OXFORD CAMBRIDGE AND RSA EXAMINATIONS
GCSE

A172/01

TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

Modules C4 C5 C6 (Foundation Tier)

TUESDAY 10 JUNE 2014: Afternoon
DURATION: 1 hour
plus your additional time allowance

MODIFIED ENLARGED

Candidate forename		Candidate surname	

Centre number						Candidate number				

Candidates answer on the Question Paper.
A calculator may be used for this paper.

OCR SUPPLIED MATERIALS:

Periodic Table

OTHER MATERIALS REQUIRED:

Pencil
Ruler (cm/mm)

READ INSTRUCTIONS OVERLEAF

DC (NH/JG) 4038852136 95382/1

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the boxes on the first page. Please write clearly and in capital letters.

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Write your answer to each question in the space provided. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

INFORMATION FOR CANDIDATES

The quality of written communication is assessed in questions marked with a pencil ().

The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 60.

Any blank pages are indicated.

A list of qualitative tests for ions is printed on pages 4 and 5.

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TWENTY FIRST CENTURY SCIENCE DATA SHEET

Qualitative analysis

Tests for ions with a positive charge

Ion	Test	Observation
calcium Ca^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper Cu^{2+}	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) Fe^{2+}	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) Fe^{3+}	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc Zn^{2+}	add dilute sodium hydroxide	a white precipitate forms; the precipitate dissolves in excess sodium hydroxide

Tests for ions with a negative charge

Ion	Test	Observation
carbonate CO_3^{2-}	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride Cl^-	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide Br^-	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide I^-	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate SO_4^{2-}	add dilute acid, then add barium chloride or barium nitrate	a white precipitate forms

Answer ALL the questions.

1 Chlorine reacts with metals to make metal chlorides.

The table shows some information about the chlorides of metals from different groups of the Periodic Table.

Metal	Group of the Periodic Table	Formula of metal chloride
lithium	1	$LiCl$
sodium	1	
beryllium	2	$BeCl_2$
	2	$MgCl_2$
aluminium	3	$AlCl_3$
silicon	4	$SiCl_4$

(a) Complete the table by filling in the missing metal and the missing formula. [2]

(b) Sulfur and phosphorus are non-metals.

Phosphorus is in group 5. It forms a chloride with the formula PCl_5.

Sulfur is in group 6. It forms a chloride with the formula SCl_2.

Do these chlorides fit the pattern in the table?

Explain your answer.

_____

_____

_____ **[2]**

(c) Write a word equation to show how sodium reacts to make sodium chloride.

[1]

[TOTAL: 5]

2 Johann Döbereiner was one of the first chemists to organise elements by their properties.

He found out that some sets of three elements seem to fit together because they have similar properties.

He called these sets of elements 'triads'.

(a) One triad contained the three elements, lithium, sodium and potassium.

(i) How are the PHYSICAL properties of lithium, sodium and potassium similar?

Put ticks (✓) in the boxes next to the TWO correct answers.

The melting points are all the same. ☐

They are all shiny solids. ☐

They all have the same chemical symbol. ☐

They are all soft and can be cut by a knife. ☐

They all have boiling points below room temperature. ☐

[2]

(ii) The CHEMICAL properties of lithium, sodium and potassium are also similar.

All three elements react with water.

Give TWO ways that the reaction of these three metals with water is similar.

_____

_____

_____ **[2]**

(b) Döbereiner suggested some other elements that may fit into triads.

How are the properties of these other elements similar?

Draw straight lines to link the ELEMENTS on the left to the correct SIMILAR PROPERTIES on the right.

ELEMENTS	SIMILAR PROPERTIES
calcium, strontium, barium	non-metals found in molecules in the air
chlorine, bromine, iodine	non-metals that all react quickly with group 1 metals
carbon, nitrogen, oxygen	metals with good electrical conductivity

[2]

(c) Döbereiner looked at the relative atomic masses of the elements in some triads.

He noticed that the relative atomic mass of the 'middle' element was close to the mean relative atomic mass of the other two.

The table shows some examples of elements that appear to fit his pattern.

