

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.

**Duration:** 1 hour

**OCR supplied materials:**  
None

**Other materials required:**

- Pencil
- Ruler (cm/mm)




Candidate forename		Candidate surname	
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Centre number						Candidate number				
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**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 $\text{Ca}^{2+}$	add dilute sodium hydroxide	a white precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
copper $\text{Cu}^{2+}$	add dilute sodium hydroxide	a light blue precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(II) $\text{Fe}^{2+}$	add dilute sodium hydroxide	a green precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
iron(III) $\text{Fe}^{3+}$	add dilute sodium hydroxide	a red-brown precipitate forms; the precipitate does not dissolve in excess sodium hydroxide
zinc $\text{Zn}^{2+}$	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 $\text{CO}_3^{2-}$	add dilute acid	the solution effervesces; carbon dioxide gas is produced (the gas turns lime water from colourless to milky)
chloride $\text{Cl}^-$	add dilute nitric acid, then add silver nitrate	a white precipitate forms
bromide $\text{Br}^-$	add dilute nitric acid, then add silver nitrate	a cream precipitate forms
iodide $\text{I}^-$	add dilute nitric acid, then add silver nitrate	a yellow precipitate forms
sulfate $\text{SO}_4^{2-}$	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	$\text{LiCl}$
sodium	1	.....
beryllium	2	$\text{BeCl}_2$
.....	2	$\text{MgCl}_2$
aluminium	3	$\text{AlCl}_3$
silicon	4	$\text{SiCl}_4$

- (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  $\text{PCl}_5$ .

Sulfur is in group 6. It forms a chloride with the formula  $\text{SCl}_2$ .

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**

calcium, strontium, barium

chlorine, bromine, iodine

carbon, nitrogen and oxygen

**similar properties**

non-metals found in  
molecules in the air

non-metals that all react  
quickly with group 1 metals

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
<b>Triad A</b>	lithium 7	<b>sodium</b> <b>23</b>	potassium 39	<b>23</b>
<b>Triad B</b>	calcium 40	<b>strontium</b> <b>88</b>	barium 137	<b>89</b>
<b>Triad C</b>	chlorine 35.5	<b>bromine</b> <b>80</b>	iodine 127	<b>81</b>

- (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	<b>silver</b> <b>108</b>	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]

Turn over

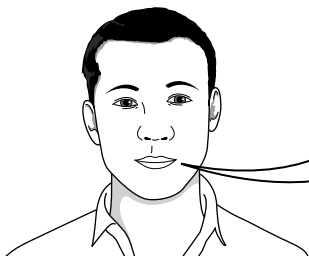
3 Joe does some research about Group 1 elements.

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

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.*

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

..... [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				

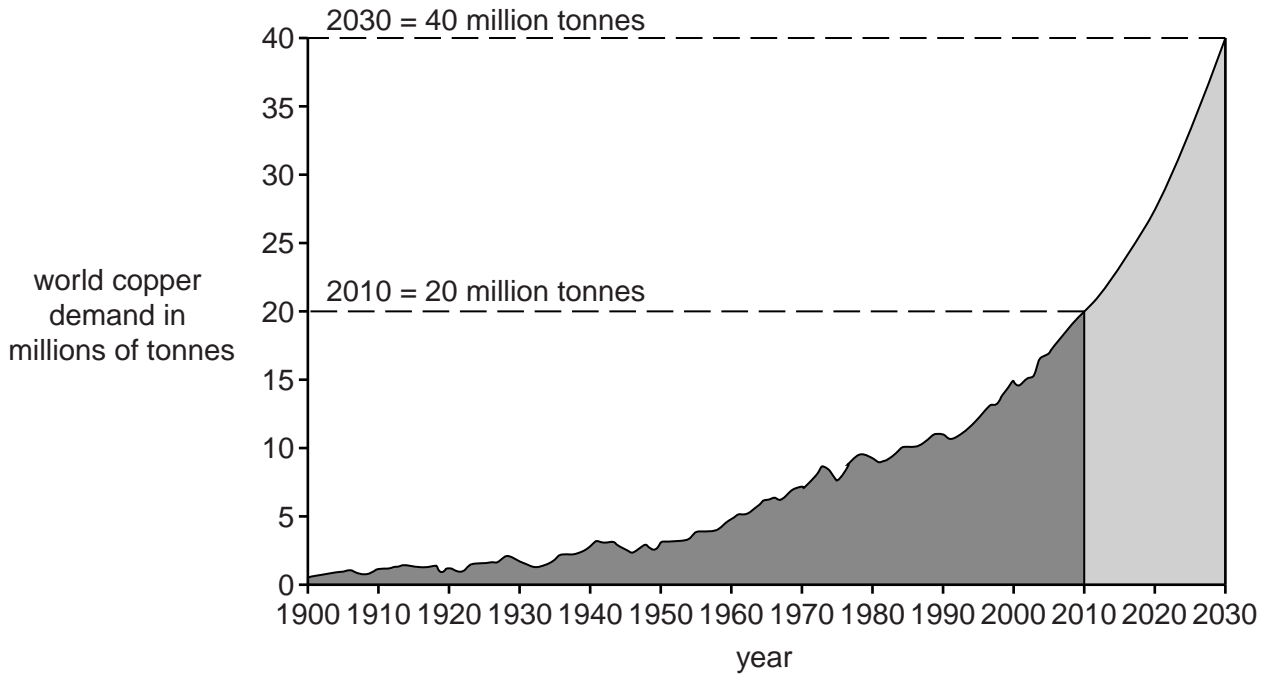
[2]

