



Oxford Cambridge and RSA

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


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. 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.

.....
.....
.....

[2]

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

Explain how oil based paints dry.

.....
.....
.....

[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.

.....
.....
.....

[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.

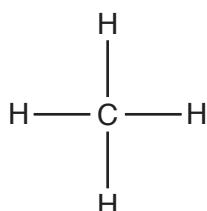
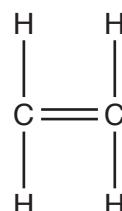
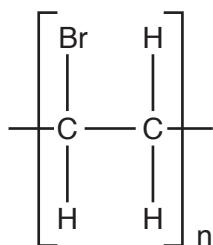
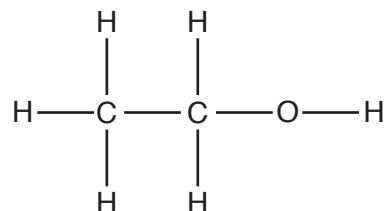
Perfumes need to be **volatile** (evaporate easily) and **insoluble in water**.

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

.....
.....
.....
.....

[2]

3 Look at the displayed formulas of some carbon compounds.

**A****B****C****D**

(a) Which compound is unsaturated?

.....

[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**.

.....
.....
.....

[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.

[6]

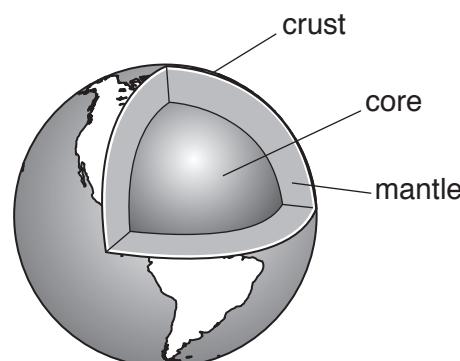
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Question 5 begins on page 8

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SECTION B – Module C2

5 This question is about the structure of the Earth.



not to scale

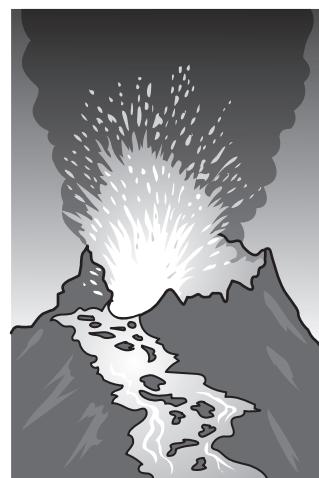
(a) The **lithosphere** is part of the structure of the Earth.

What is meant by the lithosphere?

.....
.....

[1]

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



Many scientists travelled to Chile to study the volcano.

Explain why.

.....
.....
.....

[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.

.....
.....
.....

[2]

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

Ammonium sulfate, $(\text{NH}_4)_2\text{SO}_4$, 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]

10

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



(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]

11

(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]

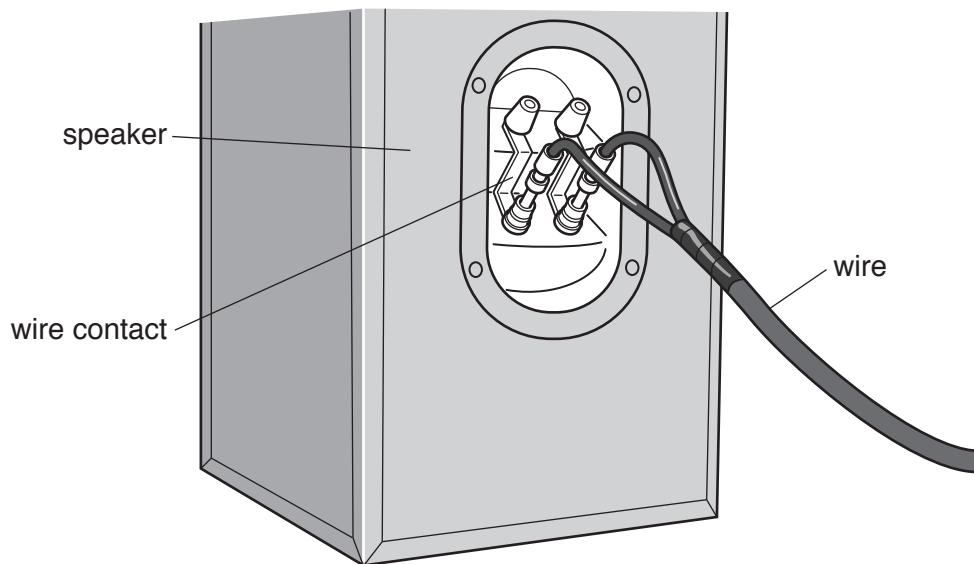
8 Brass is an alloy made of copper and zinc.

