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Wednesday 12 June 2019 – Morning

GCSE (9–1) Combined Science (Chemistry) A (Gateway Science)

J250/04 Paper 4 (Foundation Tier)

Time allowed: 1 hour 10 minutes

7709271011

You must have:
- a ruler (cm/mm)
- the Data Sheet (for GCSE Combined Science (Chemistry) A (inserted))

You may use:
- a scientific or graphical calculator
- an HB pencil

J250/04

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number | | | | | | Candidate number | | | | |

First name(s) _____

Last name _____

INSTRUCTIONS
- The Data Sheet will be found inside this document.
- Use black ink. You may use an HB pencil for graphs and diagrams.
- Answer **all** the questions.
- Where appropriate, your answers should be supported with working. Marks may be given for a correct method even if the answer is incorrect.
- Write your answer to each question in the space provided. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.

INFORMATION
- The total mark for this paper is **60**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **24** pages.

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SECTION A

You should spend a maximum of 20 minutes on this section.

Answer **all** the questions.

Write your answer to each question in the box provided.

1 How does a catalyst speed up a reaction?

A It decreases the activation energy.

B It decreases the energy of the reactant particles.

C It increases the activation energy.

D It increases the energy of the reactant particles.

Your answer ☐ **[1]**

2 Which process leads to the greenhouse effect?

A Radiation absorbed by carbon dioxide

B Radiation causing plants to grow

C Radiation causing pollution

D Radiation damaging the ozone layer

Your answer ☐ **[1]**

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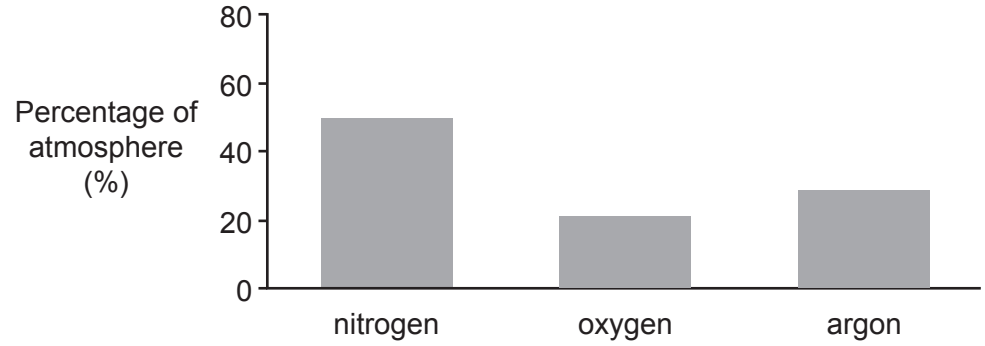
3 Which graph shows the correct percentages of the three main gases in the atmosphere today?

A



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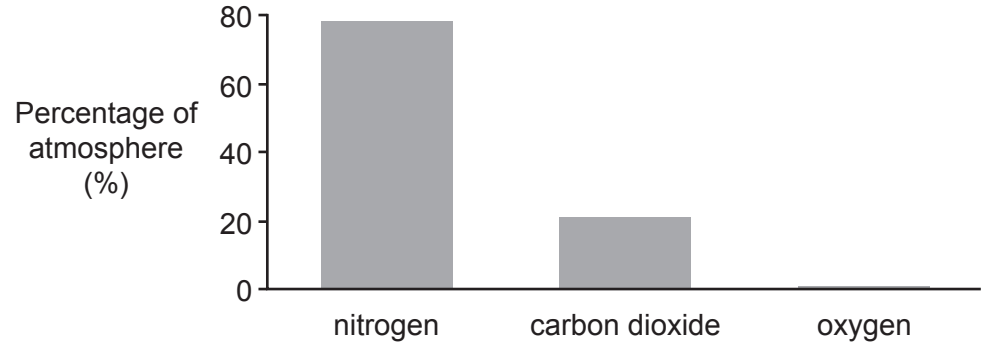

