Rate of Reaction

Question Paper 1

Level	GCSE (9-1)
Subject	Combined Science: Trilogy - Chemistry
Exam Board	AQA
Topic	5.6 Rate + Extent Chemical Change
Sub-Topic	Rate of Reaction
Difficulty Level	Standard Level
Booklet	Question Paper 1

Time Allowed: **58 minutes**

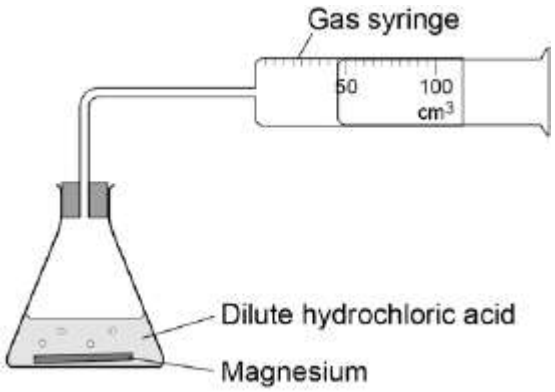
Score: **/54**

Percentage: **/100**

Grade Boundaries:

Q1. A student investigated the rate of the reaction between magnesium and dilute hydrochloric acid.
The student used the apparatus shown in **Figure 1** to collect the gas produced.

Figure 1



(a) Outline a plan to investigate how the rate of this reaction changed when the concentration of the hydrochloric acid was changed.

- Describe how you would do the investigation and the measurements you would make.
- Describe how you would make it a fair test.

You do **not** need to write about safety precautions.

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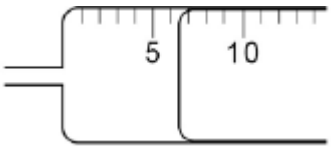
(6)

(b) **Figure 2** shows the gas syringe during one of the experiments.

Figure 2



What is the volume of gas collected?

Tick **one** box.

5.3 cm^3 ☐

6.0 cm^3 ☐

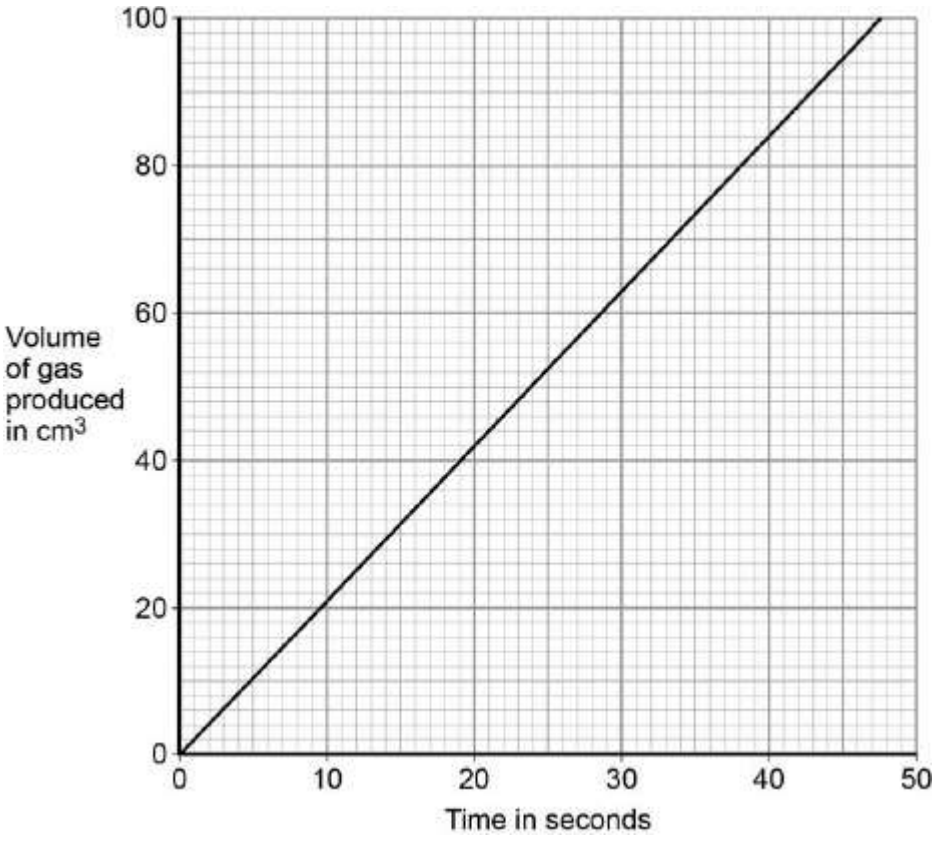
6.5 cm^3 ☐

7.0 cm^3 ☐

(1)

(c) **Figure 3** shows the student's results for one concentration of hydrochloric acid.