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]

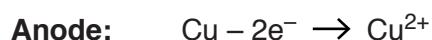
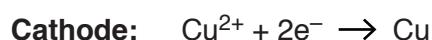
13

(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.

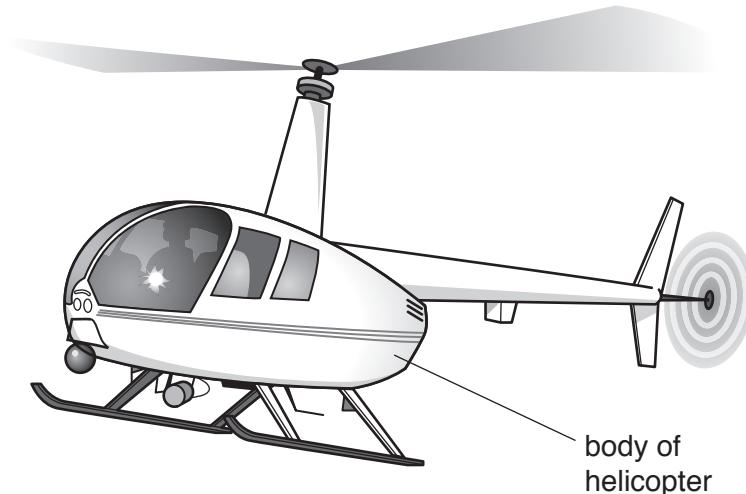


Explain why the purification of copper by electrolysis involves both **oxidation** and **reduction**.

.....
.....
.....

[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

15

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.



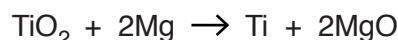
The quality of written communication will be assessed in your answer to this question.

. [6]

SECTION C – Module C3

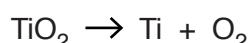
9 Titanium can be extracted from its ore by two different methods.

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



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

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



Oxygen, O₂, 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

.....

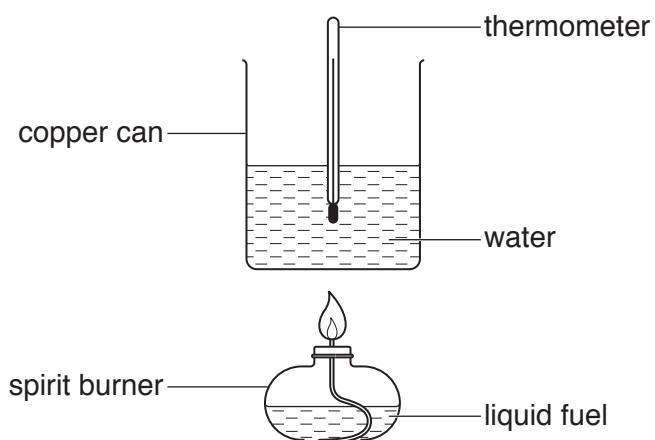
High percentage yield because

..... [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 **6300J** of energy to the water.

Use the equation

$$\text{energy} = \text{mass} \times \text{specific heat capacity} \times \text{temperature change}$$

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

The specific heat capacity of water is $4.2\text{J/g}^{\circ}\text{C}$.

$$\text{mass of water} = \dots \text{g}$$

[2]

19

(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.

.....
.....
.....

[2]

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

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

.....
.....
.....
.....

[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.