	Element and relative atomic mass			Mean relative atomic mass of first and third element
Triad A	lithium 7	sodium 23	potassium 39	23
Triad B	calcium 40	strontium 88	barium 137	89
Triad C	chlorine 35.5	bromine 80	iodine 127	81

(i) Döbereiner asked other scientists to evaluate his data and ideas.

What TWO things would Döbereiner expect the other scientists to do?

_____

_____

_____ **[2]**

(ii) **Döbereiner found that some elements with similar properties did NOT fit the atomic mass pattern.**

Three of these elements are copper, silver and gold.

Element and relative atomic mass		
copper 63.5	silver 108	gold 197

How does this data show that copper, silver and gold do NOT fit Döbereiner's atomic mass pattern?

Use a calculation to support your answer.

_____

_____ **[2]**

[TOTAL: 10]

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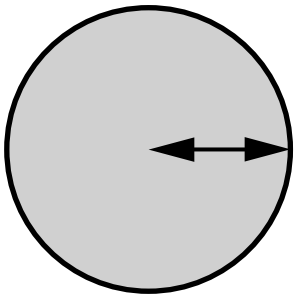
QUESTION 3 BEGINS ON PAGE 14

3 Joe does some research about Group 1 elements.

He finds out about the electron arrangement in the atoms of the first three elements in the Group.

He also finds data about the radius of each atom.



radius of an atom

Element	Total number of electrons in each atom	Electron arrangement	Radius of the atom in pm
lithium	3	2.1	152
sodium	11	2.8.1	186
potassium	19	2.8.8.1	231

Joe says, 'I have an idea that there is a pattern that links the number of electron shells in the atom to the radius of the atom. I am going to make predictions about the next two elements in group 1 (rubidium and caesium).'

How does the data support Joe's idea and what predictions can he make about rubidium and caesium?

The quality of written communication will be assessed in your answer.

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_____ **[6]**

[TOTAL: 6]

4 Chemicals have different uses and properties.

(a) Look at the data about some chemicals.

Chemical	Melting point in °C	Boiling point in °C	Electrical conductivity	Other points
A	3500	4000	does not conduct	very hard and strong
B	–210	–196	does not conduct	very unreactive
C	1500	2860	good	strong and malleable
D	–7	59	does not conduct	toxic

(i) Which chemical is a metal?

_____ **[1]**

(ii) Which chemical is a gas in the air?

_____ **[1]**

(iii) Which two chemicals are giant structures held together by strong bonds?

_____ **and** _____ **[1]**

(iv) Which chemical is diamond?

_____ **[1]**

(b) Metals have many different uses.

Which property is MOST important when choosing a metal for the following uses?

Put ONE tick (✓) in each row.

Use	Properties			
	Melting point	Electrical conductivity	Malleability	Strength
Bridge supports				
Temperature probes for hot ovens				
Electric wiring				
Metal that must be hammered into shape to make horseshoes				

[2]

[TOTAL: 6]