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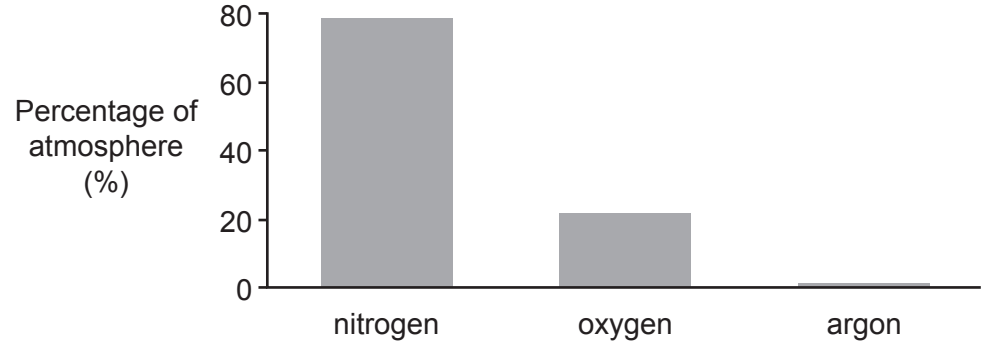

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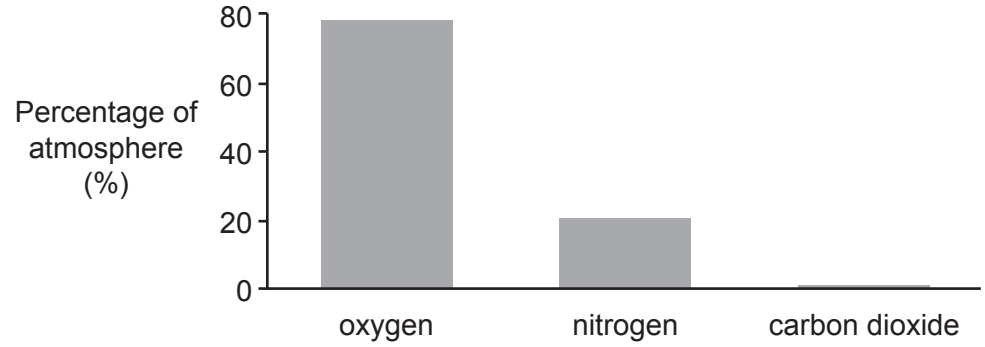

Your answer ☐ **[1]**

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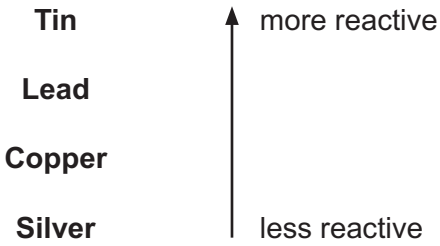
4 This is part of the reactivity series.



Which statement is correct?

A Copper can displace tin from tin chloride.

B Lead can displace copper from copper chloride.

C Lead can displace tin from tin chloride.

D Silver can displace copper from copper chloride.

Your answer ☐ **[1]**

5 Which row of the table describes Group 1 and Group 7 elements?

	Group 1 elements	**Group 7 elements**
A	metals with low melting points	metals with high melting points
B	metals with low melting points	non-metals with low melting points
C	non-metals with high melting points	non-metals with low melting points
D	non-metals with low melting points	metals with high melting points

Your answer ☐ **[1]**

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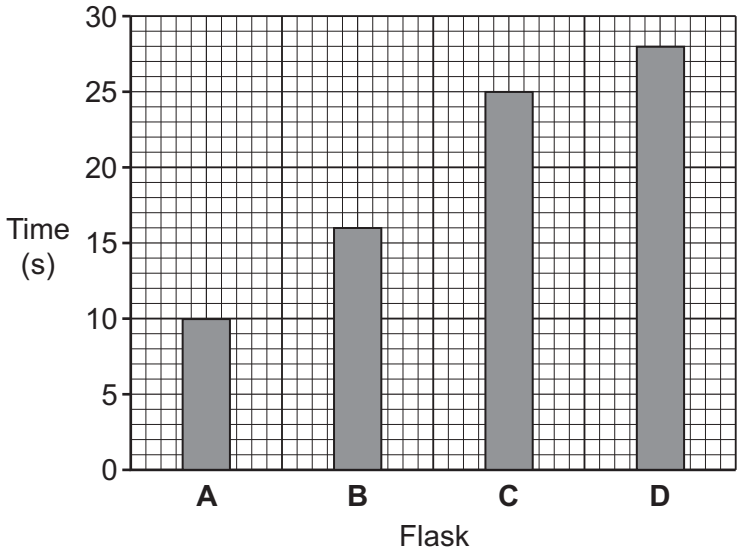
6 A teacher adds calcium carbonate to an acid in four separate flasks, **A**, **B**, **C** and **D**.