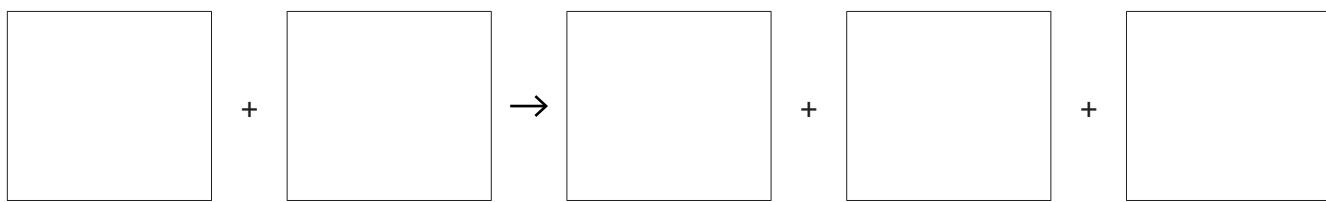
.....

[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.

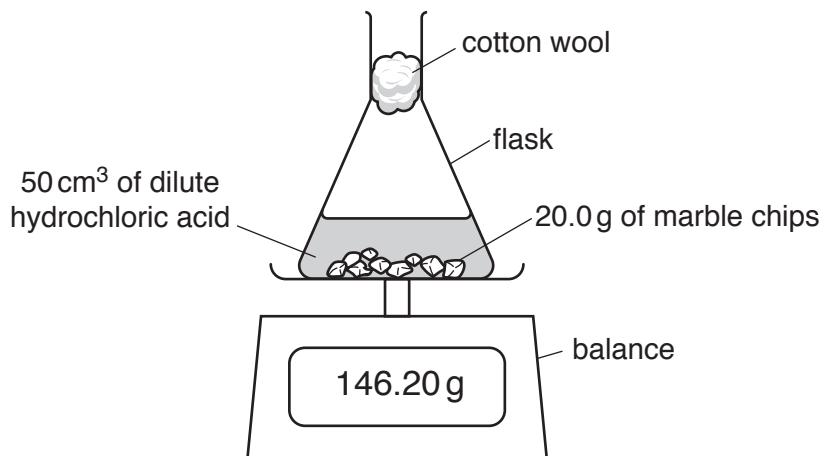


[1]

(b) Harry and Ann use 20.0 g of marble chips and 50 cm³ of dilute hydrochloric acid.

The temperature of the acid is 25 °C.

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



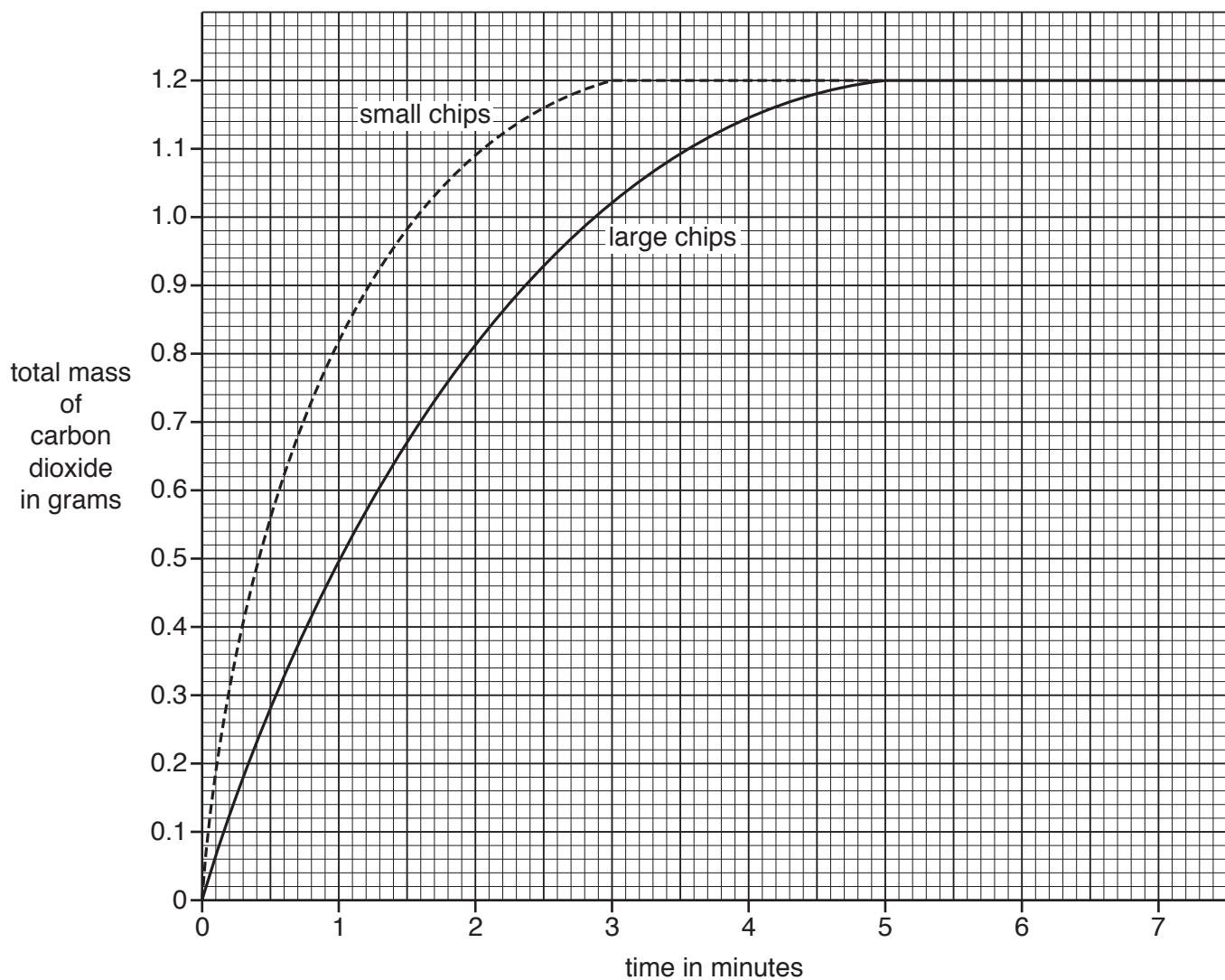
Harry and Ann measure the mass every minute until the reaction stops.

