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Wednesday 18 January 2012 – Morning

GCSE GATEWAY SCIENCE
CHEMISTRY B

B741/02 Chemistry modules C1, C2, C3 (Higher Tier)

B736700112

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 15 minutes

B741 02

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

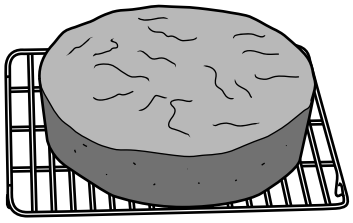
- Your quality of written communication is assessed in questions marked with a pencil (✎).
- The Periodic Table can be found on the back page.
- The number of marks is given in brackets **[ ]** at the end of each question or part question.
- The total number of marks for this paper is **75**.
- This document consists of **24** pages. Any blank pages are indicated.

Answer **all** the questions.

Section A – Module C1

1 This question is about chemical changes.

(a) Amir is making a cake.



He adds baking powder to the cake mixture.

Baking powder contains sodium hydrogencarbonate.

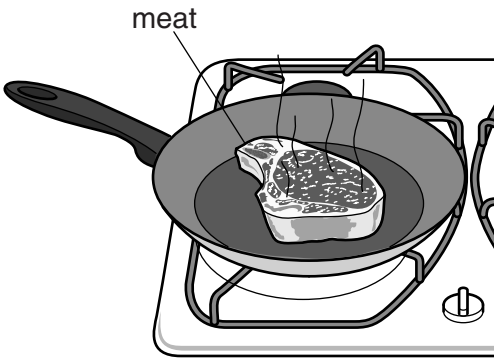
Sodium hydrogencarbonate breaks down when heated in an oven.

Sodium carbonate, water and a gas are the products made.

What gas is made?

..... **[1]**

(b) Amir cooks some meat.



Meat contains protein.

What happens to the **protein molecules** when the meat is cooked?

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..... **[1]**

[Total: 2]

2 This question is about the atmosphere.

(a) The air we breathe is a mixture of gases.

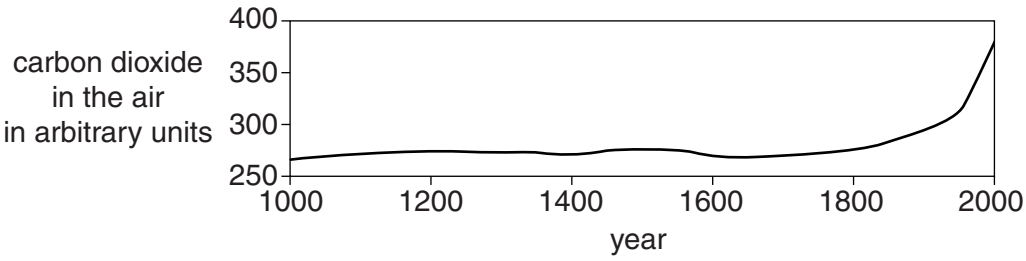
Look at the table. It shows the percentage of gases in clean air.

gas	percentage in clean air
nitrogen	.....
oxygen	21
other gases	1
carbon dioxide	0.035

Complete the table. **[1]**

(b) Look at the graph.

The graph shows the carbon dioxide levels in the air from the year 1000 to the year 2000.



Look at the table.

It shows the population of the world in the year 1000, 1800 and 2000.

year	1000	1800	2000
world population in millions	275	1000	6000

Compare the data for population and carbon dioxide levels.

Does an increase in population **directly** cause an increase in carbon dioxide levels?

Explain your answer.

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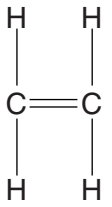
..... **[2]**

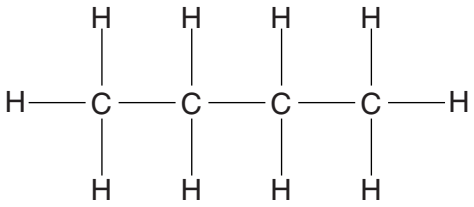
[Total: 3]

3 This question is about carbon compounds.

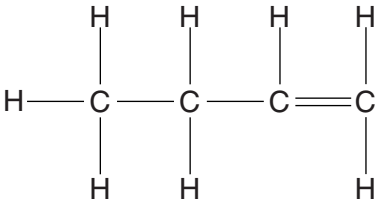
Compounds **A**, **B**, **C** and **D** are hydrocarbons.



