OCR
Oxford Cambridge and RSA

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Friday 9 June 2017 – Morning

GCSE GATEWAY SCIENCE
CHEMISTRY B

B741/02 Chemistry modules C1, C2, C3 (Higher 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 15 minutes

* B 7 4 1 0 2 *

* 6 8 7 6 0 8 5 0 4 1 *

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. If additional space is required, you should use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

INFORMATION FOR CANDIDATES

- The 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 **28** pages. Any blank pages are indicated.

Answer **all** the questions.

SECTION A – Module C1

1 This question is about pigments in paints.

Pigments give paints their colour.

Look at the table. It shows information about some pigments used in paints.

Pigment	Colour	Effect of increasing the temperature	Effect of light
A	green	no change	no change
B	purple	colour fades	colour fades
C	pink	changes to yellow	colour fades
D	blue	no change	absorbs light and later gives off light

(a) (i) Which pigment is **phosphorescent**?

Explain how you can tell.

.....

.....

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

(ii) A special spoon can be used to test the temperature of a baby's food.

Which pigment must the spoon contain?

Explain your answer.

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

(b) Oil based paints are used to paint doors and window frames.

Explain how oil based paints dry.

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

(c) Some pigments are used to make cosmetics such as nail varnish.

New cosmetics must be tested before they can be used.

Testing cosmetics on animals has been banned in the EU.

Explain why.

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

2 This question is about esters.

(a) Esters are made by reacting an acid with another type of compound.

Complete the word equation.

acid + ... → ester + water **[1]**

(b) Esters can be used as solvents.

They will remove nail varnish.

Water will not remove nail varnish.

Which **two** of these statements explain why water will **not** remove nail varnish?

Put ticks (✓) in **two** boxes.

Water molecules repel nail varnish particles.	☐
The force of attraction between water molecules is stronger than the force of attraction between water molecules and nail varnish particles.	☐
There is a strong force of attraction between water molecules and nail varnish particles.	☐
The force of attraction between nail varnish particles is stronger than the force of attraction between water molecules and nail varnish particles.	☐
Water will not evaporate as much as nail varnish remover at room temperature.	☐

[2]

(c) Esters are used to make perfumes.

Perfumes need to be **volatile** (evaporate easily) and **insoluble in water**.

Explain why **both** these properties are important.

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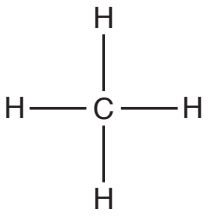
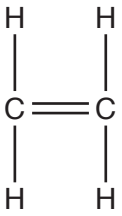
..... **[2]**

3 Look at the displayed formulas of some carbon compounds.



A



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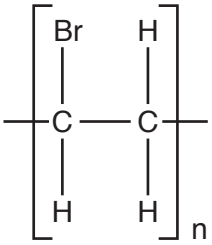
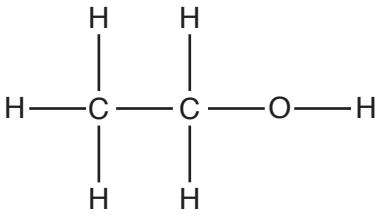


C



D

(a) Which compound is unsaturated?

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[1]

(b) Which compound is a saturated hydrocarbon?

.....

[1]

(c) Which compound will decolourise bromine water?

.....

[1]

(d) Which compound is a polymer?

.....

[1]

(e) Gore-tex® is a polymer used to make raincoats.

Gore-tex® is both waterproof and breathable.

Gore-tex® is made with nylon laminated with a PTFE / polyurethane membrane.

The PTFE has holes in it.

Explain why Gore-tex® is **waterproof** and **breathable**.

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

4 Look at the table. It shows information about some fuels.

Fuel	Energy value per kg in megajoules	Availability	Cost per kg in £	State	How long the supply will last in years	Pollution
A	45	limited	0.80	liquid	20	makes carbon dioxide
B	30	good	0.33	solid	50	makes carbon dioxide and large amounts of sulfur dioxide
C	38	good	1.30	gas	8	makes carbon dioxide

An energy company is choosing a fuel to be used in a power station.

A power station has a working life of about 25 years.

Evaluate the advantages and disadvantages of **all three** fuels.

Which fuel is the best choice? Explain your answer.