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.

[6]

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).





This image shows a blank sheet of handwriting practice paper. It features a vertical red line on the left side, likely representing a margin. To the right of this margin, there are 22 horizontal grey lines spaced evenly down the page, intended for practicing letter formation and alignment.



The image shows a set of horizontal dotted lines for handwriting practice. A vertical solid line on the left side serves as a guide for letter height. The dotted lines are evenly spaced and extend across the width of the page.



This image shows a blank sheet of handwriting practice paper. It features a vertical red line on the left side, likely representing a margin. To the right of this margin, there are 22 horizontal grey lines spaced evenly down the page, intended for practicing letter formation and alignment.



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The Periodic Table of the Elements

1	2	3	4	5	6	7	0
Li lithium 3	Be beryllium 4	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Fe iron 26
K potassium 19	Na sodium 11	Mg magnesium 12	Al aluminum 13	Mn manganese 25	Co cobalt 27	Ni nickel 28	Cu copper 29
Rb rubidium 37	Sr strontium 38	Y yttrium 39	Zr zirconium 40	Nb niobium 41	Mo molybdenum 42	Tc technetium 43	Ru ruthenium 44
Cs caesium 55	La* lanthanum 57	Yt yttrium 57	Hf hafnium 72	Ta tantalum 73	W tungsten 74	Re rhenium 75	Os osmium 76
Fr francium 87	Ra radium 88	Ac* actinium 89	Rf rutherfordium 104	Db dubnium 105	Sg seaborgium 106	Bh bohrium 107	Hs hassium 108
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]
Key	relative atomic mass atomic symbol name atomic (proton) number	atomic symbol name atomic (proton) number					
1 H hydrogen 1	2 He helium 2	3 Li lithium 3	4 Be beryllium 4	5 Na sodium 11	6 Mg magnesium 12	7 Al aluminum 13	8 S sulfur 16
9 Be beryllium 4	10 Mg magnesium 12	11 B boron 5	12 C carbon 6	13 N nitrogen 7	14 O oxygen 8	15 F fluorine 9	20 Ne neon 10
16 S sulfur 16	17 Cl chlorine 17	18 Ar argon 18	19 F fluorine 9	20 Ne neon 10	21 Ar argon 18	22 Kr krypton 36	23 Xe xenon 54
24 Mg magnesium 12	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 Ge germanium 32
32 S sulfur 16	33 As arsenic 33	34 Se selenium 34	35.5 Cl chlorine 17	36 Br bromine 35	37 I iodine 53	38 At astatine 85	39 Rn radon 86
40 Ca calcium 20	41 Sc scandium 21	42 Ti titanium 22	43 V vanadium 23	44 Cr chromium 24	45 Mn manganese 25	46 Fe iron 26	47 Co cobalt 27
48 Sc scandium 21	49 Ti titanium 22	50 V vanadium 23	51 Cr chromium 24	52 Mn manganese 25	53 Fe iron 26	54 Co cobalt 27	55 Ni nickel 28
56 Mn manganese 25	57 Fe iron 26	58 Co cobalt 27	59 Mn manganese 25	60 Fe iron 26	61 Co cobalt 27	62 Ni nickel 28	63.5 Cu copper 29
64 Ru ruthenium 44	65 Rh rhodium 45	66 Pd palladium 46	67 Os osmium 76	68 Pt platinum 78	69 Au gold 79	70 Ge germanium 32	71 As arsenic 33