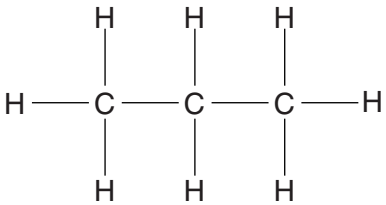
compound **A**



compound **B**



compound **C**



compound **D**

(a) Look at the displayed formulas of these compounds.

Explain why they are all hydrocarbons.

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

(b) Write down the **molecular formula** of compound **B.**

answer ..... **[1]**

(c) Look at the displayed formulas of compounds **A** and **C**.

Compounds **A** and **C** are **unsaturated**.

Explain why.

.....

..... **[1]**

(d) Compound **A** is ethene.

Ethene can be polymerised to make poly(ethene) in a process called addition polymerisation.

In polymerisation, small monomer molecules join together to make large polymer molecules.

Describe the addition polymerisation of ethene.

Your answer should include the displayed formula of poly(ethene).

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

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..... **[6]**

[Total: 10]

4 This question is about oil and the products from oil.

(a) Crude oil is transported over long distances by sea and through pipelines.

The UK gets some of its crude oil from politically unstable countries.

Suggest one argument for, and one argument against, getting oil from such countries.

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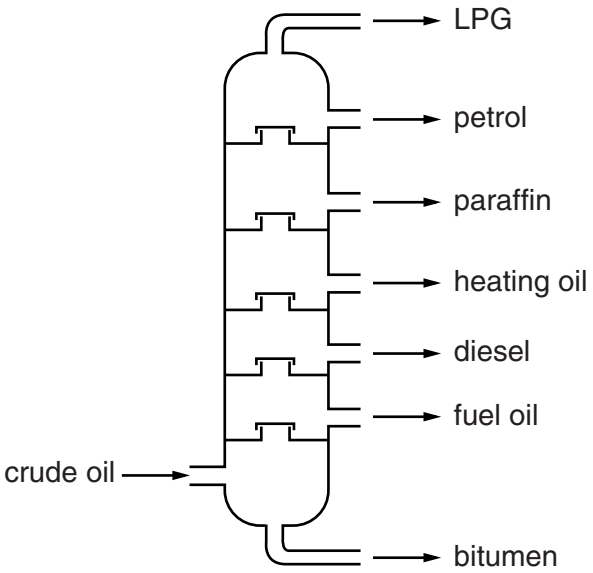
..... **[2]**

(b) Crude oil is separated into many fractions by fractional distillation.

Look at the diagram.

It shows a fractionating column.



LPG has a lower boiling point than petrol.

Explain why.

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

(c) Look at the table.

It shows the percentage of each fraction in crude oil.

It also shows the percentage of each fraction needed for everyday use.

fraction	% in crude oil	% needed
LPG	4	4
petrol	5	22
heating oil	9	5
diesel	19	23
paraffin	13	8
fuel oil and bitumen	50	38

The table shows that fractional distillation cannot supply all the petrol that is needed.

Explain how an oil refinery uses **cracking** to make sure that enough petrol is made.

Use information from the table.

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

(d) Look at the table.

It gives information about some fuels.

fuel	energy released by one gram of fuel in kJ	products of burning	availability
ethene	44.3	carbon dioxide and water	limited
hydrogen	143.0	water	limited
LPG	55.6	carbon dioxide and water	available
petrol	48.3	carbon dioxide, water and other gases	widely available

Petrol can be used to power a car.

Recommend one of these fuels as an alternative fuel to petrol.

fuel .....

Explain your answer using information from the table.

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

(e) Ethene, C_2H_4, reacts with oxygen, O_2.

Carbon dioxide and water are made.

Write the **balanced symbol** equation for this reaction.

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

[Total: 10]

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Question 5 begins on page 10.

PLEASE DO NOT WRITE ON THIS PAGE

Section B – Module C2

5 George is researching information about construction materials on the internet.

Look at his results.

material	formula	density in g/cm^3	relative hardness (1=soft, 10=very hard)	relative strength (1=weak, 500=very strong)
brick	no information	2.0	6	3
steel	mainly Fe	7.7	6	400
limestone	$CaCO_3$	2.4	3	7
granite	mainly SiO_2	2.9	7	23
lead	Pb	11.4	1	12
marble	$CaCO_3$	2.7	5	15
copper	Cu	8.9	3	200
wood	no information	0.9	0.8	1

(a) Which material would be the **most** scratch resistant?