[Total: 6]

Turn over

- 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.





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.

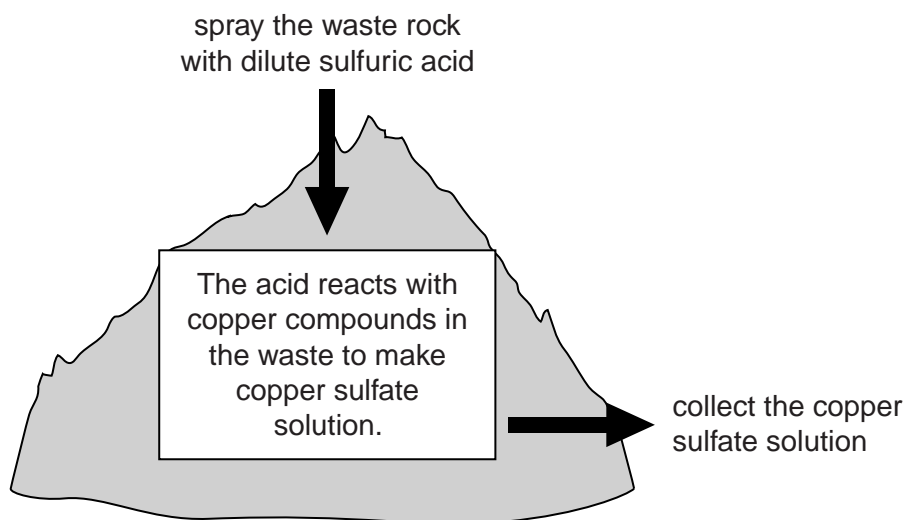
The rock is broken up into pieces and so has no use.

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]

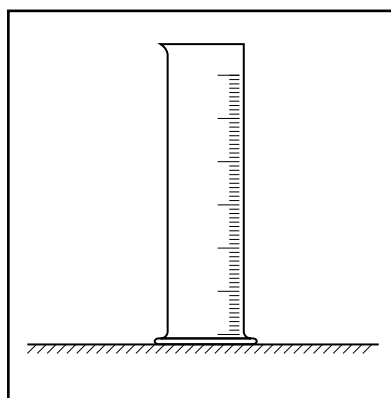
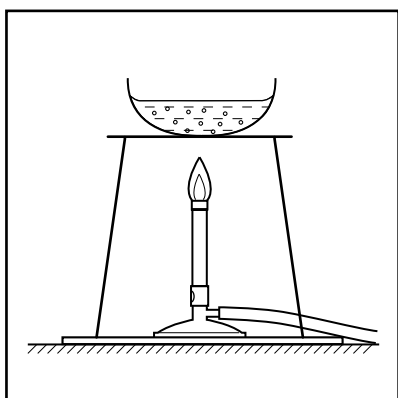
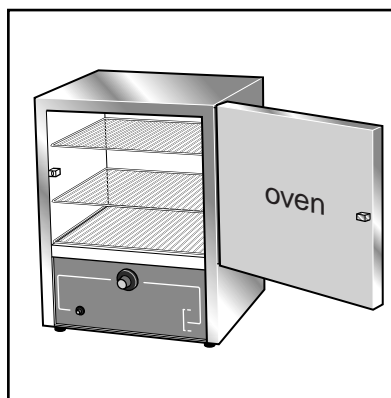
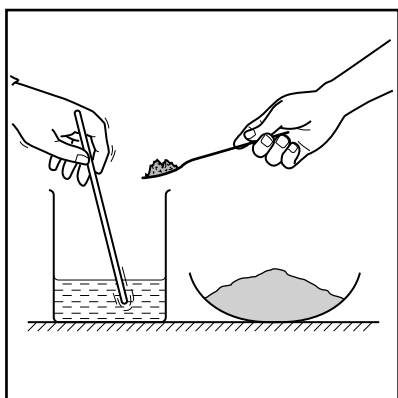
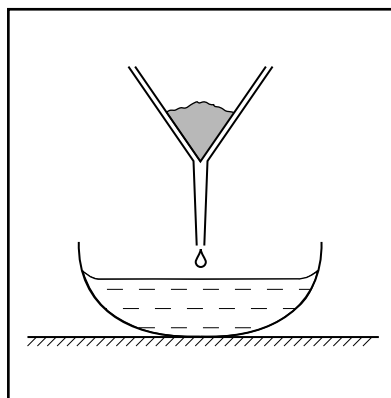
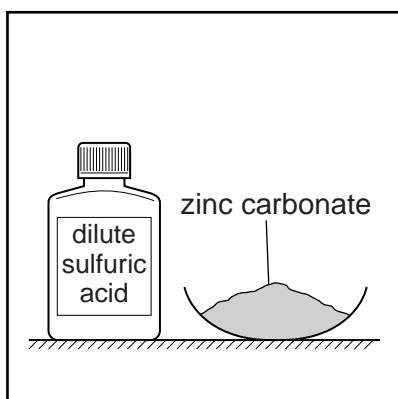
[Total: 8]