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
79 Au gold 79	80 Hg mercury 80	81 Tl thallium 81	82 Bi bismuth 83	83 Po polonium 84	84 Po polonium 84	85 At astatine 85	86 Rn radon 86
87 Fr francium 87	88 Ra radium 88	89 Ac* actinium 89	90 Rf rutherfordium 104	91 Db dubnium 105	92 Sg seaborgium 106	93 Bh bohrium 107	94 Hs hassium 108
95 Cs caesium 55	96 Sr strontium 38	97 Yt yttrium 57	98 Tc technetium 43	99 Ru ruthenium 44	100 Os osmium 76	101 Rh rhodium 45	102 Pd palladium 46
103 Ru ruthenium 44	104 Os osmium 76	105 Ir iridium 77	106 Pd palladium 46	107 Pt platinum 78	108 Ag silver 47	109 Cd cadmium 48	110 Ge germanium 32
109 Pt platinum 78	111 Bi bismuth 83	112 Sb antimony 51	113 In indium 49	114 Sn tin 50	115 In indium 49	116 Sb antimony 51	117 Te tellurium 52
117 Te tellurium 52	118 Po polonium 84	119 Sb antimony 51	120 Po polonium 84	121 Te tellurium 52	122 Sb antimony 51	123 Po polonium 84	124 Po polonium 84
125 Po polonium 84	126 Po polonium 84	127 Po polonium 84	128 Po polonium 84	129 Po polonium 84	130 Po polonium 84	131 Po polonium 84	132 Po polonium 84
133 Cs caesium 55	134 Ba barium 56	135 La* lanthanum 57	136 Hf hafnium 72	137 Ta tantalum 73	138 W tungsten 74	139 Re rhenium 75	140 Os osmium 76
141 Po polonium 84	142 Po polonium 84	143 Po polonium 84	144 Po polonium 84	145 Po polonium 84	146 Po polonium 84	147 Po polonium 84	148 Po polonium 84
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349 Po polonium 84	350 Po polonium 84	351 Po polonium 84	352 Po polonium 84	353 Po polonium 84	354 Po polonium 84	355 Po polonium 84	356 Po polonium 84
357 Po polonium 84	358 Po polonium 84	359 Po polonium 84	360 Po polonium 84	361 Po polonium 84	362 Po polonium 84	363 Po polonium 84	364 Po polonium 84
365 Po polonium 84	366 Po polonium 84	367 Po polonium 84	368 Po polonium 84	369 Po polonium 84	370 Po polonium 84	371 Po polonium 84	372 Po polonium 84
373 Po polonium 84	374 Po polonium 84	375 Po polonium 84	376 Po polonium 84	377 Po polonium 84	378 Po polonium 84	379 Po polonium 84	380 Po polonium 84
381 Po polonium 84	382 Po polonium 84	383 Po polonium 84	384 Po polonium 84	385 Po polonium 84	386 Po polonium 84	387 Po polonium 84	388 Po polonium 84
389 Po polonium 84	390 Po polonium 84	391 Po polonium 84	392 Po polonium 84	393 Po polonium 84	394 Po polonium 84	395 Po polonium 84	396 Po polonium 84
397 Po polonium 84	398 Po polonium 84	399 Po polonium 84	400 Po polonium 84	401 Po polonium 84	402 Po polonium 84	403 Po polonium 84	404 Po polonium 84
405 Po polonium 84	406 Po polonium 84	407 Po polonium 84	408 Po polonium 84	409 Po polonium 84	410 Po polonium 84	411 Po polonium 84	412 Po polonium 84
413 Po polonium 84	414 Po polonium 84	415 Po polonium 84	416 Po polonium 84	417 Po polonium 84	418 Po polonium 84	419 Po polonium 84	420 Po polonium 84
421 Po polonium 84	422 Po polonium 84	423 Po polonium 84	424 Po polonium 84	425 Po polonium 84	426 Po polonium 84	427 Po polonium 84	428 Po polonium 84
