

# Rates of Reaction

## Question Paper

Level	GCSE
Subject	Chemistry
Exam Board	Edexcel IGCSE
Module	Single Award (Paper 2C)
Topic	Physical Chemistry
Sub-Topic	Rates of Reaction
Booklet	Question Paper

**Time Allowed:** 47 minutes

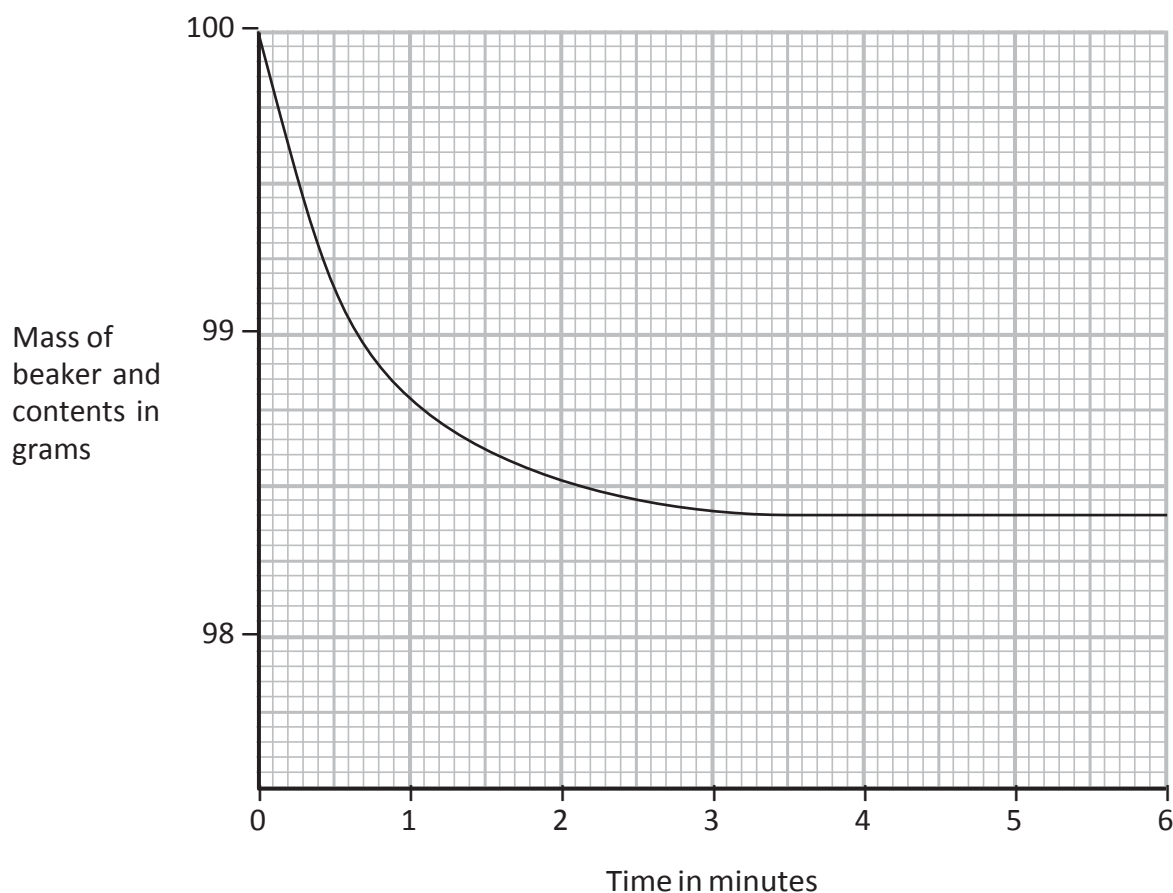
**Score:** /39

**Percentage:** /100

**Grade Boundaries:**

A*	A	B	C	D	E	U
>85%	75%	70%	60%	55%	50%	<50%

- 1 An excess of dilute hydrochloric acid was added to a lump of calcium carbonate in a beaker. The mass of the beaker and contents was recorded every 30 seconds. The graph shows the results.