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

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

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Question 5 begins on page 8

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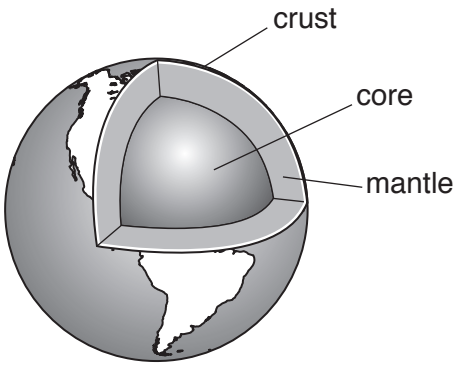
SECTION B – Module C2

5 This question is about the structure of the Earth.



not to scale

(a) The **lithosphere** is part of the structure of the Earth.

What is meant by the lithosphere?

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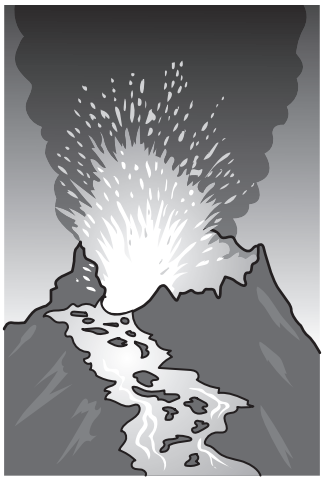
..... **[1]**

(b) In April 2015 the Calbuco volcano in Chile erupted.



Many scientists travelled to Chile to study the volcano.

Explain why.

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

(c) Many teams of scientists have published theories about the structure of the Earth.

Suggest why scientists work in teams and why they then publish their work.

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

6 Helen reacts ammonia, NH_3, with sulfuric acid, H_2SO_4.

Ammonium sulfate, $(NH_4)_2SO_4$, is made.

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

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

(b) In another reaction Helen reacts potassium hydroxide with nitric acid.

Write down the **name** of the salt made.

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

(c) In solution all acids contain ions.

Which ion is in **all** acids?

Choose from the list.

Cl^-

H^+

NH_4^+

SO_4^{2-}

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

7 Ammonia is made from nitrogen and hydrogen in a **reversible** reaction.

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

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

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

(b) Look at the table.

It gives some information about the percentage yield of ammonia at different temperatures and pressures.

Pressure in atmospheres	**Percentage yield (%) of ammonia at:**				
	100 °C	**200 °C**	**300 °C**	**400 °C**	**500 °C**
25	92	64	27	9	3
50	95	74	40	15	6
100	97	82	53	25	11
200	98	89	67	39	30
400	99	95	80	55	32

(i) What happens to the percentage yield of ammonia when the **pressure** increases?

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

(ii) What happens to the percentage yield of ammonia when the **temperature** increases?

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

(iii) At 100 °C and 400 atmospheres the percentage yield of ammonia is 99%.

The actual conditions used in the production of ammonia are

- 450 °C
- 200 atmospheres pressure
- iron catalyst.

Suggest why these conditions are used.

Use ideas about rate of reaction and percentage yield.

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

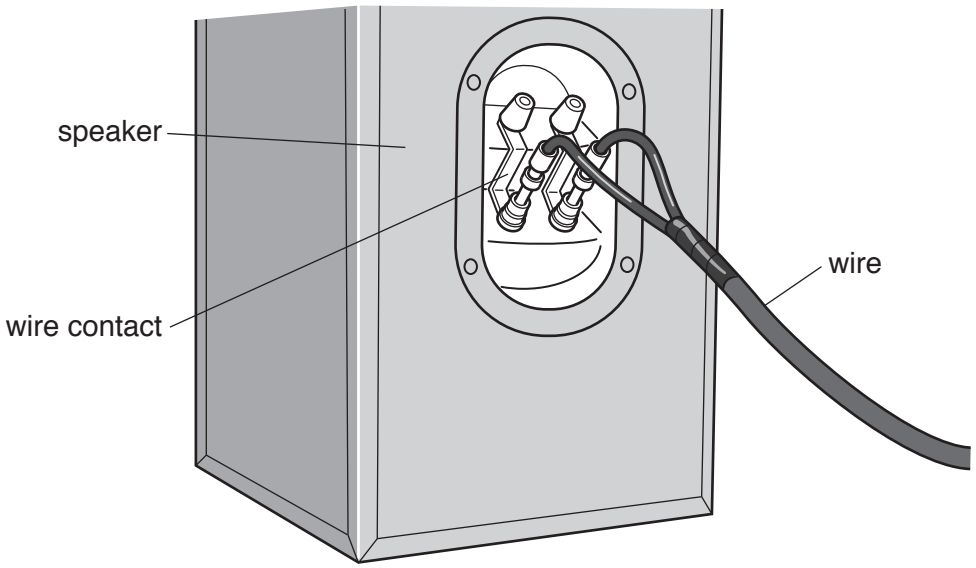
8 Brass is an alloy made of copper and zinc.

