OCR

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Tuesday 10 June 2014 – Afternoon

GCSE TWENTY FIRST CENTURY SCIENCE CHEMISTRY A/ADDITIONAL SCIENCE A

A172/01 Modules C4 C5 C6 (Foundation Tier)

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

OCR supplied materials:
None

Other materials required:
- Pencil
- Ruler (cm/mm)

Duration: 1 hour

Candidate forename		Candidate surname	

Centre number						Candidate number				

INSTRUCTIONS TO CANDIDATES

- Write your name, centre number and candidate number in the boxes above. 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).
- Do **not** write in the bar codes.

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**.
- This document consists of **20** pages. Any blank pages are indicated.
- A list of qualitative tests for ions is printed on page **2**.
- The Periodic Table is printed on the back page.

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** to the correct **similar properties**.

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 and 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.

.....

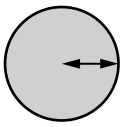
..... **[2]**

[Total: 10]

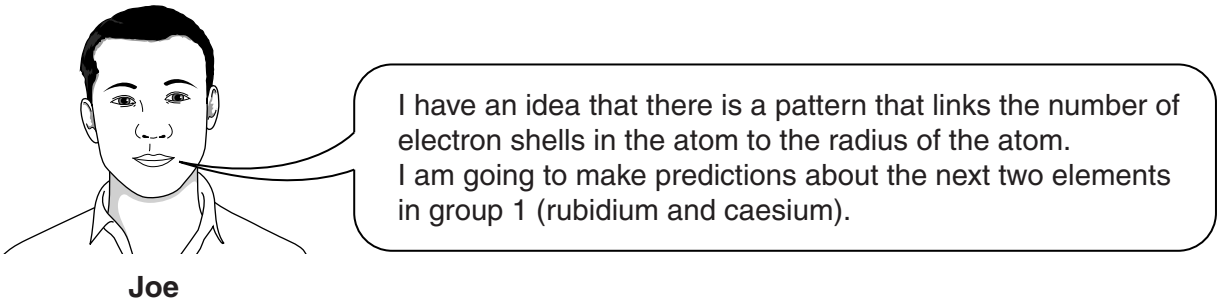
3 Joe does some research about Group 1 elements.

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.



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

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.

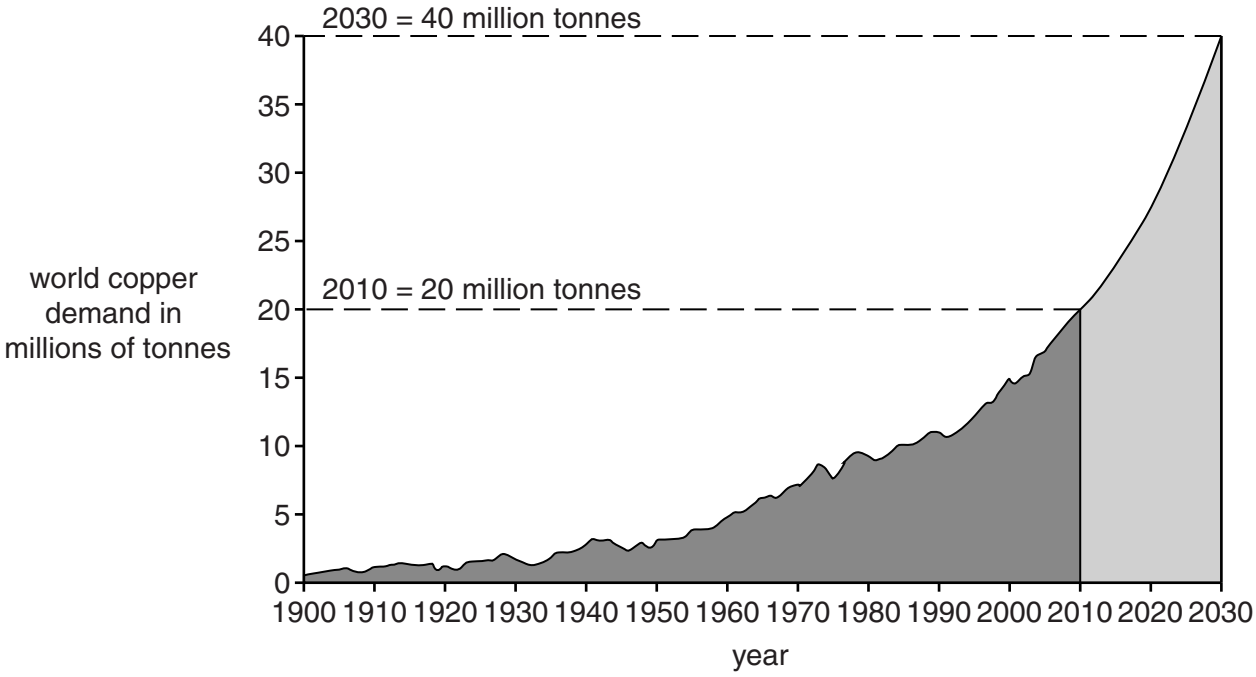
Use	Properties			
	Melting point	Electrical conductivity	Malleability	Strength
Bridge supports				
Temperature probes for hot ovens				
Electric wiring				
Metal that must be hammered into shape to make horseshoes				

[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 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.