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

He starts with 20 cm<sup>3</sup> 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.





(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 <sup>3</sup>
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**.

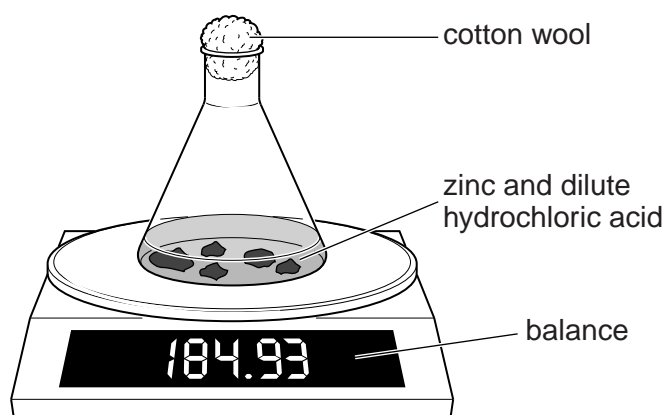
reaction	gas
	carbon dioxide
	nitrogen
sulfuric acid + zinc carbonate	hydrogen
sulfuric acid + zinc	oxygen
	sulfur dioxide

[2]

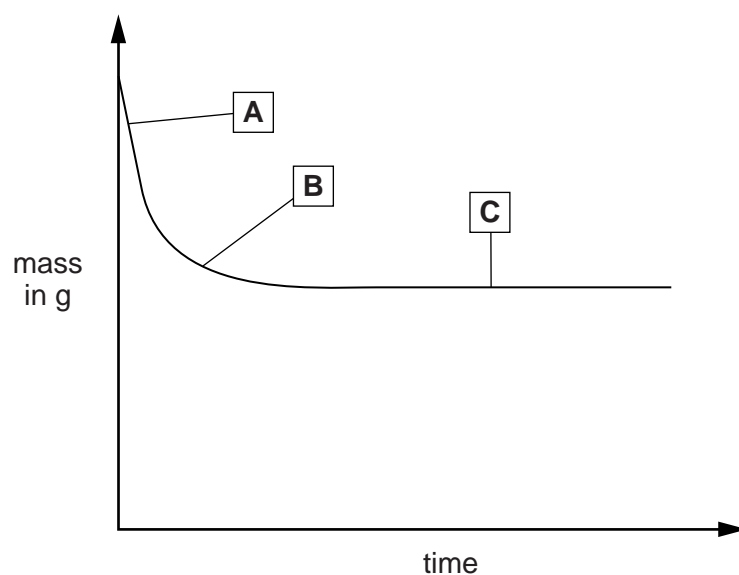
[Total: 11]