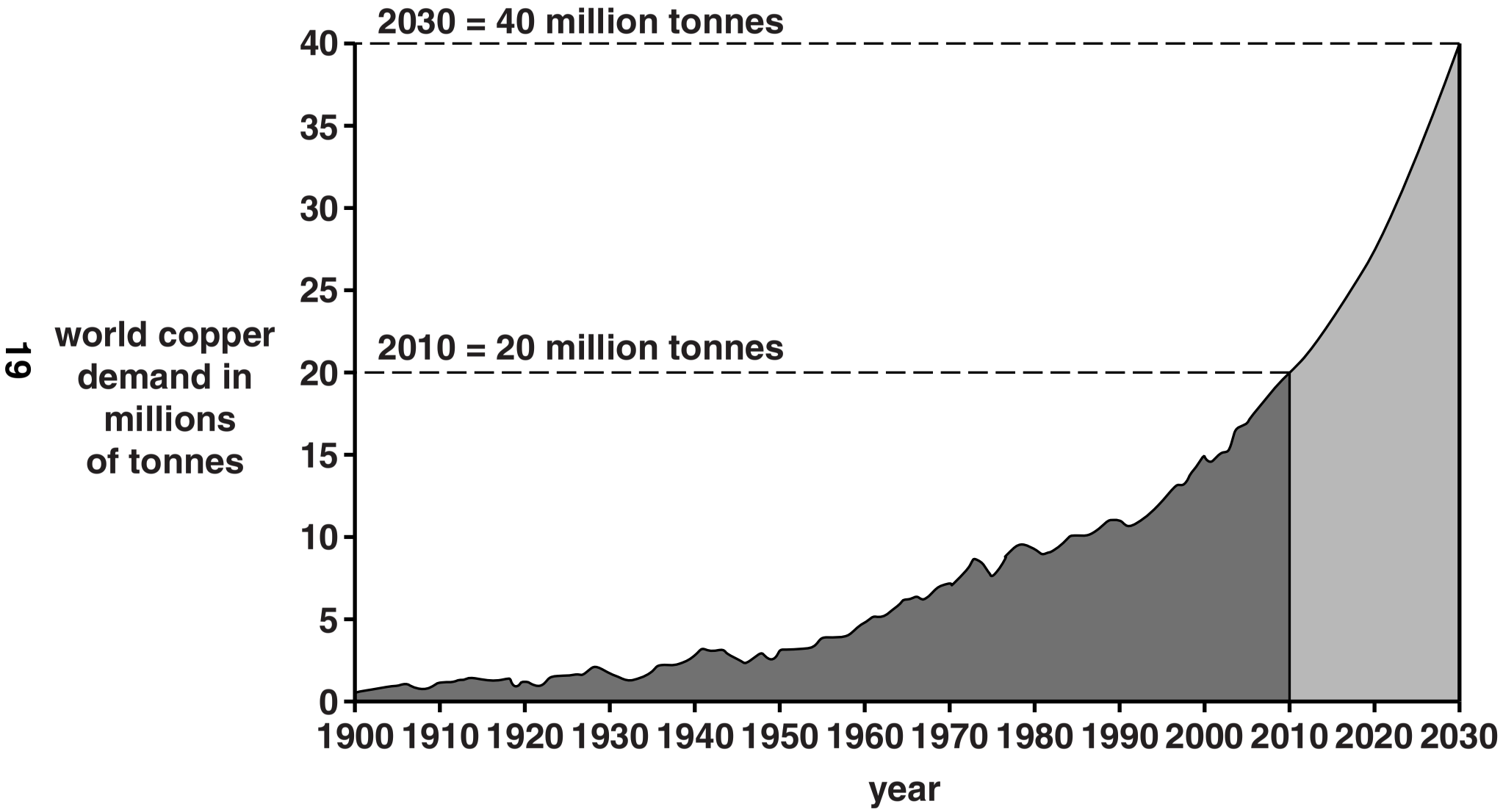
5 Scientists are concerned about how the demand for copper is changing and how this will affect the supply of copper for the future.

The graph opposite shows how the total world DEMAND for copper has changed since 1900. The graph also shows the predicted demand for copper between 2010 and 2030.

The SUPPLIES of copper in the world come from four main countries. The copper deposits left in these countries are shown in the table.

Country	Estimated copper deposits in millions of tonnes
Chile	140
United States	90
Canada	23
Poland	36

Even if all scrap copper is recycled, this meets less than 50% of the world demand for copper.


19
world copper demand in millions of tonnes
2030 = 40 million tonnes
2010 = 20 million tonnes
40
35
30
25
20
15
10
5
0
1900 1910 1920 1930 1940 1950 1960 1970 1980 1990 2000 2010 2020 2030
year

Scientists are very concerned about the balance between the supply and demand for copper from 2010 onwards.

Use the information to discuss why they are so concerned.

The quality of written communication will be assessed in your answer.

_____

_____

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_____ **[6]**

[TOTAL: 6]

6 Mining copper produces large amounts of waste rock.

(a) Why does mining copper produce large amounts of waste rock?

Put a tick (✓) in the box next to the correct answer.