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. ☐

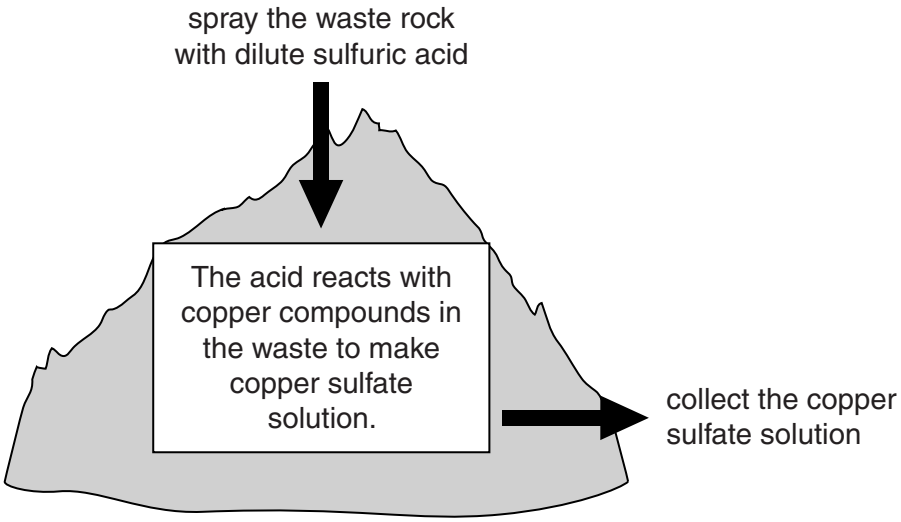
The rock is broken up into pieces and so has no use. ☐

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 page 2 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]

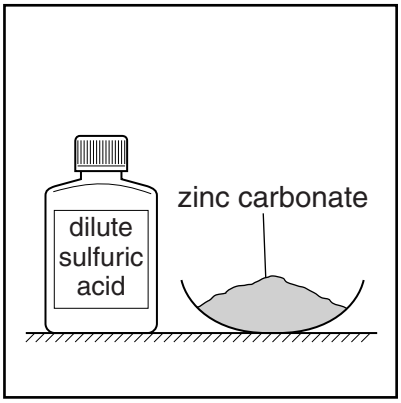
[Total: 8]

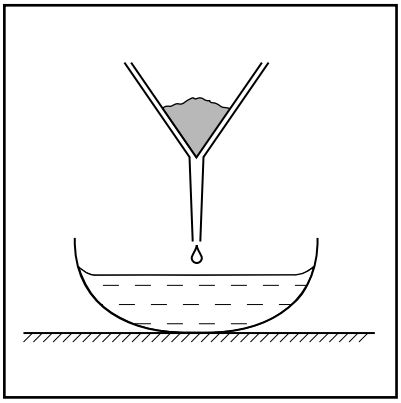
7 Jak makes some zinc sulfate crystals from solid zinc carbonate and dilute sulfuric acid.

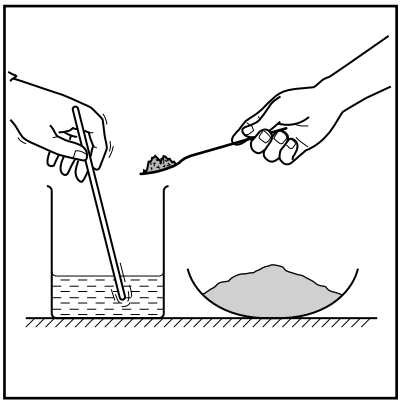
He starts with 20 cm^3 of dilute sulfuric acid.

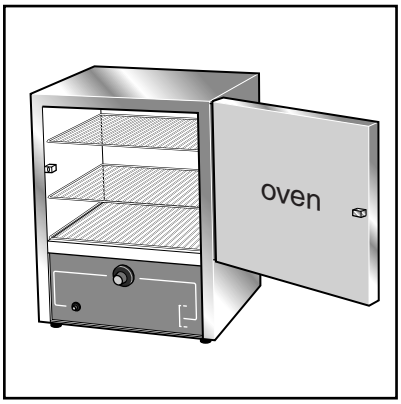
The diagrams below show some of the apparatus and chemicals he uses.