Choose from the table.

Explain your answer.

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

(b) Look at the picture of a girder bridge.

Which material would be best to use to make the girders of this bridge?

Choose from the table.

Explain your answer.

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

(c) Marble, granite and wood are materials that can be used to make a kitchen worktop.

Describe the **advantages** and **disadvantages** of marble, granite and wood for making a kitchen worktop.

Use information from the table.

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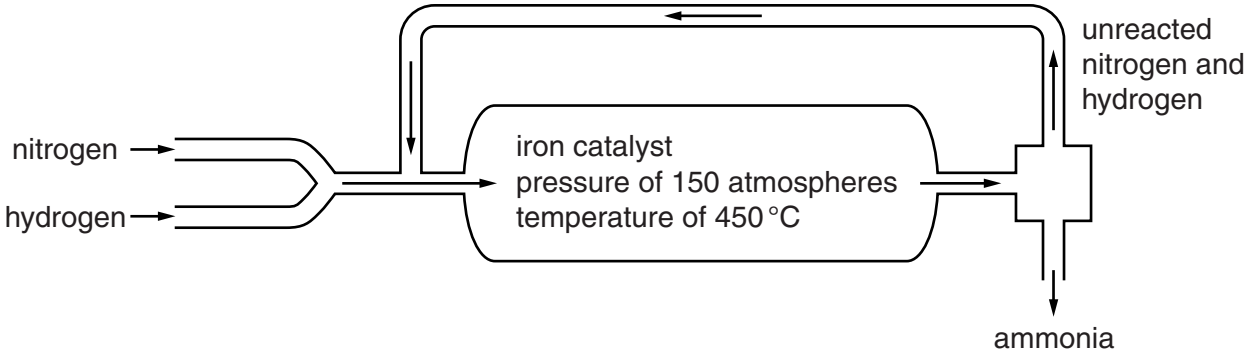
..... **[3]**

[Total: 7]

6 Look at the diagram. It shows how ammonia is made in the Haber process.



(a) Unreacted nitrogen and hydrogen are recycled.

Explain why.

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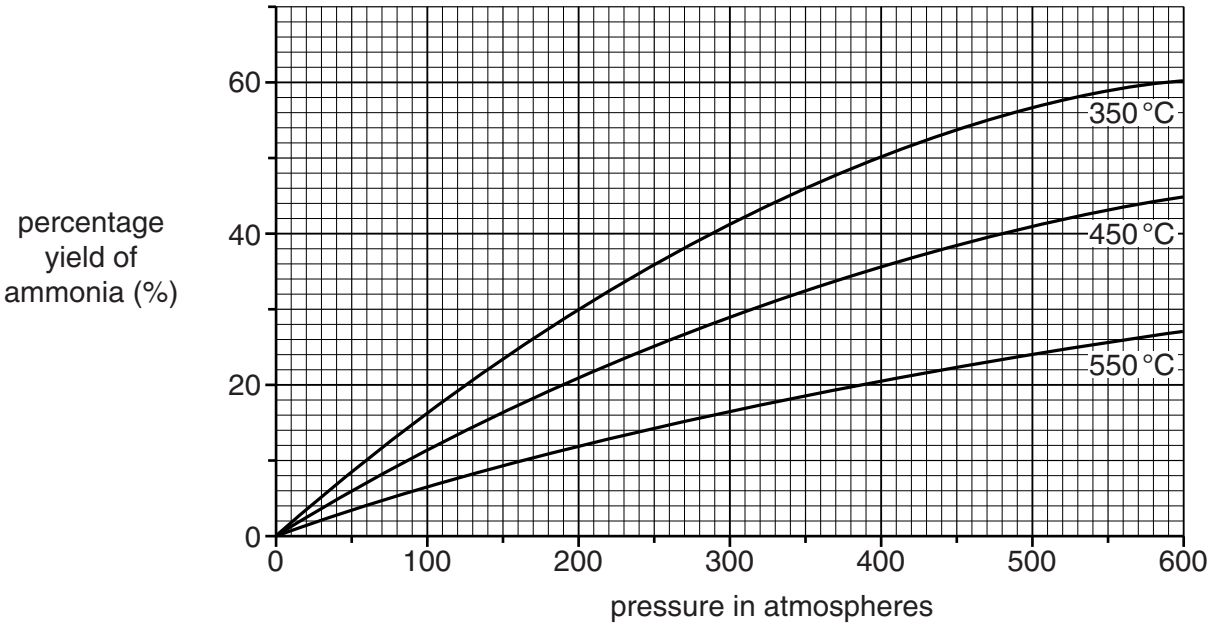
..... **[1]**

(b) Look at the graph.