Copper ore contains only small amounts of copper. ☐

The machinery is designed to handle large amounts of rock. ☐

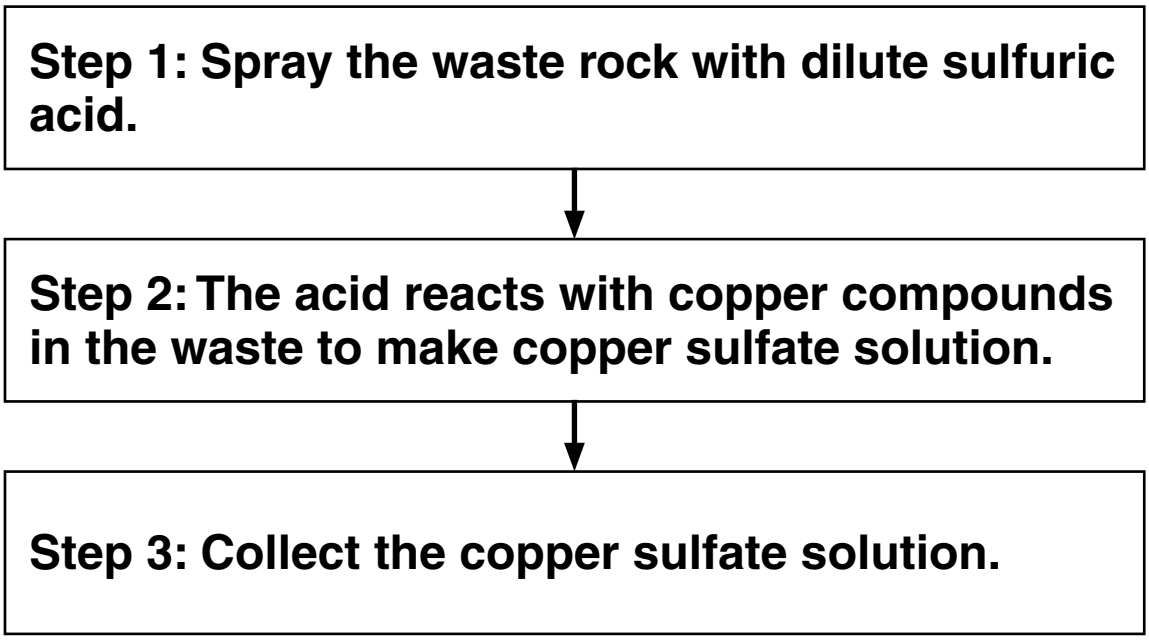
The rock is broken up into pieces and so has no use. ☐

There is a high percentage of other metals in the rock. ☐

[1]

(b) The waste rock still contains some copper.

A new process uses dilute sulfuric acid to extract this copper from the waste rock.



Use the data sheet on pages 4 and 5 to help you answer these questions.

A scientist tests the solution to check that it contains copper sulfate.

(i) He adds dilute sodium hydroxide to test for copper ions.

What does the scientist see if the solution contains copper ions?

_____

_____ **[2]**

(ii) What does the scientist add to test for sulfate ions?

What result does he expect?

test _____

result _____

[2]

(c) Copper can be extracted from copper sulfate solution by passing an electric current through the solution.

(i) What is this process called?

_____ [1]

(ii) Which two statements explain why copper sulfate solution conducts electricity?

Put ticks (✓) in the boxes next to the TWO correct answers.

Copper sulfate is an ionic compound. ☐

Solid copper is a good electrical conductor. ☐

When copper sulfate dissolves, ions are free to move. ☐

The particles in copper sulfate have a regular arrangement. ☐

Bonds in copper sulfate are very weak. ☐

[2]