He measures the time it takes for the same volume of carbon dioxide to be produced in each flask.

This is a graph of his results.



Which flask has the fastest rate of reaction?

Your answer ☐ **[1]**

7 Aluminium is extracted from aluminium oxide using electrolysis.

Carbon cannot be used to do this.

Why is electrolysis used?

A Aluminium is more reactive than carbon.

B Aluminium oxide dissolves in water.

C Aluminium oxide has a high melting point.

D Electrolysis uses less energy than extraction with carbon.

Your answer ☐ **[1]**

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8 Some metals react faster with an acid than others.

Which statement explains why?

A The acid gives off hydrogen atoms more easily.

B The acid gives off hydrogen gas more easily.

C The metal forms a negative ion more easily.

D The metal forms a positive ion more easily.

Your answer ☐ **[1]**

9 The elements neon and argon in Group 0 are unreactive.

Which statement explains why?

A These elements have 8 electrons in the nucleus.

B These elements have 8 electrons in the outer shell.

C These elements have 8 protons in the nucleus.

D These elements have 8 protons in the outer shell.

Your answer ☐ **[1]**

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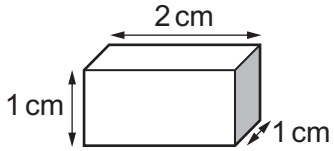
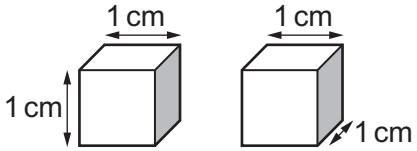
10 Two pieces of chalk, **X** and **Y**, both have the same volume.

A student cuts **Y** into two pieces.

The student reacts **X** and both pieces of **Y** with separate samples of an acid.



Chalk **X**



Chalk **Y** after cutting

The two pieces of chalk **Y** react faster than chalk **X**.

Which row on the table shows the surface area of **X** and **Y**?

	Surface area of X	**Total surface area of the two pieces of Y**
A	$10\,cm^2$	$10\,cm^2$
B	$10\,cm^2$	$12\,cm^2$
C	$10\,cm^2$	$20\,cm^2$
D	$12\,cm^2$	$10\,cm^2$

Your answer ☐ **[1]**

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SECTION B

Answer **all** the questions.

11 This question is about Group 1 and Group 7 elements.

(a) A Group 1 element **D** reacts with water.

This is the equation:

$2\mathbf{D} + 2H_2O \rightarrow 2NaOH + \mathbf{E}$

(i) Name element **D**.

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

(ii) A teacher shows this reaction to his class.

Describe **one** safety precaution he should use.

.....

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

(iii) **E** is a colourless gas.

How can you show if the gas is hydrogen or oxygen?

Describe the tests for hydrogen and oxygen, and the results you would expect with gas **E**.

test for hydrogen .....

.....

result with gas **E** .....

test for oxygen .....

.....

result with gas **E** .....

[2]

(iv) Group 1 elements are very reactive.

Write down the reason why.

.....

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

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(b) **Table 11.1** shows the densities of the first four Group 1 elements at room temperature.

Element	Density (g / cm^3)
Lithium	0.534
Sodium	0.968
Potassium	0.855
Rubidium	1.532

Table 11.1

(i) Calculate how many times larger the density of **rubidium** is than the density of **lithium**.