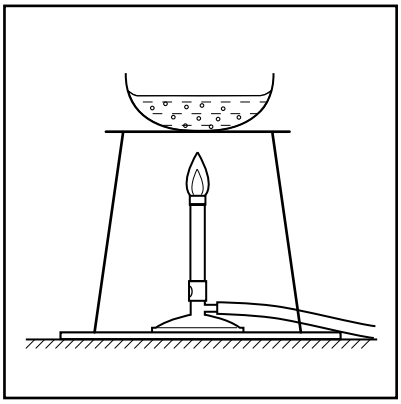
They are **not** in the order that Jak uses them.

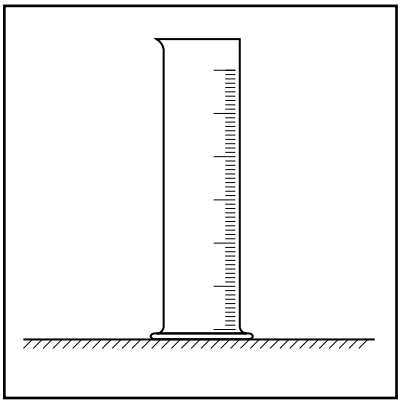












(a) Describe how Jak uses the apparatus and chemicals shown in the diagrams to make some clean, dry crystals of zinc sulfate.

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** with the correct **gas**.

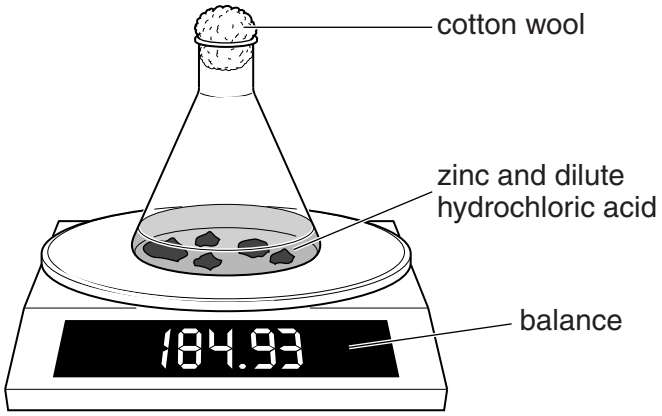
reaction	**gas**
	carbon dioxide
	nitrogen
sulfuric acid + zinc carbonate	
	hydrogen
sulfuric acid + zinc	
	oxygen
	sulfur dioxide

[2]

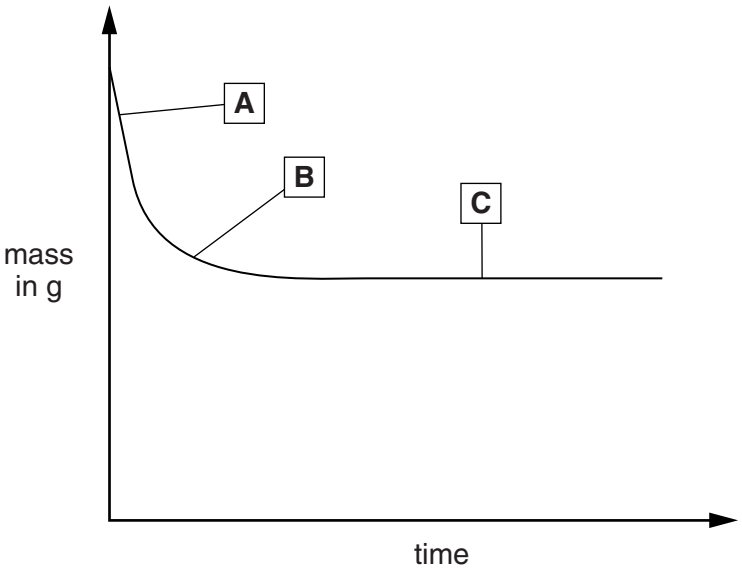
[Total: 11]

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?

