfuric acid = _____ mol/dm³



09.4

Explain why the student should use a pipette to measure the dilute sulfuric acid and a burette to measure the sodium hydroxide solution.

[2 marks]

09.5

Calculate the mass of sodium hydroxide in 30.0 cm^3 of a 0.105 mol/dm^3 solution.

Relative formula mass (M_r): $\text{NaOH} = 40$

[2 marks]

Mass of sodium hydroxide = _____ g

12

END OF QUESTIONS



0 5

This question is about electrolysis.

0 5 . 1

Some metals are extracted from molten compounds using electrolysis.

Why is electrolysis used to extract some metals?

[1 mark]

0 5 . 2

Aluminium is produced by electrolysis of a molten mixture.

What **two** substances does the molten mixture contain?**[2 marks]**

1

2

0 5 . 3

Copper and chlorine are produced when molten copper chloride is electrolysed.

Complete the half equation for the reaction at each electrode.

[2 marks]

Half equation at negative electrode

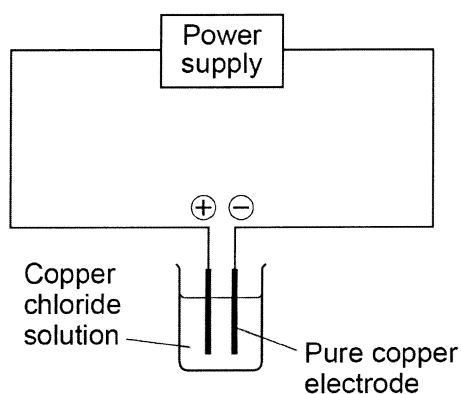


Half equation at positive electrode



Figure 4 shows the apparatus a student used to electrolyse copper chloride solution.

Figure 4



The student:

- measured the mass of copper deposited on the negative electrode after 60 minutes
- compared the mass deposited with the expected value.

0 5 . 4

Suggest **two** reasons why the mass deposited was different from the expected value.
[2 marks]

1 _____

2 _____

Question 5 continues on the next page

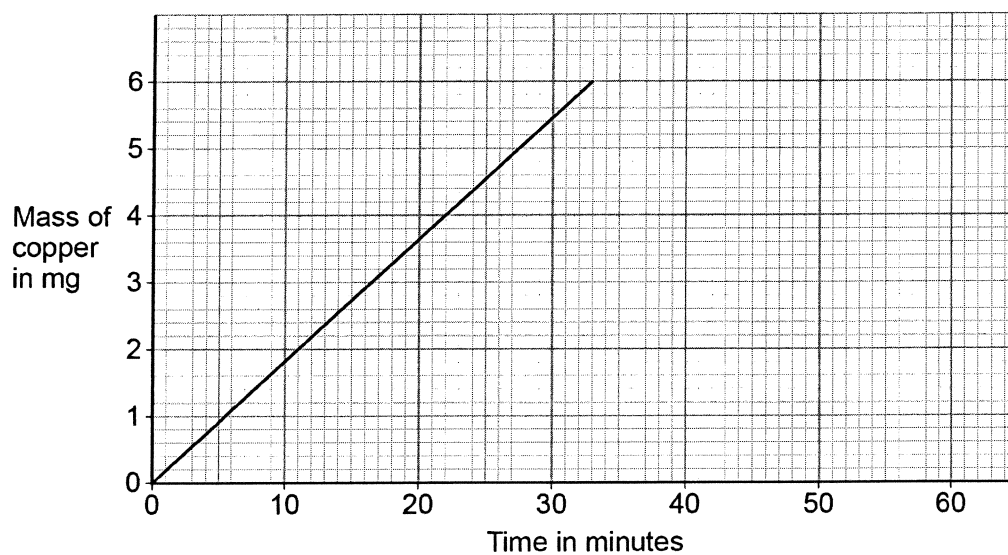
Turn over ►



0 5 . 5

Figure 5 shows the expected mass of copper produced each minute.

Figure 5



Determine the expected mass of copper after 24 hours.

Use Figure 5.