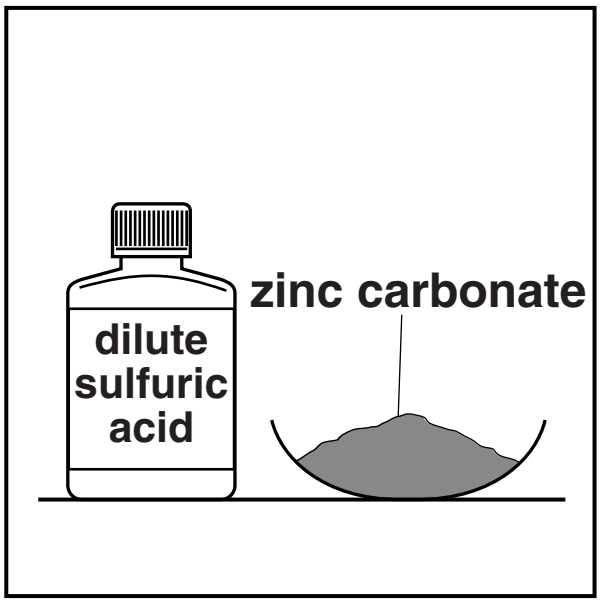
[TOTAL: 8]

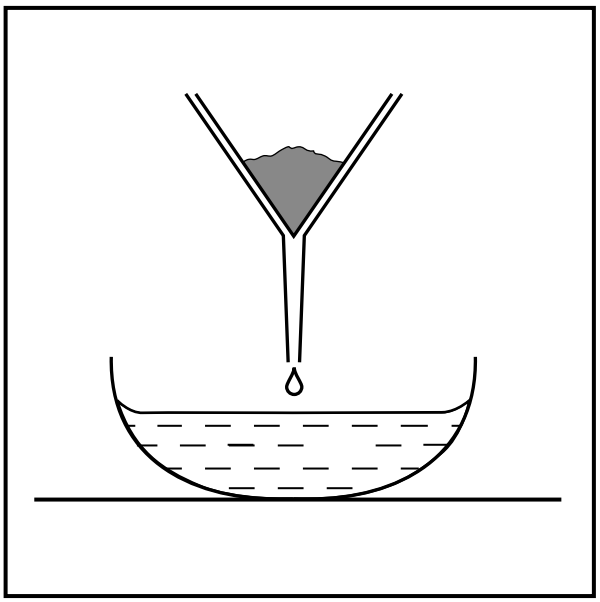
7 Jak makes some zinc sulfate crystals from solid zinc carbonate and dilute sulfuric acid.

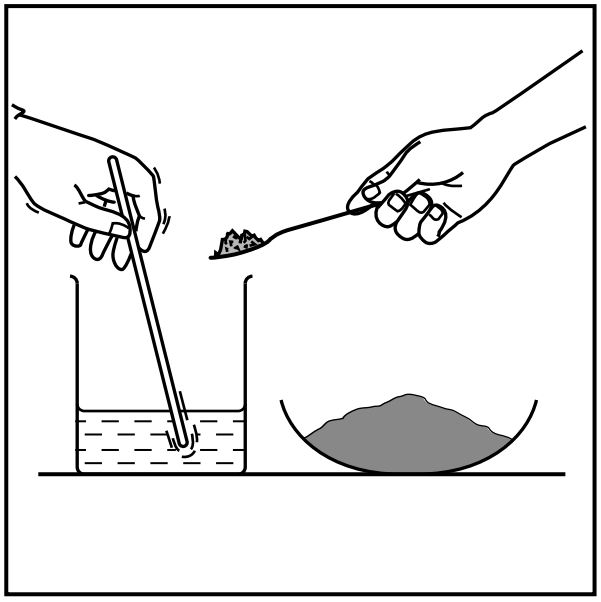
He starts with 20 cm^3 of dilute sulfuric acid.