Figure 3



The table below shows the student's results when the concentration was two times greater than the results on **Figure 3**

Time in seconds	Volume of gas produced in cm^3
0	0
10	35
15	52
20	80
30	87

Plot the results in the table above on the grid in **Figure 3**.
Draw a line of best fit.

(3)

(d) Give **one** conclusion about how the rate of reaction changed when the concentration of hydrochloric acid was changed.

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(1)

(Total 11 marks)

Q2. The rate of chemical reactions can be changed by changing the conditions.

(a) Methane burns in oxygen to produce carbon dioxide and water.

The activation energy for the reaction is 2648 kJ / mol.

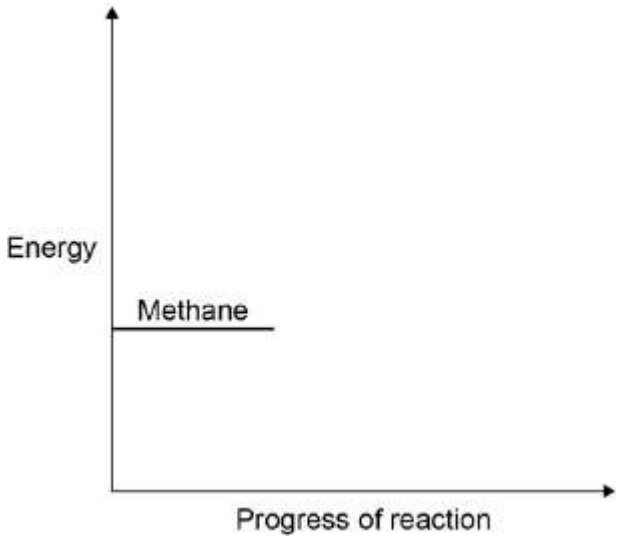
The reaction gives out 818 kJ / mol of energy.

The figure below shows the reaction profile for this reaction.

Complete the reaction profile.

Draw arrows to represent:

- the activation energy
- the energy given out.



(4)

(b) What percentage of the activation energy is the energy given out?

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(1)

(c) Calcium carbonate decomposes when it is heated:

The decomposition of calcium carbonate is an endothermic reaction.

How would the reaction profile for decomposition of calcium carbonate be different from the reaction profile of methane burning in oxygen?

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(1)

(d) Catalysts are used in chemical reactions in industry.

Give **two** properties of catalysts.

For each property, explain why it makes the catalyst useful in industry.

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(4)

(e) Enzymes are biological catalysts.

What type of molecule is an enzyme?

Tick **one** box.

Carbohydrate ☐

Hydrocarbon ☐

Lipid ☐

Protein ☐

(1)

(f) If enzymes are denatured they stop working.

Give **two** ways an enzyme can be denatured.

1 .....

2 .....

(2)

(g) An enzyme called lactase catalyses the reaction that breaks down lactose to smaller molecules.

One model used to explain how enzymes affect reactions is called the lock and key model.

Use the lock and key model to explain why lactase cannot be used to speed up **all** chemical reactions.