[3 marks]

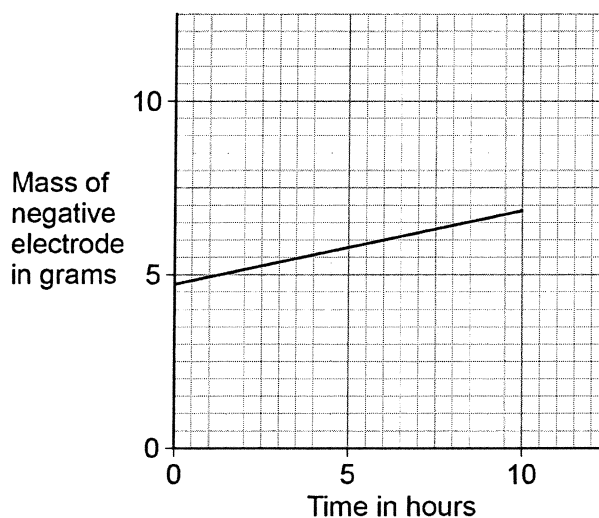
Mass = _____ mg



Silver nitrate solution is electrolysed.

Figure 6 shows the change in mass of the negative electrode over 10 hours.

Figure 6



0 5 . 6

Determine the mass of the negative electrode at the start of the experiment.

Use Figure 6.

[1 mark]

0 5 . 7

Calculate the gradient of the line in Figure 6.

Give the unit.

[3 marks]

Gradient _____

Unit _____



0	5
---	---

Two students investigated the electrolysis of copper sulfate solution.

When copper sulfate solution is electrolysed, copper is produced at the negative electrode.

0	5	.	1
---	---	---	---

What substance is produced at the positive electrode when copper sulfate solution is electrolysed?

[1 mark]

Tick **one** box.

Hydrogen

☐

Oxygen

☐

Sulfur

☐

Sulfur dioxide

☐

The students made the following hypothesis:

‘The mass of copper deposited on the negative electrode will be directly proportional to the current.’

Table 4 shows the students’ results.

Table 4

Current in amps	Mass of copper deposited on the negative electrode in grams
0.12	0.024
0.24	0.047
0.36	0.057
0.48	0.095
0.60	0.118
0.72	0.142

0 5 . 3

Student **A** said that the results did support the hypothesis.

Student **B** said that the results did **not** support the hypothesis.

Explain the extent to which the data in **Table 4** supports the students’ hypothesis.

[4 marks]



0 5 . 4

Calculate the number of moles of copper deposited on the negative electrode when the current is 0.72 A

Give your answer in standard form.

Use Table 4.

Relative atomic mass (A_r) of copper = 63.5

[2 marks]

Number of moles = _____

0 5 . 5

What change to the investigation would increase the mass of copper deposited on the negative electrode?

[1 mark]

Tick **one** box.

Decrease the concentration of copper sulfate solution

☐

Decrease the volume of copper sulfate solution

☐

Increase the distance between the electrodes

☐

Increase the time the circuit is switched on for

☐

11

Turn over for the next question

Turn over ►

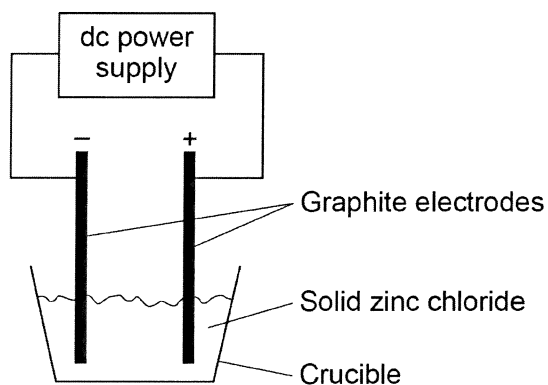


0 6

A student investigated the electrolysis of different substances.

Figure 6 shows the apparatus.

Figure 6



0 6 . 1

Explain why electrolysis would **not** take place in the apparatus shown in Figure 6.

[2 marks]

0 6 . 2

Explain why graphite conducts electricity.