The equation for the reaction is



- (a) State **two** observations that can be made when dilute hydrochloric acid is added to calcium carbonate.

(2)

1 .....

2 .....

- (b) Give the test for carbon dioxide gas.

(2)

Test .....

Result .....

(c) Describe the relationship between the mass of the beaker and contents, and the time. (1)

.....

.....

(d) (i) After how many minutes did the reaction stop? (1)

.....

(ii) State why the reaction eventually stopped. (1)

.....

.....

(e) Identify the compounds, other than water, present in the solution in the beaker

(i) after two minutes (1)

.....

(ii) after five minutes (1)

.....

(f) The experiment was repeated using the same mass of calcium carbonate, but as a powder instead of a single lump.

On the graph, sketch the curve you would expect to obtain from this second experiment.

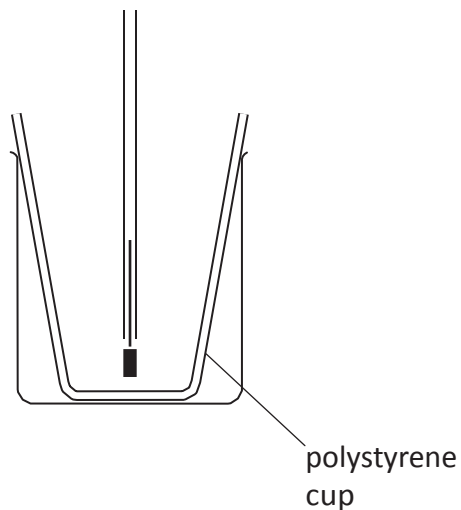
(2)

**(Total for Question 1 = 11 marks)**

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2 A student investigated the neutralisation of acids by measuring the temperature changes when alkalis were added to acids of known concentrations.

He used this apparatus to add different volumes of sodium hydroxide solution to a fixed volume of dilute nitric acid.



He used this method.

- measure the temperature of 25.0 cm<sup>3</sup> of the acid in the polystyrene cup
- add the sodium hydroxide solution in 5.0 cm<sup>3</sup> portions until a total of 30.0 cm<sup>3</sup> has been added

(a) State two properties of the sodium hydroxide solution that should be kept constant for each 5.0 cm<sup>3</sup> portion.

(2)

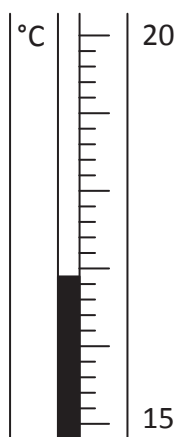
1 .....

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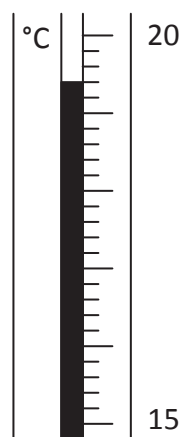
2 .....

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(b) The diagram shows the thermometer readings in one experiment.



before adding alkali



after adding alkali

Write down the thermometer readings and calculate the temperature change.

(3)

temperature after adding alkali..... °C

temperature before adding alkali ..... °C

temperature change ..... °C

(c) The student carried out the experiment three times.

The table shows his results.

Volume of alkali added in cm <sup>3</sup>	Temperature in °C		
	experiment 1	experiment 2	experiment 3
0.0	17.4	16.6	15.9
5.0	18.5	21.0	18.0
10.0	19.6	24.5	20.0
15.0	20.5	23.6	22.2
20.0	21.4	22.7	23.6
25.0	22.5	21.4	22.8
30.0	23.4	20.5	22.0

The teacher said that only the results for experiment 3 showed the expected increase and decrease in temperature.