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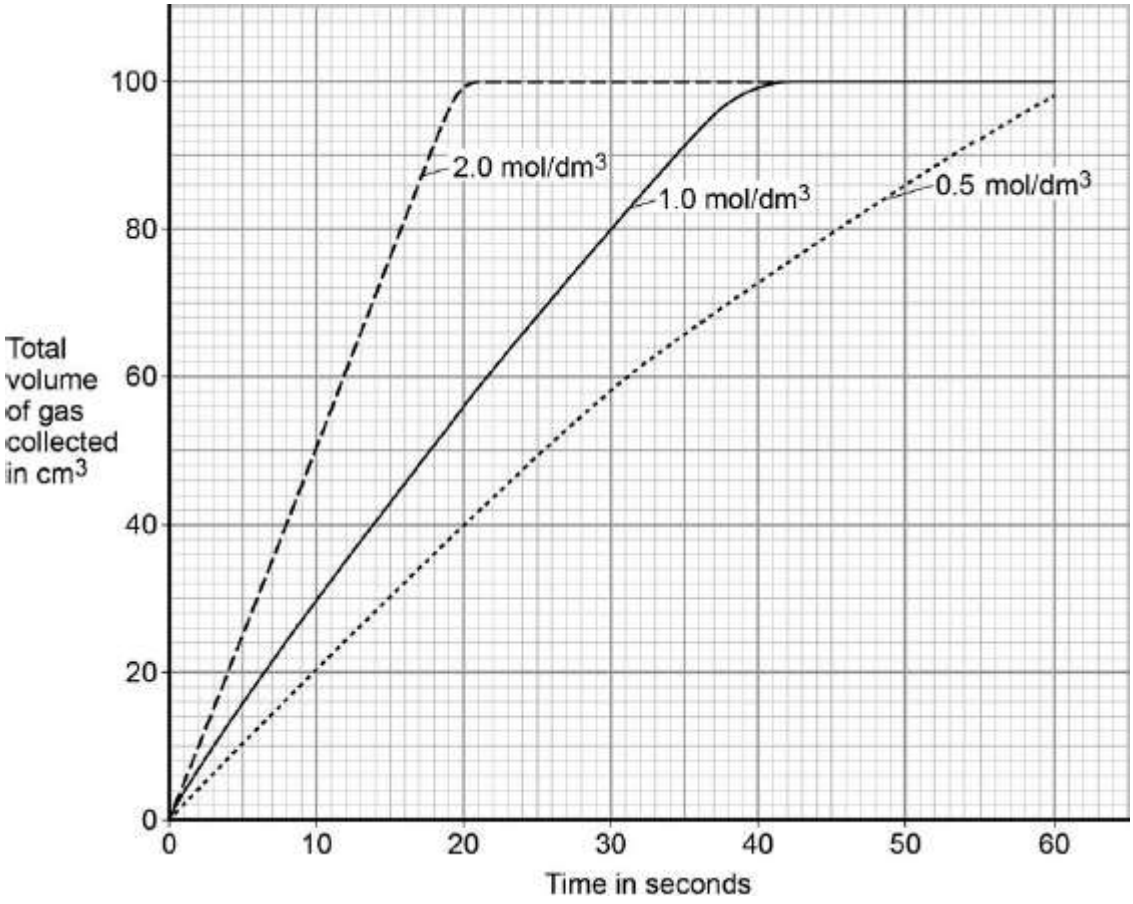
(3)
(Total 16 marks)

Q3.A student investigates how the concentration of an acid affects the rate of a reaction.

This is the method used.

1. Put a 3 cm piece of magnesium ribbon into a conical flask.
2. Add 50 cm^3 of 0.5 mol / dm^3 hydrochloric acid to the flask.
3. Collect and measure the volume of gas produced at 10 second intervals.
4. Repeat with different concentrations of hydrochloric acid using the same length of magnesium ribbon and volume of acid.

The student's results are shown in the figure below.



(a) How do the results show that increasing the concentration of acid increases the rate of reaction?

You **must** use data from the graph in your answer.

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(2)

(b) Explain why the rate of reaction changes as the concentration of the acid increases.

You should answer in terms of particles.

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(3)

(c) Student **A** said that the final volume of gas collected was lower for a concentration of 0.5 mol dm^3 because the reaction had not finished.

Student **B** said it was because all the acid had reacted.

Describe further experimental work the students could do to find out which student was correct.