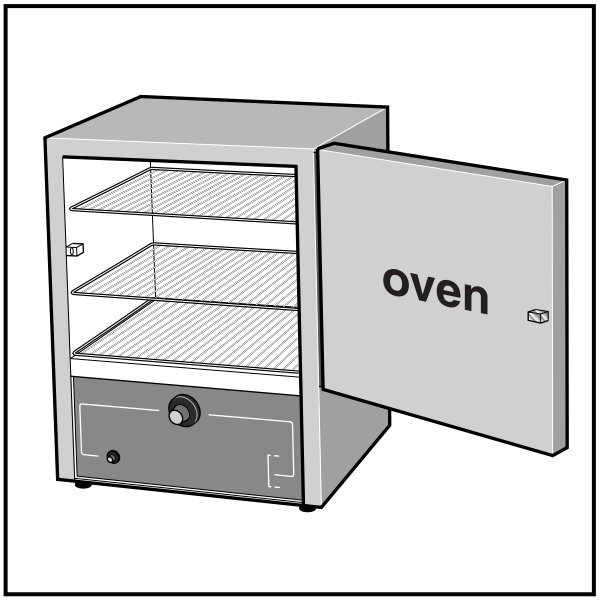
The diagrams opposite show some of the apparatus and chemicals he uses.

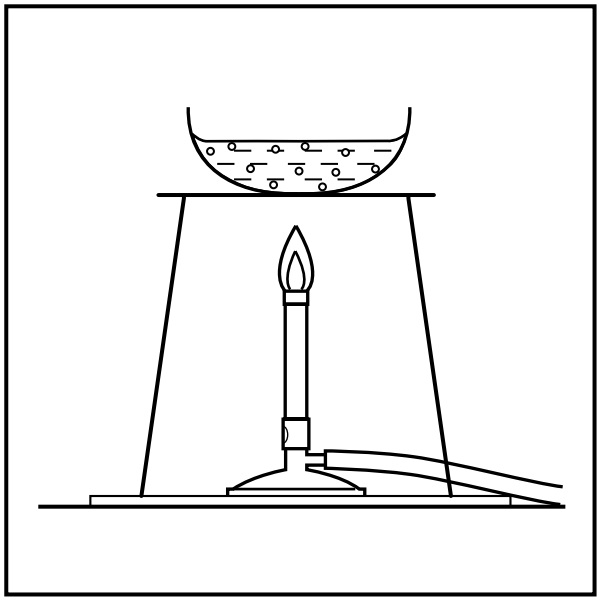
They are NOT in the order that Jak uses them.

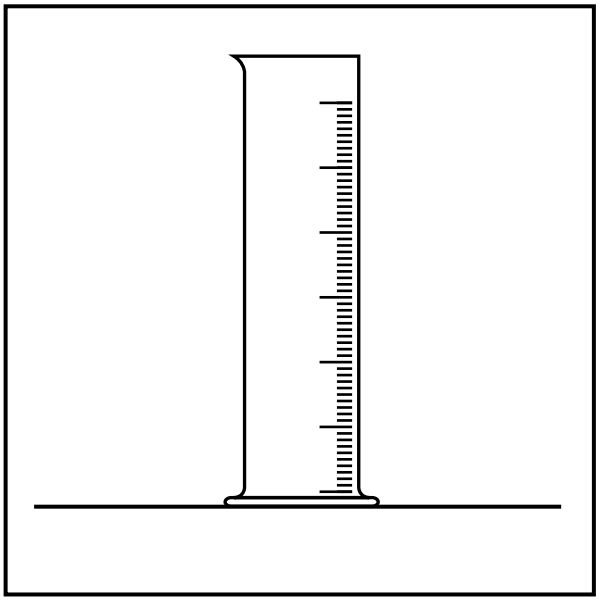

dilute sulfuric acid
zinc carbonate






oven





(a) Describe how Jak uses the apparatus and chemicals shown in the diagrams to make some clean, dry crystals of zinc sulfate.

The quality of written communication will be assessed in your answer.

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_____ **[6]**

(b) Jak puts his zinc sulfate crystals in a weighing bottle.

He records some data about his experiment.

volume of dilute sulfuric acid used	**20 cm^3**
mass of zinc carbonate at the start	**10.0 g**
mass of empty weighing bottle	**18.5 g**
mass of weighing bottle and crystals	**21.7 g**

(i) What is the ACTUAL YIELD of crystals in Jak's experiment?

answer = _____ g [1]

(ii) Jak works out that the theoretical yield of crystals is 4.0 g.