Give your answer to **1** significant figure.

Number of times larger = ... **[2]**

(ii) 1 g of **sodium** and 1 g of **potassium** are mixed to form an alloy.

Calculate the density of the alloy.

Density = ... g / cm^3 **[1]**

(iii) The element caesium (Cs) is also in Group 1. Caesium is found below rubidium in the Periodic Table.

Use the information in **Table 11.1** and your knowledge of trends in properties for Group 1 elements to estimate the density of caesium.

Density of caesium = ... g / cm^3 **[1]**

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(c) A student reacts a solution of KBr with chlorine, Cl_2.

(i) Balance the equation for this reaction. **[1]**

..... KBr + Cl_2 → ..... KCl + Br_2

(ii) What is the name of the chemical KBr?

Tick (✓) **one** box.

Bromine ☐

Potassium ☐

Potassium bromide ☐

Potassium bromine ☐ **[1]**

(iii) What does the reaction tell you about the reactivity of Br_2 and Cl_2?

Explain your answer.

.....

.....

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

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12 The reaction between sulfur dioxide and oxygen is reversible.

$2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$

(a) In a closed system the reaction between sulfur dioxide and oxygen reaches a dynamic equilibrium.

Use a symbol from the list to complete the sentence.

> < = $\frac{1}{2}$

At equilibrium, the rate of the forward reaction is ……..... the rate of the reverse reaction. **[1]**

(b) What is meant by the term **reversible reaction**?

.....

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

(c) **(i)** Name **one** source of sulfur dioxide in the atmosphere.

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

(ii) Describe **two** problems caused by the release of sulfur dioxide into the atmosphere.

1 .....

.....

2 .....

.....

[2]

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(d) The table shows some relative atomic masses.

Element	Relative atomic mass
Sulfur	32.1
Oxygen	16.0

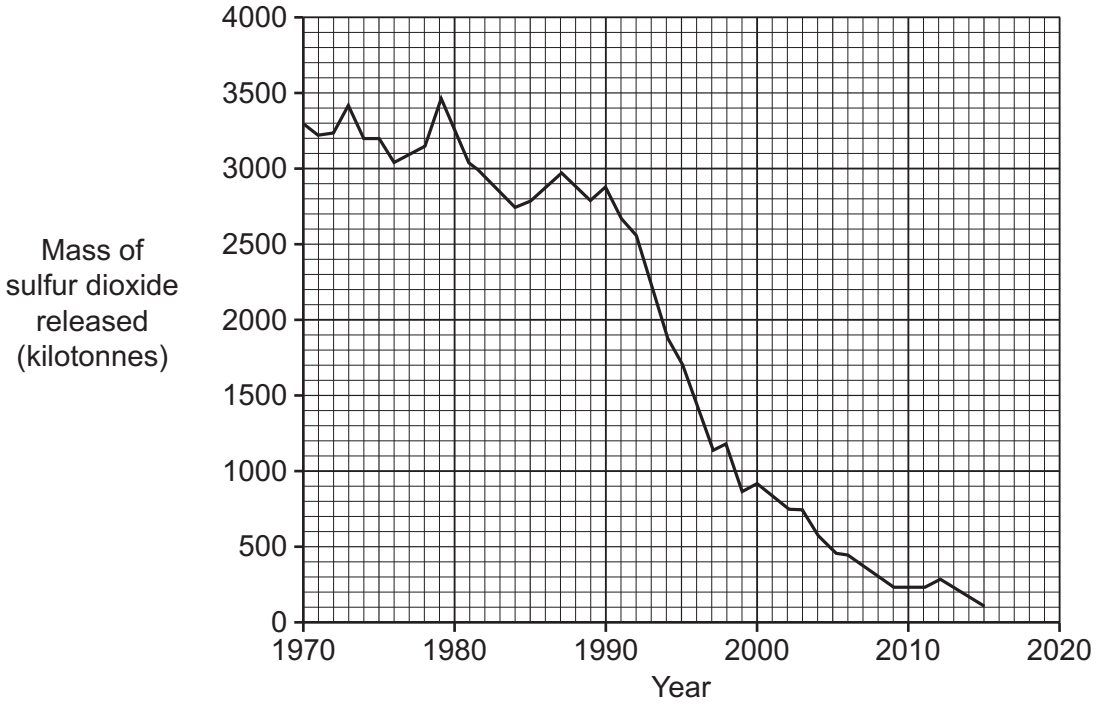
Calculate the percentage, by mass, of oxygen in SO_2.