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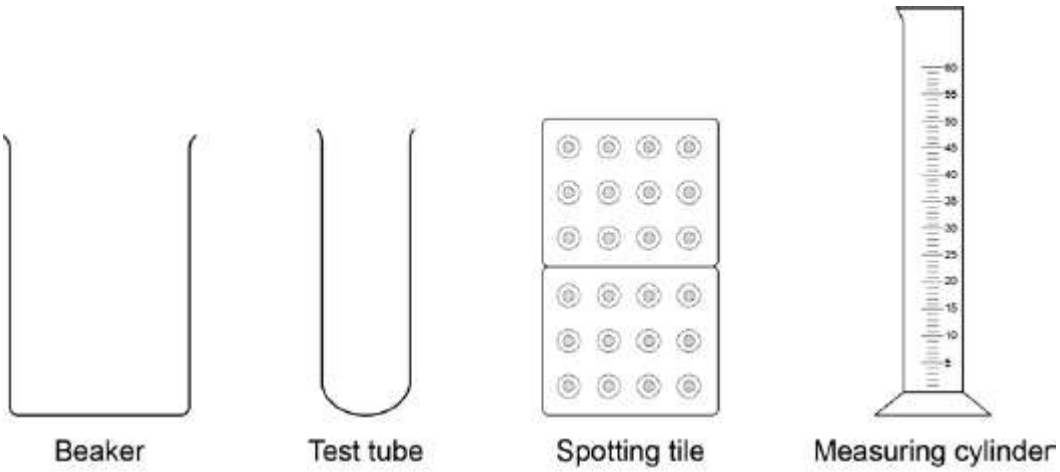
(2)
(Total 7 marks)

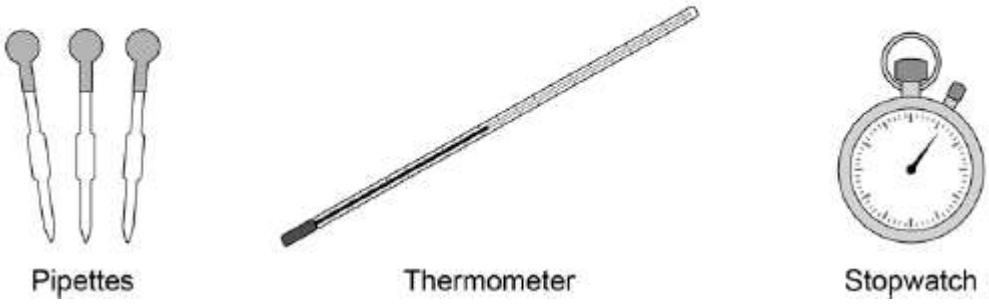
Q4. Amylase catalyses the breakdown of starch into sugars.

A student investigated the effect of amylase on the reaction at different temperatures.

Figure 1 shows the apparatus the student used.

Figure 1





This is the method used.

1. Put starch suspension into a test tube.
2. Add amylase solution.
3. Put the test tube in a beaker of water at 15 °C.
4. Remove a small sample of the mixture every 30 seconds and put in a spotting tile.
5. Test the sample for starch.
6. Time how long it takes to break down all of the starch in the mixture.
7. Repeat steps 1–5 at 20 °C, 25 °C and 30 °C.
8. Repeat for each temperature twice more.

The table below shows the student's results.

	Time taken until there was no starch in the sample in minutes			
Temperature in °C	**Test 1**	**Test 2**	**Test 3**	**Mean**
15	6.1	9.4	10.0	8.5
20	4.8	5.0	4.6	4.8

25	3.0	2.5	3.0	3.2
30	1.5	2.0	2.0	

(a) One of the results in the table above is anomalous.

Draw a ring around the anomalous result.

(1)

(b) Calculate the mean for 30 °C.