It shows the percentage yield of ammonia at different temperatures and pressures.



What is the percentage yield of ammonia at **450 °C** and **400 atmospheres**?

answer ..... % **[1]**

(c) Look at the graph.

(i) What conditions, shown on the graph, give the **highest** yield of ammonia?

pressure = ... atmospheres

temperature = ... °C **[1]**

(ii) Ammonia is manufactured at 450 °C and 150 atmospheres using an iron catalyst.

Explain why these conditions are used.

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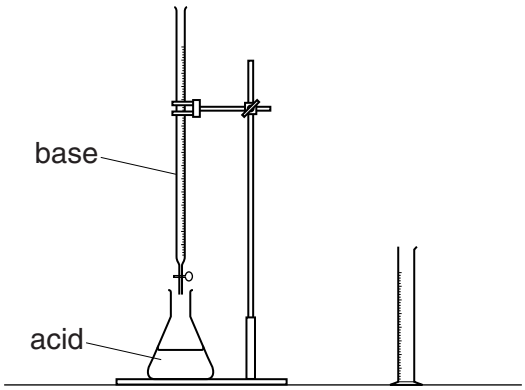
..... **[3]**

[Total: 6]

7 Jade and Philip are making fertilisers by neutralisation.



(a) Complete the **word** equation for neutralisation.

acid + base → ..... + water **[1]**

(b) Jade and Philip want to make potassium nitrate.

Which **acid** and which **base** should they use?

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

(c) Jade and Philip also make ammonium phosphate.

The formula of ammonium phosphate is

$$(NH_4)_3PO_4$$

What is the total number of **atoms** in this formula?

..... **[1]**

[Total: 4]

8 Scientists accept that the surface of the Earth is made up of **tectonic plates**.

(a) Describe the theory of plate tectonics and use this theory to explain subduction.

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

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..... **[6]**

(b) Geologists study the structure of the Earth.

This is not an easy thing to do.

Explain why.

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

[Total: 8]

Section C – Module C3

9 Pharmaceutical drugs or medicines are speciality chemicals.

(a) Pharmaceutical drugs are often made by batch processes rather than continuous processes.

Explain why.

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..... **[1]**

(b) Pharmaceutical drugs often cost a lot of money to make and develop.

One reason is that it takes many years to research and test a new drug.

Explain **two** other reasons why it is expensive to make and develop a new drug.

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

(c) Pharmaceutical drugs need to be tested to make sure they are safe to use.

The research and testing of pharmaceutical drugs may include

- animal testing
- testing on human volunteers.

The ideas and views of people in society affect the work of scientists.

Suggest how the ideas and views of people in society have changed the way scientists research and test pharmaceutical drugs.

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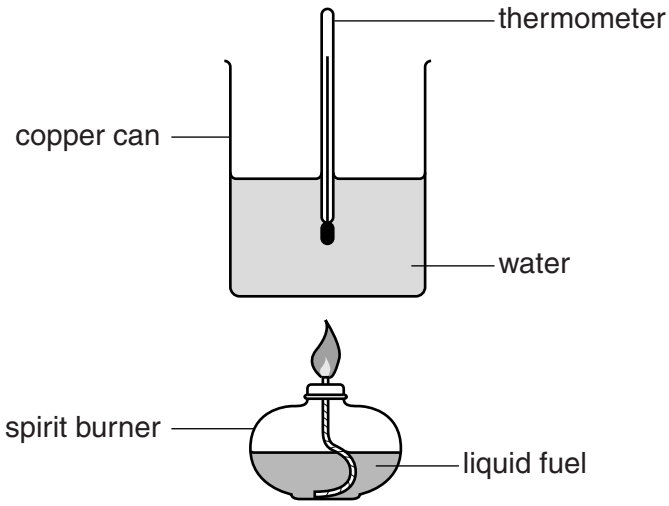
..... **[2]**

[Total: 5]

10 Petrol is a mixture of hydrocarbons.

David investigates the energy released when five of these hydrocarbons are burned.

Look at the apparatus he uses.



Each time, he burns 0.5 g of hydrocarbon and heats 100 g of water.

David measures the temperature of the water before heating.

He measures the temperature again when the hydrocarbon has finished burning.