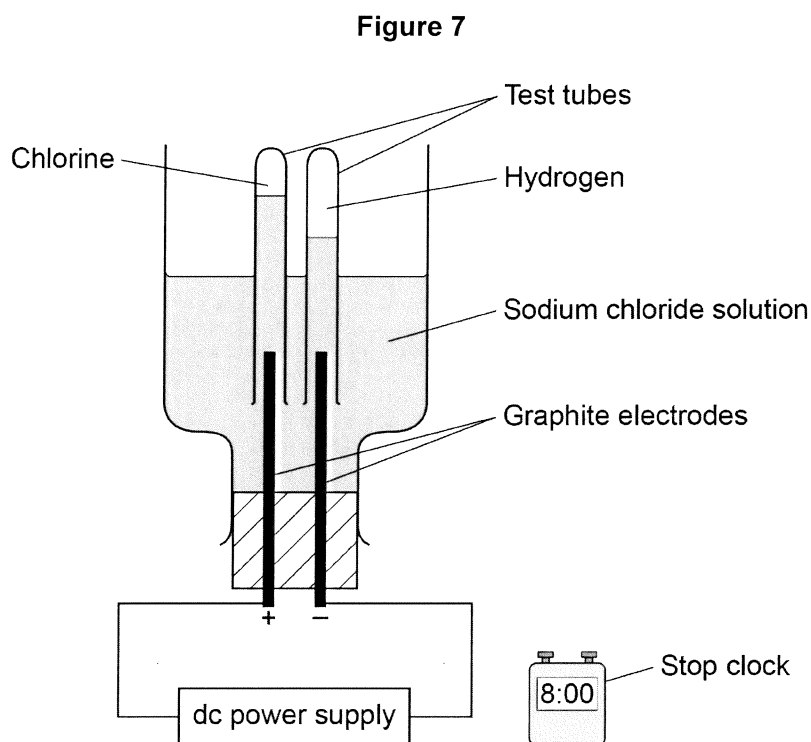
Answer in terms of the structure and bonding in graphite.

[3 marks]



The student investigated how the volume of gases produced changes with time in the electrolysis of sodium chloride solution.

Figure 7 shows the apparatus.



0 6 . 3 The student made an error in selecting the apparatus for this investigation.

How should the apparatus be changed?

Give **one** reason for your answer.

[2 marks]