Look at the table.

It gives information about different types of brass.

Type of brass	Relative strength	Relative ductility	Relative electrical conductivity
A	18	55	45
B	20	65	35
C	21	70	28
D	27	45	25
E	28	20	24

(a) Brass is often used to make the wire contacts for music speakers.



Phil thinks that brass **B** would be the best type of brass to use.

Is he right?

Use information from the table to explain your answer.

.....

.....

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

(b) Copper is used for electrical wiring.

The copper is purified by electrolysis before it is used.

Look at the equations.

They show the reactions at the electrodes.

Cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

Anode: $Cu - 2e^- \rightarrow Cu^{2+}$

Explain why the purification of copper by electrolysis involves both **oxidation** and **reduction**.

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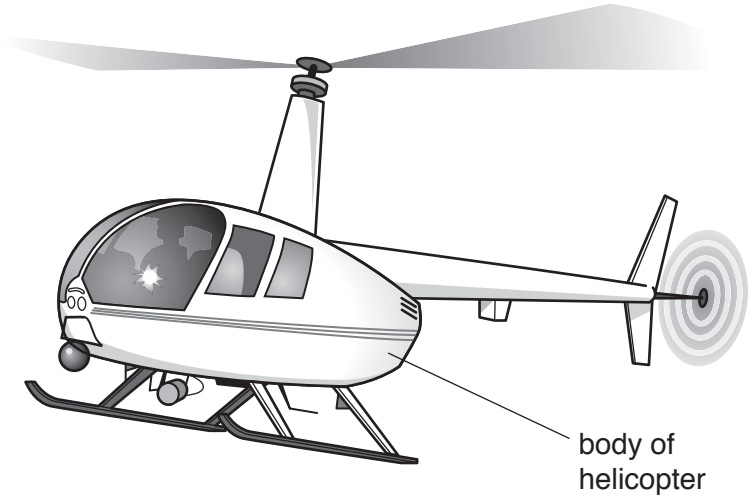
..... **[1]**

(c) The body of a helicopter can be made from either aluminium or steel.



Look at the table.

It shows some of the properties of aluminium and steel.

Property	Aluminium	Steel
Corrosion in moist conditions	does not corrode	rusts slowly
Density (1 = low, 10 = high)	3	8
Magnetic attraction	not attracted	attracted
Hardness (1 = soft, 10 = hard)	5	8
Strength (1 = weak, 10 = strong)	4	9
Electrical conductivity (1 = poor, 10 = good)	8	7
Other properties	malleable and a good conductor of heat	malleable and a good conductor of heat

Evaluate the advantages and disadvantages of using aluminium **and** of using steel to make the body of a helicopter.

Which metal is the best choice? Explain your answer.

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

[6]

SECTION C – Module C3

9 Titanium can be extracted from its ore by two different methods.

Method 1 uses a more reactive metal to displace the titanium:

$$TiO_2 + 2Mg \rightarrow Ti + 2MgO$$

Magnesium oxide, MgO, is a **waste product**.

Method 2 is electrolysis of titanium oxide. The overall reaction for this method is:

$$TiO_2 \rightarrow Ti + O_2$$

Oxygen, O_2, is a **waste product**.

Look at the table of relative formula masses.

Substance	Relative formula mass, M_r
TiO_2	80
Mg	24
Ti	48
MgO	40
O_2	32

(a) The **atom economy** for method **1** is 37.5%.

Calculate the atom economy for method **2**.

atom economy = ...% **[2]**

(b) Alex is a scientist working for a company that extracts and sells titanium.

She predicts that she should make 96 tonnes of titanium using method **1**.

She actually makes 81 tonnes.

Calculate her **percentage yield** of titanium.

Give your answer to **2 significant figures**.

percentage yield of titanium = ... **[2]**

(c) It is important for the company to have a high atom economy **and** a high percentage yield.

Explain why.

High atom economy because .....

.....