These are his results.

hydrocarbon	**molecular formula**	**temperature of water in °C**	
		at start	**at end**
hexane	C_6H_{14}	20	40
heptane	C_7H_{16}	19	41
octane	C_8H_{18}	15	39
nonane	C_9H_{20}	18	45
decane	$C_{10}H_{22}$	20	46

(a) Calculate the energy released per gram by **hexane**.

Use the equation

energy = mass × specific heat capacity × temperature change

The specific heat capacity of water is 4.2 J/g °C.

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energy released per gram = ... J/g **[2]**

(b) David knows that the bigger the hydrocarbon molecule, the more carbon atoms it has.

David concludes that the bigger the hydrocarbon molecule, the more energy per gram is released.

Explain whether David's results fully support this conclusion.

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

[Total: 4]

11 Hydrogen peroxide has the molecular formula H_2O_2.

Hydrogen peroxide can be manufactured by reacting barium peroxide, BaO_2, with sulfuric acid, H_2SO_4.

$$BaO_2 + H_2SO_4 \rightarrow BaSO_4 + H_2O_2$$

Barium sulfate, $BaSO_4$, is a waste product.

Look at the table of relative formula masses, M_r.

formula	relative formula mass, M_r
BaO_2	169
H_2SO_4	98
$BaSO_4$	233
H_2O_2	34

(a) Show that the **atom economy** for the reaction is 12.7%.

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..... **[1]**

(b) A factory makes 18 tonnes of hydrogen peroxide.

Phil predicts the factory should make 20 tonnes of hydrogen peroxide.

Calculate the **percentage yield** of hydrogen peroxide.

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.....

percentage yield = ... % **[2]**

(c) The manufacture of hydrogen peroxide from barium peroxide is **not sustainable**.

Explain why.

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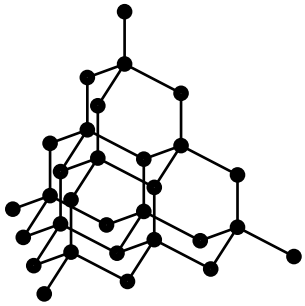
..... **[1]**

[Total: 4]

12 Diamond is a form of carbon.

Look at the structure of diamond.



Scientists use the structure **and** bonding of a substance to explain its properties.

(a) Diamond has a very high melting point.

Explain why.

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

(b) Diamond does not conduct electricity.

Explain why.

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..... **[1]**

[Total: 3]

13 Magnesium reacts with dilute hydrochloric acid, HC*l*.

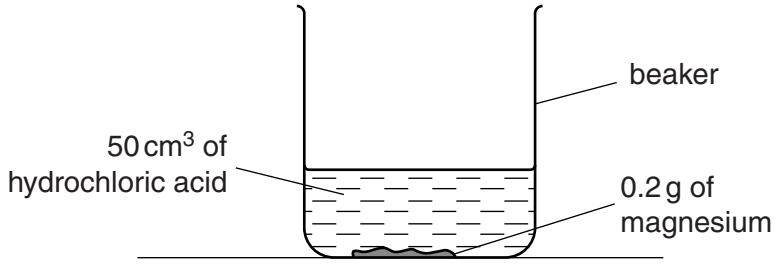
Magnesium chloride and hydrogen, H_2, are made.

(a) Write down the **balanced symbol** equation for this reaction.

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

(b) Peter and Rachel investigate the reaction between magnesium and hydrochloric acid.

Look at the apparatus they use.



They time how long it takes for all of the magnesium to react (the reaction time).

Look at their results.

experiment	temperature of acid	concentration of acid	magnesium ribbon or powder	reaction time in seconds	mean rate of reaction in g/s
A	cold	dilute	ribbon	240	8.33×10^{-4}
B	cold	concentrated	ribbon	120	
C	warm	dilute	ribbon	100	2.00×10^{-3}
D	cold	dilute	powder	50	4.00×10^{-3}

(i) Look at the results for experiment **B**.

Calculate the mean rate of reaction in experiment **B**.

Give your answer to **three** significant figures.

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rate of reaction = ... g/s **[1]**

(ii) Peter and Rachel can use a model called **collision theory** to explain how factors affect the rate of a reaction.

They know the rate of reaction increases when

- the temperature of the acid increases
- magnesium powder is used instead of magnesium ribbon.

Explain why, using collision theory.

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

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..... **[6]**

[Total: 9]

END OF QUESTION PAPER

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.