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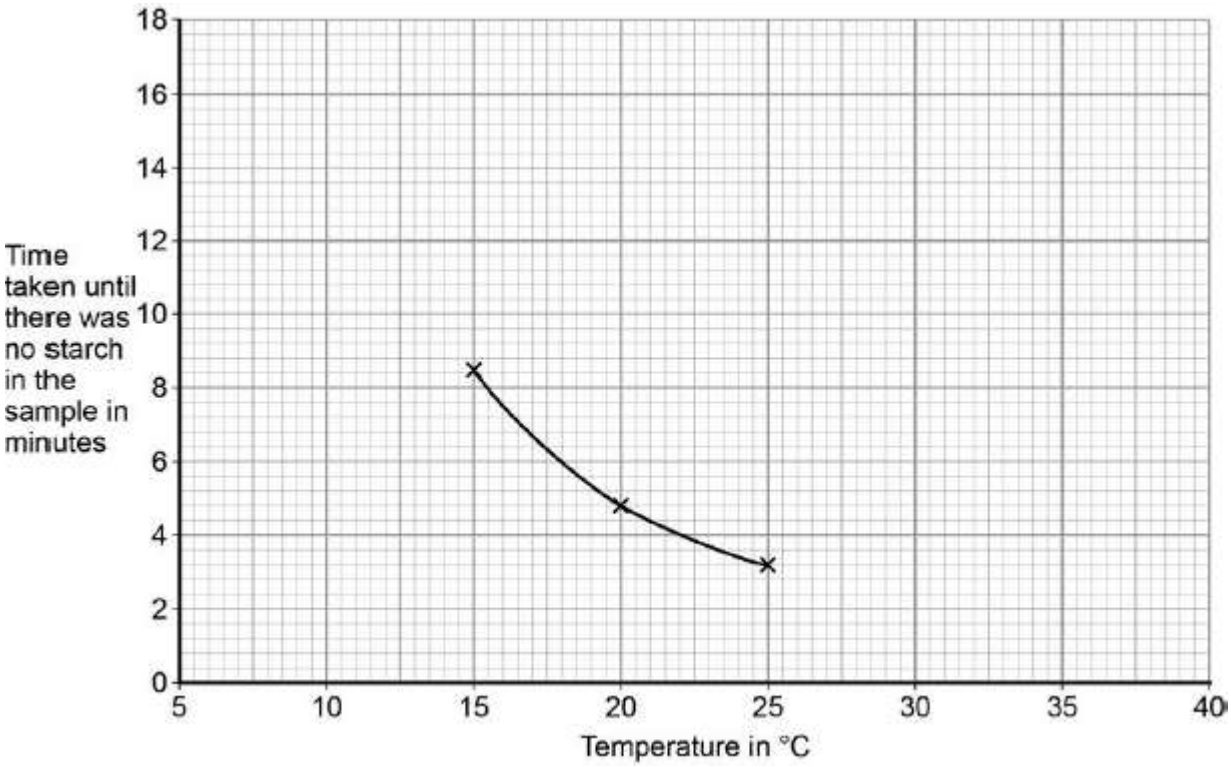
(1)

(c) **Figure 2** shows a graph of the student's results.

Figure 2



Use the graph to predict how long it would take to break down all of the starch at 10 °C.

Time = ... minutes

(1)

(d) The student tested samples of the mixture for starch every 30 seconds.

In each test she added one drop of iodine to the sample in the spotting tile.

Predict the colour of the samples from the 20 °C test at 4.0 minutes and 7.0 minutes.

Colour at 4.0 minutes .....

Colour at 7.0 minutes .....

(2)

(e) The student did a fourth test at 30 °C.

In this test the starch did not break down, even after 45 minutes.

Why did the amylase not break down the starch in this test?

Tick **one** box.

- The amylase solution and the starch suspension were mixed before the start of the experiment. ☐
- The amylase solution had been prepared with water at 95 °C. ☐
- The amylase solution had been prepared with water at 20 °C. ☐
- The amylase solution had been stored in the fridge. ☐

(1)

(f) The student made the following conclusion about the optimum temperature for amylase to work at.

'Amylase works fastest at 40 °C'

Her teacher said that this is **not** a valid conclusion from her results.

Describe how the student could change her method to give results that would improve the validity of her conclusion.

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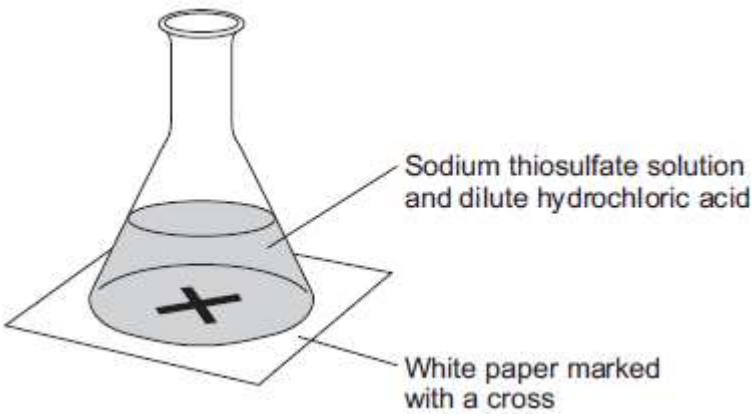
(6)
(Total 12 marks)

Q5. A student investigated the rate of reaction between sodium thiosulfate solution and dilute hydrochloric acid, as shown in **Figure 1**.