Give your answer to **1** decimal place.

Percentage = ... % **[3]**

(e) The amount of sulfur dioxide released in the UK is decreasing.

This graph shows how it has decreased since 1970.



How much did the sulfur dioxide decrease between 1975 and 2015?

Sulfur dioxide decrease = ... kilotonnes **[2]**

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13 One homologous series of organic compounds is called the alkanes.

They have the general formula C_nH_{2n+2}.

(a) The alkane with one carbon atom, $n = 1$, is called methane.

Write down the formula of methane.

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

(b) **Table 13.1** shows the energy released when some alkanes burn in oxygen.

Alkane	Number of C atoms	Energy released (kJ/mol)
C_3H_8	3	2220
C_4H_{10}	4	2877
C_5H_{12}	5	3510
C_6H_{14}	6	4163
C_7H_{16}	7	4816
C_8H_{18}	8	5470

Table 13.1

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(i) Plot a graph of number of carbon atoms against energy released using the data in **Table 13.1** and draw a line of best fit.

[4]

(ii) Use the graph to predict the energy released when methane burns (1 carbon atom).

Energy released = ... kJ / mol **[1]**

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(c) Hexane is a liquid alkane that burns in oxygen.

hexane + oxygen $\longrightarrow$ carbon dioxide + water

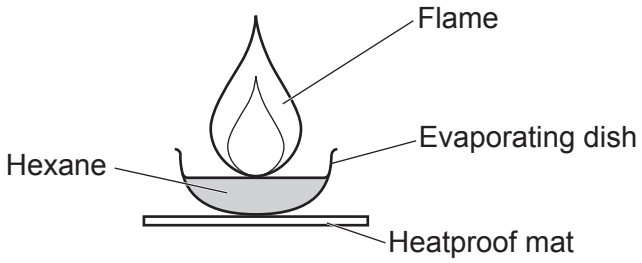
(i) Which element in hexane is oxidised to produce water?

Give a reason for your answer.

element .....

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

(ii) A student burns 10.0 g of hexane.



These are his results.

Mass of hexane before burning = 10.0 g
Mass of hexane after burning = 0.0 g

The law of conservation of mass is **true** for this reaction.

Explain why.

.....

.....

.....

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

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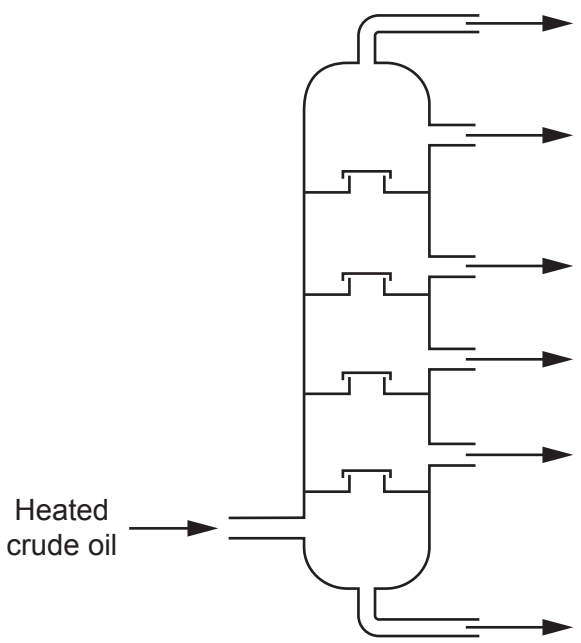
14* Fractional distillation can be used to separate different fractions from crude oil.

Fig. 14.1 gives some information about the process.