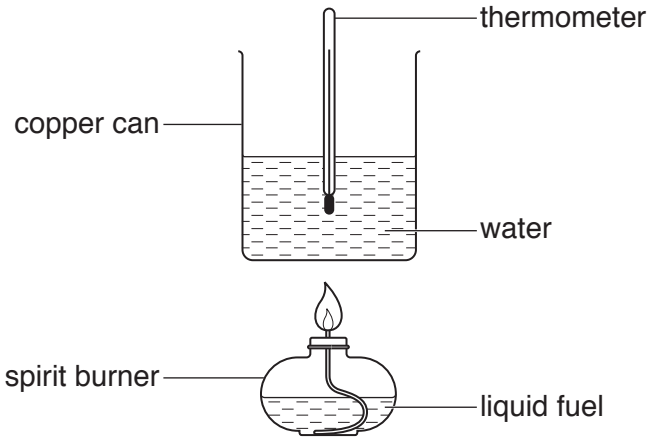
High percentage yield because .....

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

10 Trevor needs to find a fuel to use in a camping stove.

He decides to investigate the energy given out by four different fuels.

Look at the diagram. It shows the apparatus Trevor uses.



Look at the table. It shows Trevor's results.

Fuel	Temperature of water at start in °C	Temperature of water at end in °C	Mass of fuel burned in grams
A	18	40	1.2
B	22	42	0.8
C	18	28	0.6
D	25	45	0.7

(a) Look at the results for fuel **B**.

Trevor calculates that fuel **B** transfers **6300 J** of energy to the water.

Use the equation

energy = mass × specific heat capacity × temperature change

to calculate the **mass of water** that Trevor used in his experiment.

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

mass of water = ... g **[2]**

(b) Trevor decides that fuel **A** is the best fuel to use in his camping stove.

Is this a sensible choice?

Use the information in the table to explain your answer.

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.....

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

(c) Burning fuels is an **exothermic** reaction.

Explain, in terms of bond breaking and bond making, why burning fuels is an exothermic reaction.

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

(d) Fuel **D** is propanol, C_3H_8O.

Propanol burns in oxygen, O_2.

Carbon dioxide and water are made.

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

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

11 Harry and Ann investigate the reaction between marble chips (calcium carbonate) and hydrochloric acid.

Carbon dioxide is given off during the reaction.

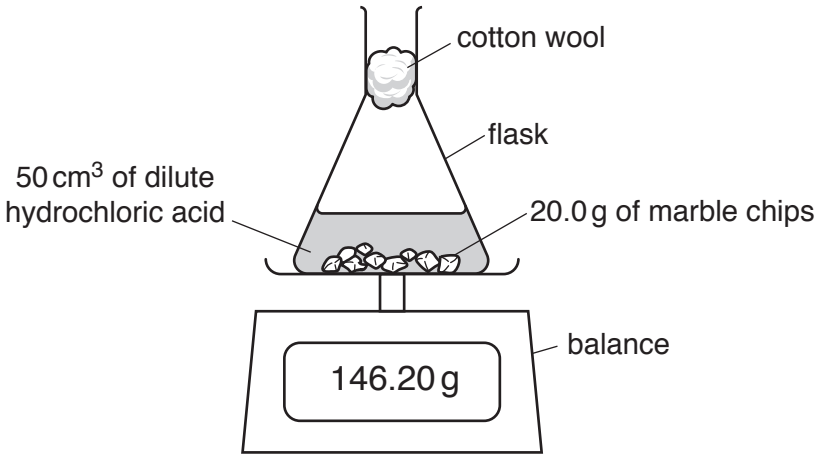
(a) Write a **word equation** for the reaction.

[1]

(b) Harry and Ann use 20.0 g of marble chips and 50 cm^3 of dilute hydrochloric acid.

The temperature of the acid is 25 °C.

Look at the diagram. It shows the apparatus they use.