Figure 1



The reaction produced a precipitate, which made the mixture turn cloudy.

The student timed how long it took until she could no longer see the cross.

She calculated the rate of the reaction.

(a) The equation for the reaction is:

$$Na_2S_2O_3(aq) + 2\ HCl(aq) \longrightarrow 2\ NaCl(aq) + S(s) + SO_2(g) + H_2O(l)$$

Name the product that made the mixture go cloudy.

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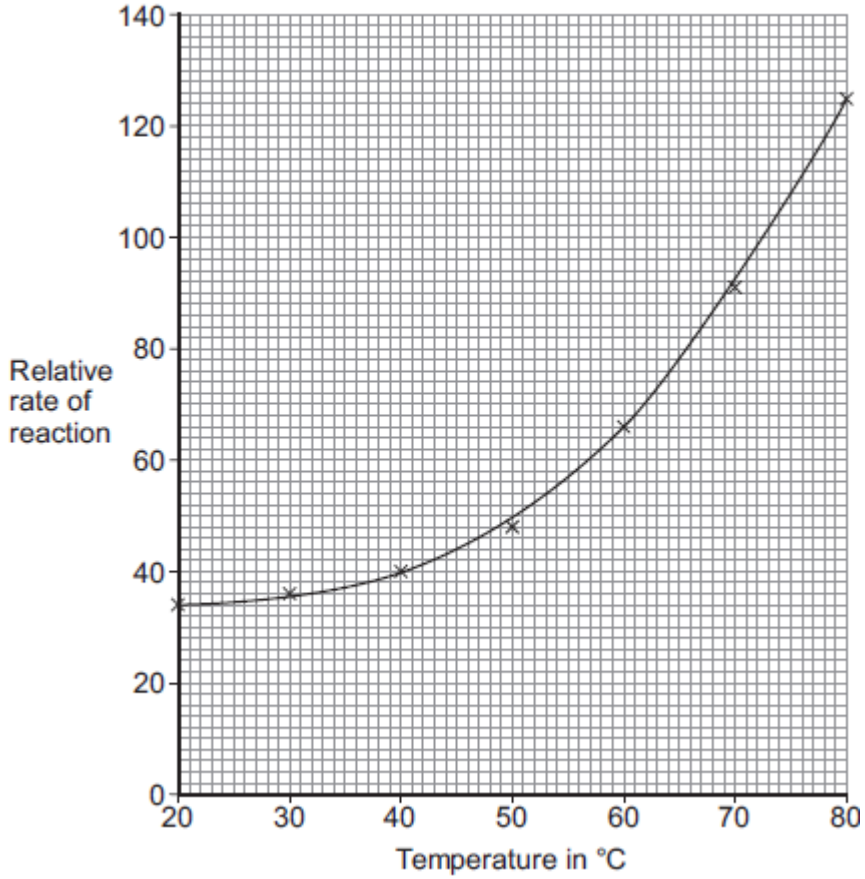
(1)

(b) The student investigated the effect of changing the temperature of the sodium thiosulfate solution on the rate of reaction.

She plotted her results on a graph, as shown in **Figure 2**.

Figure 2



Describe the trends shown in the student's results.

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(2)

(c) The student then investigated the effect of changing the concentration of sodium thiosulfate solution on the rate of the reaction.

(i) Suggest **two** variables the student would need to control to make sure that her results were valid.

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(2)

(ii) From this investigation the student correctly concluded:

'As the concentration of sodium thiosulfate solution doubles, the rate of reaction doubles.'

Explain the student's conclusion in terms of particles.

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(3)
(Total 8 marks)