Fraction	Boiling point (°C)	Average number of carbon atoms in alkanes present in fraction
LPG	< 40	3
Naphtha	40 – 190	10
Kerosene	190 – 270	15
Gas oil	270 – 360	20
Lubricating oil	360 – 540	35
Residue	> 540	40

Fig. 14.1

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Explain how fractional distillation produces the different fractions from crude oil.

Use the information in **Fig. 14.1** and include ideas about intermolecular forces in your answer.

.....

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

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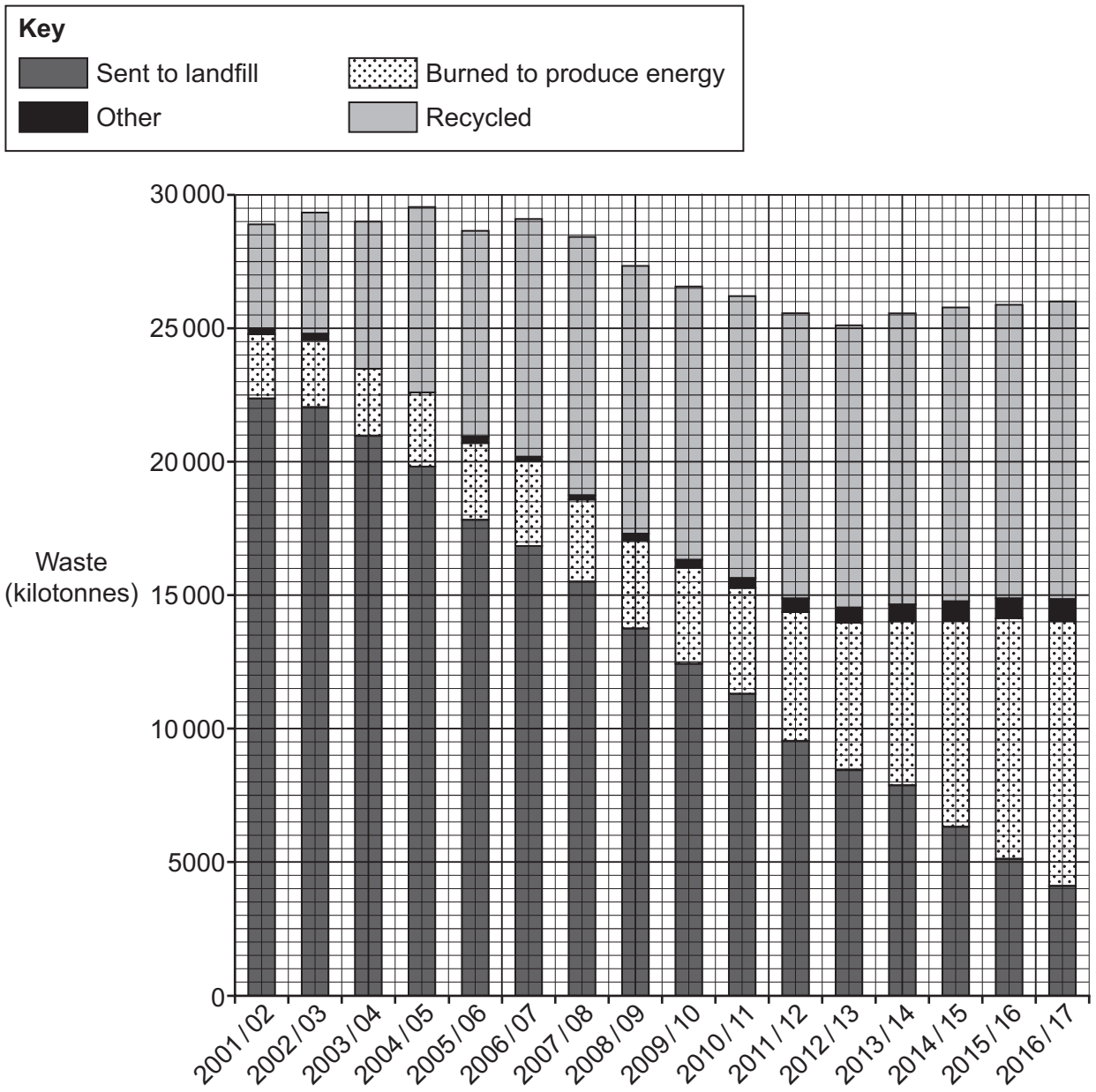
15 Local councils collect waste from households.