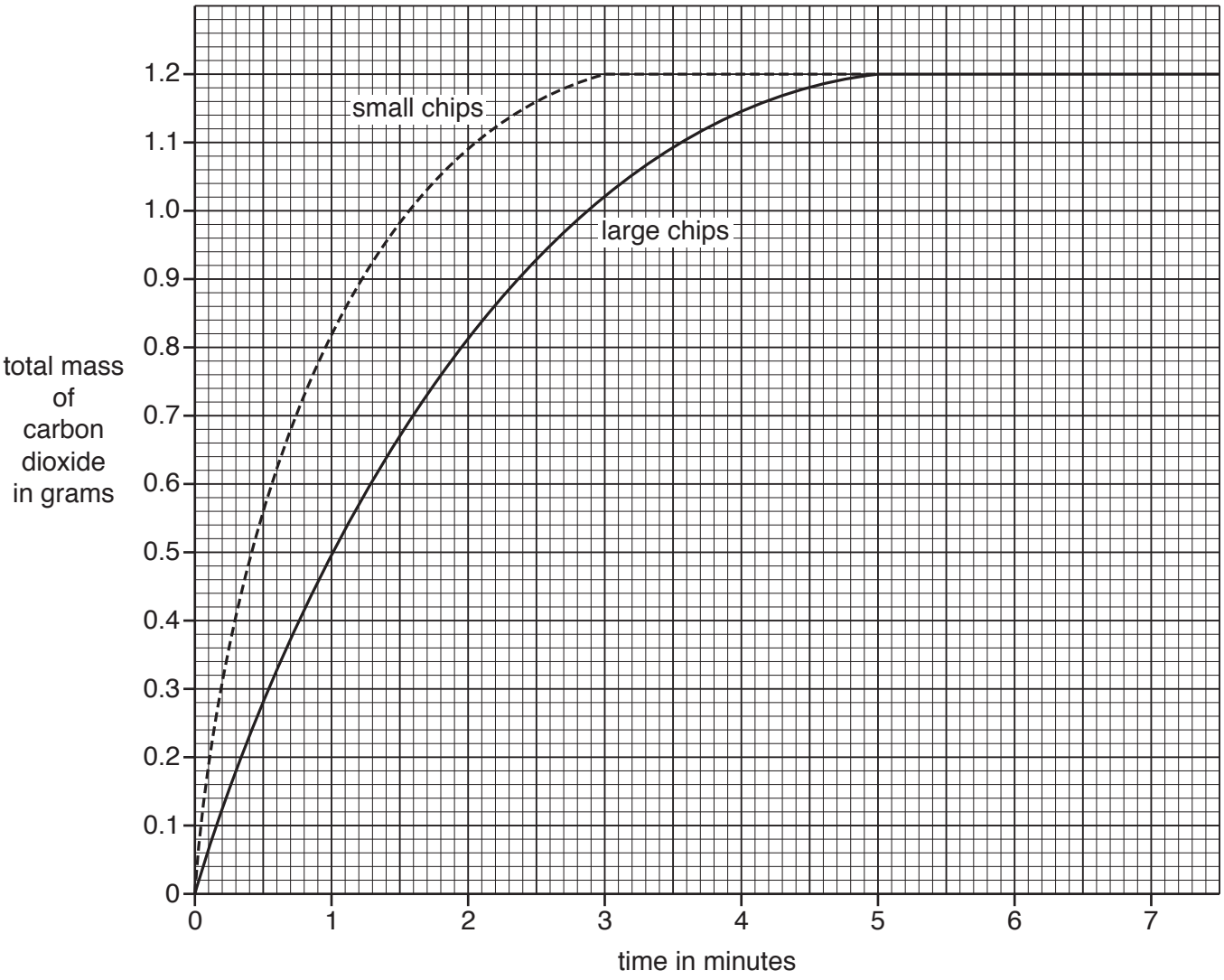
Harry and Ann measure the mass every minute until the reaction stops.

They calculate the total mass of carbon dioxide made.

They do the experiment again. They use the same volume of dilute acid and the same mass of marble.

This time they use **smaller** marble chips.

Look at the graph. It shows their results.



(i) Look at the curve for the **small** marble chips.

How long does it take for the reaction to finish?

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

(ii) The reaction using small marble chips is faster than the reaction using large marble chips.

How can you tell from the **two curves**?

.....

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

(c) Hydrochloric acid is the **limiting reactant** in these reactions between hydrochloric acid and marble chips.

The amount of carbon dioxide gas formed will double if double the amount of hydrochloric acid is used.

Explain why in terms of reacting particles.

.....

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

(d) Harry and Ann can increase the rate of reaction between marble chips and hydrochloric acid by

- increasing the concentration of the hydrochloric acid
- increasing the temperature of the hydrochloric acid.

Explain, in terms of the reacting particle model, why both these methods increase the rate of this reaction.

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

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END OF QUESTION PAPER

ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).

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.