He works out his percentage yield using this equation.

$$\text{percentage yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

Use your answer to part (i) to work out Jak's percentage yield.

answer = _____ % [2]

(c) Jak makes more zinc sulfate crystals by a different method.

This time he reacts the acid with zinc instead of with zinc carbonate.

He notices that a gas is made in each reaction.

Draw straight lines to connect each REACTION on the left with the correct GAS on the right.

REACTION	GAS
	carbon dioxide
	nitrogen
sulfuric acid + zinc carbonate	
	hydrogen
sulfuric acid + zinc	
	oxygen
	sulfur dioxide

[2]

[TOTAL: 11]

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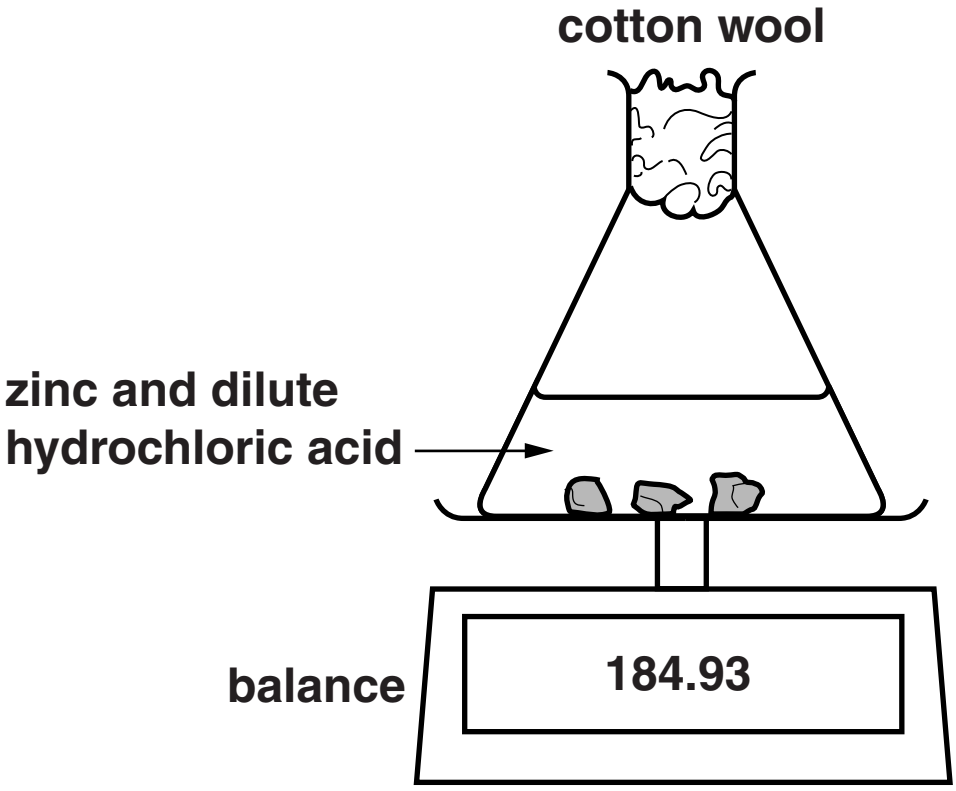
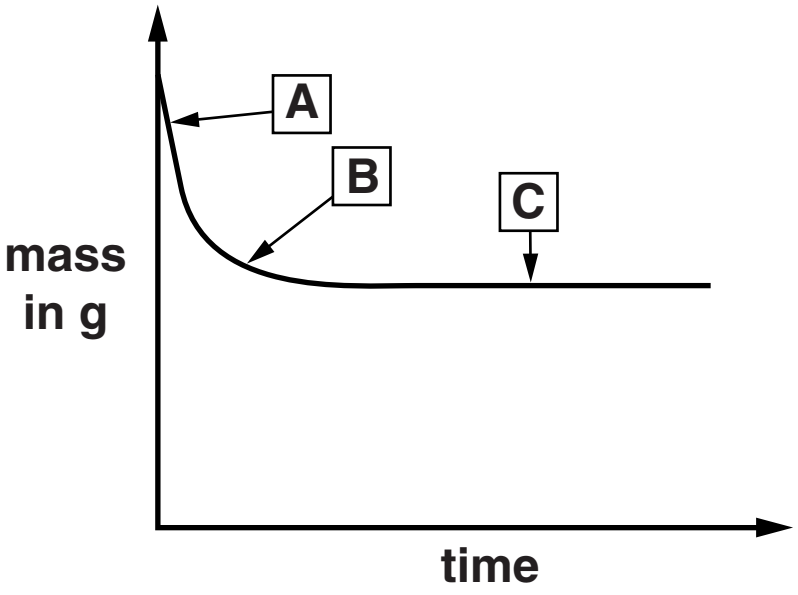
QUESTION 8 BEGINS ON PAGE 30