- 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
<div style="border: 1px solid black; padding: 5px; width: 60px; margin: 0 auto;">A</div>	<div style="border: 1px solid black; padding: 5px; width: 150px; margin: 0 auto;">reaction has stopped</div>
<div style="border: 1px solid black; padding: 5px; width: 60px; margin: 0 auto;">B</div>	<div style="border: 1px solid black; padding: 5px; width: 150px; margin: 0 auto;">rate has speeded up</div>
<div style="border: 1px solid black; padding: 5px; width: 60px; margin: 0 auto;">C</div>	<div style="border: 1px solid black; padding: 5px; width: 150px; margin: 0 auto;">rate has slowed down</div>
	<div style="border: 1px solid black; padding: 5px; width: 150px; margin: 0 auto;">rate is at its fastest</div>

[2]

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

..... [1]

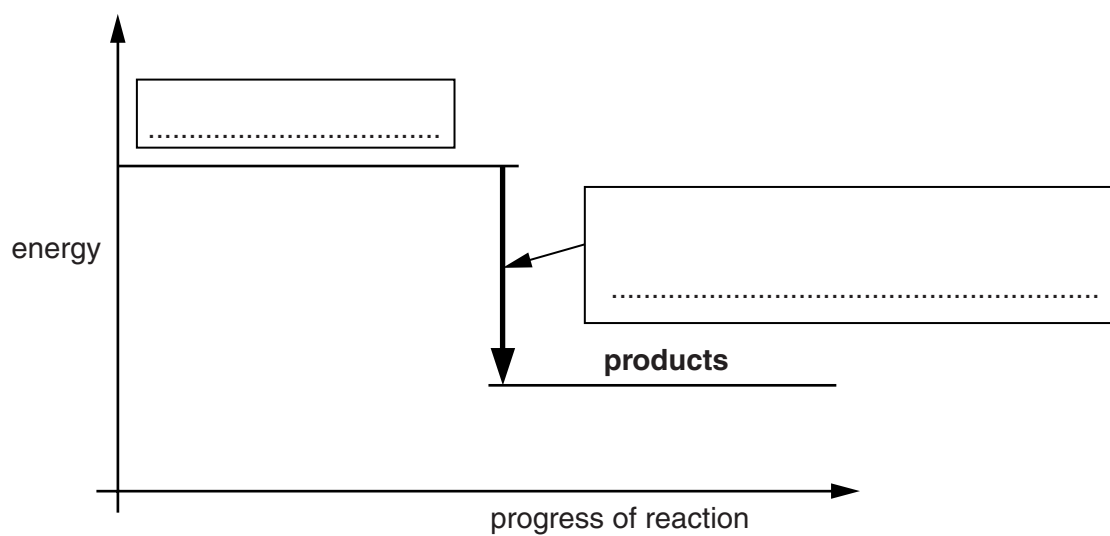
(c) Liz reads an article on the internet which says that copper acts as a catalyst for this reaction.

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**

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# The Periodic Table of the Elements

	1	2	3	4	5	6	7	0										
	7 Li lithium 3	9 Be beryllium 4	11 Na sodium 11	12 Mg magnesium 12	13 Al aluminium 13	14 Si silicon 14	15 P phosphorus 15	16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18								
	19 K potassium 19	20 Ca calcium 20	21 Sc scandium 21	22 Ti titanium 22	23 V vanadium 23	24 Cr chromium 24	25 Mn manganese 25	26 Fe iron 26	27 Co cobalt 27	28 Ni nickel 28	29 Cu copper 29	30 Zn zinc 30	31 Ga gallium 31	32 Ge germanium 32	33 As arsenic 33	34 Se selenium 34	35 Br bromine 35	36 Kr krypton 36
	37 Rb rubidium 37	38 Sr strontium 38	39 Y yttrium 39	40 Zr zirconium 40	41 Nb niobium 41	42 Mo molybdenum 42	43 Tc technetium [98]	44 Ru ruthenium 44	45 Rh rhodium 45	46 Pd palladium 46	47 Ag silver 47	48 Cd cadmium 48	49 In indium 49	50 Sn tin 50	51 Sb antimony 51	52 Te tellurium 52	53 I iodine 53	54 Xe xenon 54
	55 Cs caesium 55	56 Ba barium 56	57 La* lanthanum 57	72 Hf hafnium 72	73 Ta tantalum 73	74 W tungsten 74	75 Re rhenium 75	76 Os osmium 76	77 Ir iridium 77	78 Pt platinum 78	79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Pb lead 82	83 Bi bismuth 83	84 Po polonium 84	85 At astatine 85	86 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						

1  
H  
hydrogen  
1

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.