The graph shows what happened to the waste between 2001 and 2017.



(a) Describe **and** explain **one** trend shown by the graph.

.....

.....

.....

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

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(b) State **one** disadvantage of recycling.

.....

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

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16 A student adds some magnesium to dilute hydrochloric acid (HCl).

Magnesium chloride ($MgCl_2$) and hydrogen gas is formed.

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

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

(b) She wants to investigate how changing the concentration of hydrochloric acid affects the rate of reaction.

The student uses:

- hydrochloric acid with a concentration of 1 mol / dm^3
- magnesium ribbon
- a conical flask
- a measuring cylinder
- a mass balance
- a stopwatch.

(i) Identify the independent variable in the investigation.

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

(ii) Identify **two** control variables in the investigation.

1 .....

2 .....

[2]

(c) The student measures the time it takes from adding the magnesium to the hydrochloric acid until the reaction mixture stops bubbling.

The table shows the student's results.

Concentration of acid (mol / dm^3)	Time 1 (s)	Time 2 (s)	Time 3 (s)	Mean (average) time (s)
1.00	15	15	15	15
0.75	65	55	41	54
0.50	85	90	88	88
0.25	300	290	295	295

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The results at 0.75 mol / dm^3 are **not** precise.

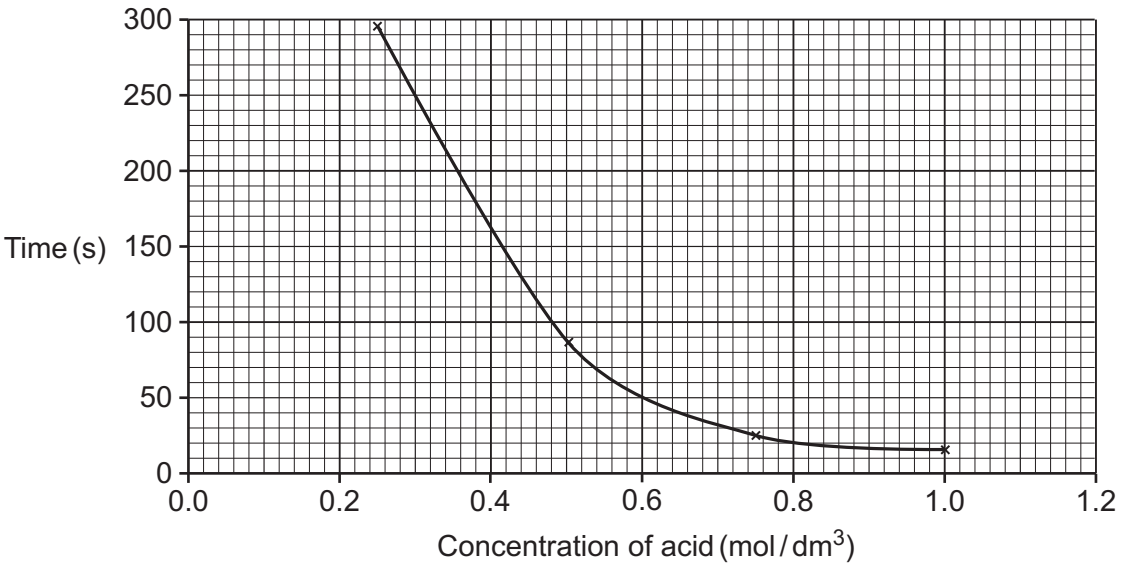
Suggest **one** reason why this might have happened.

.....

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

(d) The results at 0.75 mol / dm^3 are repeated.

This is a graph of the student's results.



What conclusion can you make from these results?

Include ideas about **particles** in your answer.

.....

.....

.....

.....

.....

.....

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

END OF QUESTION PAPER

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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).

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