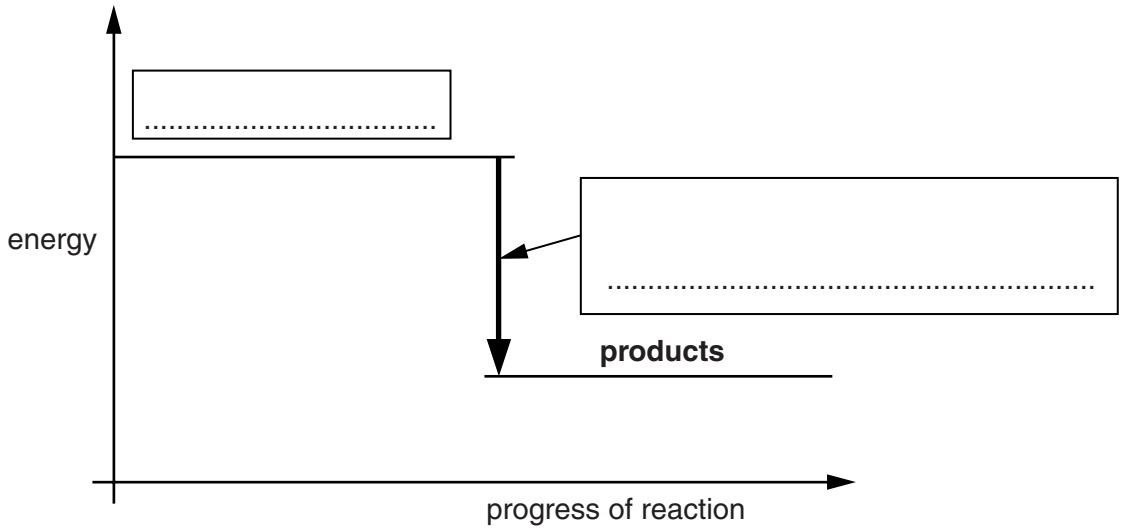
.....

.....

.....

..... **[3]**

(d) The diagram 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

PLEASE DO NOT WRITE ON THIS PAGE

The Periodic Table of the Elements

1	2											3	4	5	6	7	0
							1 **H** hydrogen 1										4 **He** helium 2
7 **Li** lithium 3	9 **Be** beryllium 4											11 **B** boron 5	12 **C** carbon 6	14 **N** nitrogen 7	16 **O** oxygen 8	19 **F** fluorine 9	20 **Ne** neon 10
23 **Na** sodium 11	24 **Mg** magnesium 12											27 **Al** aluminium 13	28 **Si** silicon 14	31 **P** phosphorus 15	32 **S** sulfur 16	35.5 **Cl** chlorine 17	40 **Ar** argon 18
39 **K** potassium 19	40 **Ca** calcium 20	45 **Sc** scandium 21	48 **Ti** titanium 22	51 **V** vanadium 23	52 **Cr** chromium 24	55 **Mn** manganese 25	56 **Fe** iron 26	59 **Co** cobalt 27	59 **Ni** nickel 28	63.5 **Cu** copper 29	65 **Zn** zinc 30	70 **Ga** gallium 31	73 **Ge** germanium 32	75 **As** arsenic 33	79 **Se** selenium 34	80 **Br** bromine 35	84 **Kr** krypton 36
85 **Rb** rubidium 37	88 **Sr** strontium 38	89 **Y** yttrium 39	91 **Zr** zirconium 40	93 **Nb** niobium 41	96 **Mo** molybdenum 42	[98] **Tc** technetium 43	101 **Ru** ruthenium 44	103 **Rh** rhodium 45	106 **Pd** palladium 46	108 **Ag** silver 47	112 **Cd** cadmium 48	115 **In** indium 49	119 **Sn** tin 50	122 **Sb** antimony 51	128 **Te** tellurium 52	127 **I** iodine 53	131 **Xe** xenon 54
133 **Cs** caesium 55	137 **Ba** barium 56	139 **La*** lanthanum 57	178 **Hf** hafnium 72	181 **Ta** tantalum 73	184 **W** tungsten 74	186 **Re** rhenium 75	190 **Os** osmium 76	192 **Ir** iridium 77	195 **Pt** platinum 78	197 **Au** gold 79	201 **Hg** mercury 80	204 **Tl** thallium 81	207 **Pb** lead 82	209 **Bi** bismuth 83	[209] **Po** polonium 84	[210] **At** astatine 85	[222] **Rn** radon 86
[223] **Fr** francium 87	[226] **Ra** radium 88	[227] **Ac*** actinium 89	[261] **Rf** rutherfordium 104	[262] **Db** dubnium 105	[266] **Sg** seaborgium 106	[264] **Bh** bohrium 107	[277] **Hs** hassium 108	[268] **Mt** meitnerium 109	[271] **Ds** darmstadtium 110	[272] **Rg** roentgenium 111	Elements with atomic numbers 112-116 have been reported but not fully authenticated						

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

**** The lanthanoids (atomic numbers 58-71) and the actinoids (atomic numbers 90-103) have been omitted.***

The relative atomic masses of copper and chlorine have not been rounded to the nearest whole number.