8 Liz does an experiment to investigate the rate of reaction between zinc and dilute hydrochloric acid.

She measures the mass of the flask during the reaction.



Liz plots her results on the graph below.



(a) Draw straight lines to connect each POINT ON THE GRAPH to what is happening to the RATE OF REACTION.

POINT ON THE GRAPH	RATE OF REACTION
	reaction has stopped
A	
	rate has speeded up
B	
	rate has slowed down
C	
	rate is at its fastest

[2]

(b) What is the name of the salt that is made when zinc reacts with hydrochloric acid?

_____ **[1]**

(c) Liz reads an article on the internet which says that copper acts as a catalyst for this reaction.

She does an investigation to find out if this is true.

How should she do the investigation, and what results should she expect?

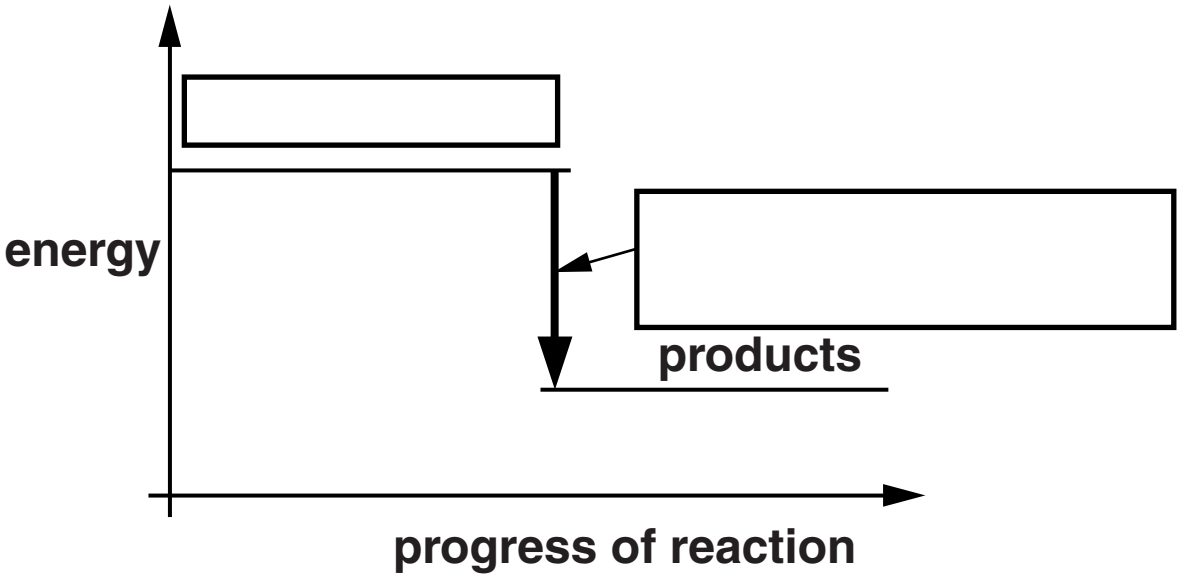
_____

_____

_____

_____ **[3]**

(d) **The diagram below shows an energy level diagram for the reaction.**



Write the correct words in the boxes to label the diagram.

Choose words from this list.

energy change of reaction

catalyst

rate of reaction

gas given off

reactants

[2]

[TOTAL: 8]

END OF QUESTION PAPER

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