429 Po polonium 84	430 Po polonium 84	431 Po polonium 84	432 Po polonium 84	433 Po polonium 84	434 Po polonium 84	435 Po polonium 84	436 Po polonium 84
437 Po polonium 84	438 Po polonium 84	439 Po polonium 84	440 Po polonium 84	441 Po polonium 84	442 Po polonium 84	443 Po polonium 84	444 Po polonium 84
445 Po polonium 84	446 Po polonium 84	447 Po polonium 84	448 Po polonium 84	449 Po polonium 84	450 Po polonium 84	451 Po polonium 84	452 Po polonium 84
453 Po polonium 84	454 Po polonium 84	455 Po polonium 84	456 Po polonium 84	457 Po polonium 84	458 Po polonium 84	459 Po polonium 84	460 Po polonium 84
461 Po polonium 84	462 Po polonium 84	463 Po polonium 84	464 Po polonium 84	465 Po polonium 84	466 Po polonium 84	467 Po polonium 84	468 Po polonium 84
469 Po polonium 84	470 Po polonium 84	471 Po polonium 84	472 Po polonium 84	473 Po polonium 84	474 Po polonium 84	475 Po polonium 84	476 Po polonium 84
477 Po polonium 84	478 Po polonium 84	479 Po polonium 84	480 Po polonium 84	481 Po polonium 84	482 Po polonium 84	483 Po polonium 84	484 Po polonium 84
485 Po polonium 84	486 Po polonium 84	487 Po polonium 84	488 Po polonium 84	489 Po polonium 84	490 Po polonium 84	491 Po polonium 84	492 Po polonium 84
493 Po polonium 84	494 Po polonium 84	495 Po polonium 84	496 Po polonium 84	497 Po polonium 84	498 Po polonium 84	499 Po polonium 84	500 Po polonium 84
501 Po polonium 84	502 Po polonium 84	503 Po polonium 84	504 Po polonium 84	505 Po polonium 84	506 Po polonium 84	507 Po polonium 84	508 Po polonium 84
509 Po polonium 84	510 Po polonium 84	511 Po polonium 84	512 Po polonium 84	513 Po polonium 84	514 Po polonium 84	515 Po polonium 84	516 Po polonium 84
517 Po polonium 84	518 Po polonium 84	519 Po polonium 84	520 Po polonium 84	521 Po polonium 84	522 Po polonium 84	523 Po polonium 84	524 Po polonium 84
525 Po polonium 84	526 Po polonium 84	527 Po polonium 84	528 Po polonium 84	529 Po polonium 84	530 Po polonium 84	531 Po polonium 84	532 Po polonium 84
533 Po polonium 84	534 Po polonium 84	535 Po polonium 84	536 Po polonium 84	537 Po polonium 84	538 Po polonium 84	539 Po polonium 84	540 Po polonium 84
541 Po polonium 84	542 Po polonium 84	543 Po polonium 84	544 Po polonium 84	545 Po polonium 84	546 Po polonium 84	547 Po polonium 84	548 Po polonium 84
549 Po polonium 84	550 Po polonium 84	551 Po polonium 84	552 Po polonium 84	553 Po polonium 84	554 Po polonium 84	555 Po polonium 84	556 Po polonium 84
557 Po polonium 84	558 Po polonium 84	559 Po polonium 84	560 Po polonium 84	561 Po polonium 84	562 Po polonium 84	563 Po polonium 84	564 Po polonium 84
565 Po polonium 84	566 Po polonium 84	567 Po polonium 84	568 Po polonium 84	569 Po polonium 84	570 Po polonium 84	571 Po polonium 84	572 Po polonium 84
573 Po polonium 84	574 Po polonium 8						

* 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.