Turn over ►

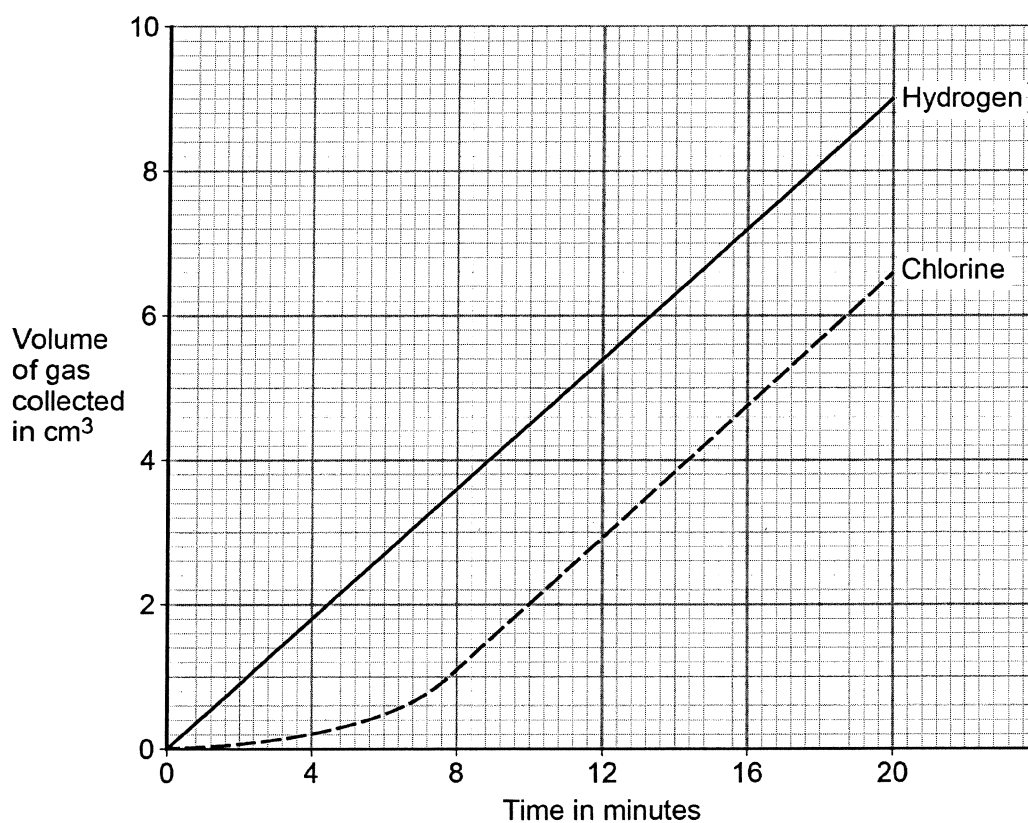


Another student used the correct apparatus.

This student measured the volumes of gases collected every minute for 20 minutes.

Figure 8 shows the student's results.

Figure 8



0 6 . 4 Describe the trends shown in the results.

Use values from Figure 8.

[3 marks]



0 6 . 5

The number of moles of each gas produced at the electrodes is the same.

No gas escapes from the apparatus.

Suggest **one** reason for the difference in volume of each gas collected.

[1 mark]

0 6 . 6

Calculate the amount in moles of chlorine collected after 20 minutes.

Use **Figure 8**.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Give your answer in standard form.

[3 marks]

Moles of chlorine = _____ mol

Turn over for the next question

14

Turn over ►



0 7

This question is about electrolysis.

Aluminium is produced by electrolysis of a molten mixture of aluminium oxide and cryolite.

0 7 . 1

Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

0 7 . 2

What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

Aluminium atoms gain electrons.

☐

Aluminium atoms lose electrons.

☐

Aluminium ions gain electrons.

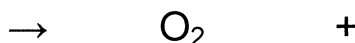
☐

Aluminium ions lose electrons.

☐**0 7 . 3**

Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

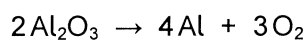
07.4

Explain why the positive electrode must be continually replaced.

[3 marks]

07.5

The overall equation for the electrolysis of aluminium oxide is:



Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed.

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

[4 marks]

Mass of oxygen = _____ kg

Turn over ►

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6

Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

0 7 . 7

Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): $\text{Cl}_2 = 71$

[2 marks]

Volume = _____ dm^3



0	8
---	---

Iceland is a country with many waterfalls.

0	8	.	1
---	---	---	---

Which energy resource uses falling water to generate electricity?

[1 mark]

0	8	.	2
---	---	---	---

Most of the electricity generated in Iceland is used in the production of aluminium.

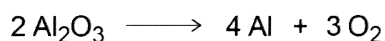
Aluminium ore is imported and used to produce aluminium. The aluminium is then exported.

Suggest **one** advantage of producing aluminium in Iceland.

[1 mark]

Aluminium is produced from aluminium oxide by electrolysis.

The equation for the reaction is:



0	8	.	3
---	---	---	---

Calculate the mass of aluminium produced from 1000 kg of aluminium oxide.

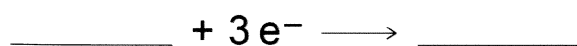
Relative atomic masses (A_r): Al = 27 O = 16

[4 marks]

Mass of aluminium = _____ kg



- 0 8 . 4** Complete the half equation for the production of aluminium at the negative electrode. **[1 mark]**



- 0 8 . 5** Explain why the electrolyte used is a mixture of aluminium oxide and cryolite. **[2 marks]**

- 0 8 . 6** Explain why the electrolysis of aluminium oxide produces large quantities of carbon dioxide. **[3 marks]**

Question 8 continues on the next page

Turn over ►



08.7

A ceramic material could be used as the positive electrode in the electrolysis of aluminium oxide.

The ceramic material must be a good conductor of electricity.

Suggest **two** other properties the ceramic material must have for use in the electrolysis of aluminium oxide.

Give a reason why each property is needed.

[4 marks]

Property 1 _____

Reason _____

Property 2 _____

Reason _____

16