(i) Why was there no temperature decrease in experiment 1?

(1)

- A The alkali was added too quickly
- B The starting temperature of the acid was too high
- C The acid concentration was half what it should have been
- D The volume of acid used was 50.0 cm<sup>3</sup> instead of 25.0 cm<sup>3</sup>

(ii) Why were the temperature increases in experiment 2 much greater than expected?

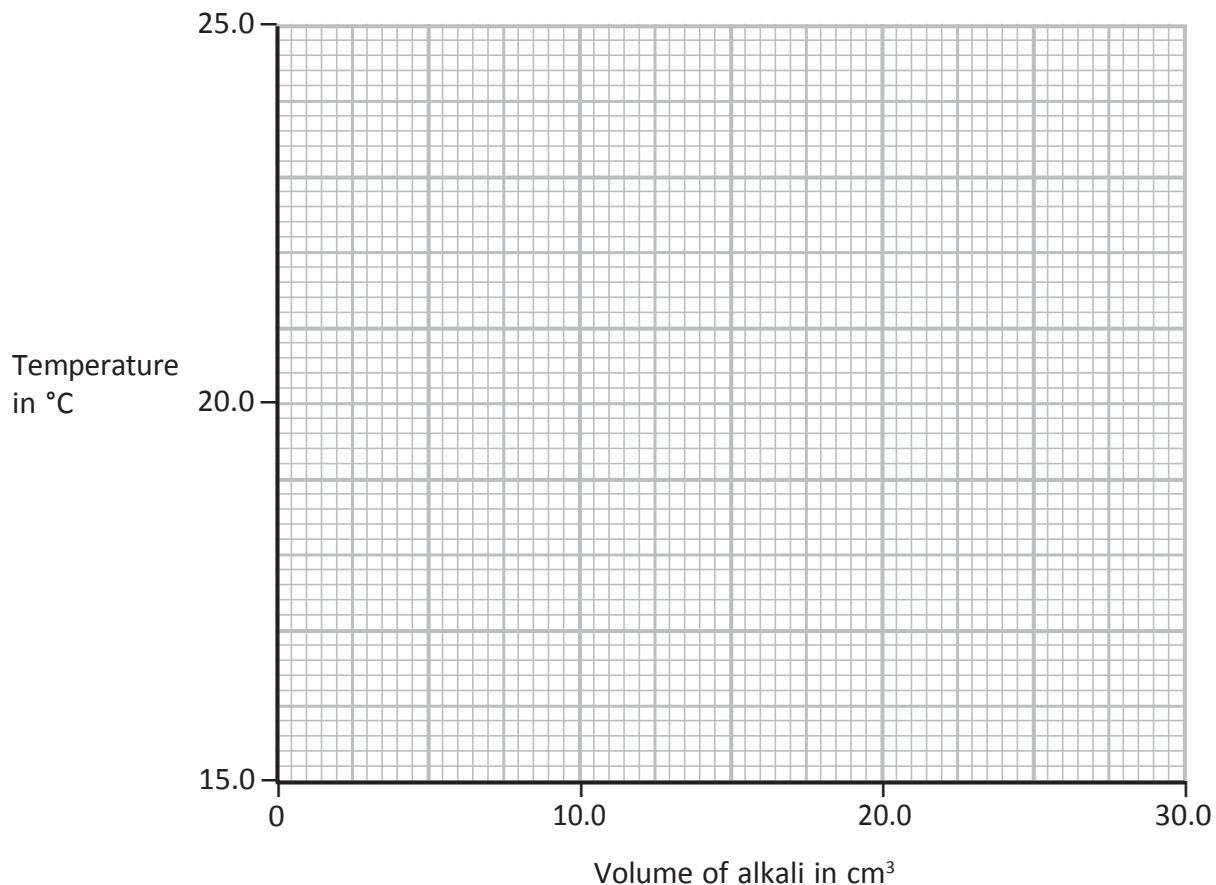
(1)

- A The starting temperature of the acid was too high
- B The acid concentration was double what it should have been
- C The volume of acid used was 50.0 cm<sup>3</sup> instead of 25.0 cm<sup>3</sup>
- D The alkali was added in 10.0 cm<sup>3</sup> portions but were recorded as 5.0 cm<sup>3</sup> portions

(d) Plot the results of experiment 3 on the grid.

Draw a straight line of best fit through the first four points, and another straight line of best fit through the last three points. Make sure that the two lines cross.

(4)



(e) The point where the lines cross indicates the volume of alkali added to exactly neutralise the acid and also the maximum temperature reached.

Record these values.

(2)

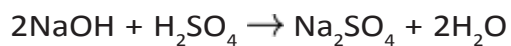
volume of alkali..... cm<sup>3</sup>

maximum temperature..... °C

(f) Another student used sulfuric acid instead of nitric acid in her experiments. She started with 25.0 cm<sup>3</sup> of sulfuric acid of concentration 0.650 mol/dm<sup>3</sup>.

She added 0.500 mol/dm<sup>3</sup> sodium hydroxide solution until the acid was completely neutralised.

The equation for this reaction is



(i) Calculate the amount, in moles, of sulfuric acid used. (2)

amount = ..... mol

(ii) Calculate the amount, in moles, of sodium hydroxide needed to neutralise this amount of sulfuric acid.

(1)

amount = ..... mol

(iii) Calculate the volume, in cm<sup>3</sup>, of sodium hydroxide solution needed to neutralise this amount of sulfuric acid.

(2)

volume = ..... cm<sup>3</sup>

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**(Total for Question 2 = 18 marks)**



- 3 A student investigates the rate of reaction between sodium thiosulfate and hydrochloric acid at 25 °C.

The equation for the reaction is



She uses this method.

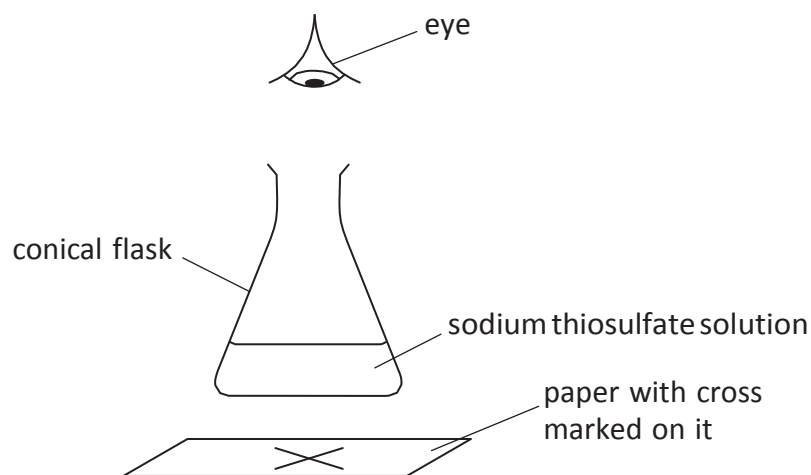
pour 50 cm<sup>3</sup> of sodium thiosulfate solution into a conical flask

place the conical flask on top of a sheet of paper with a cross drawn on it

add 10 cm<sup>3</sup> of hydrochloric acid and start the timer

stop the timer when the cross can no longer be seen and record the time taken

The student repeats the experiment five times with different volumes of sodium thiosulfate solution. She adds water as necessary to keep the total volume of reaction mixture constant.



- (a) Why can the student no longer see the cross at the end of each experiment?

(1)

.....

.....

- (b) The student keeps the total volume of the reaction mixture constant in each experiment.

Explain how this makes each experiment a fair test.

(1)

.....

.....

(c) The table shows the student's results.

Experiment	Volume of Na <sub>2</sub> S <sub>2</sub> O <sub>3</sub> solution in cm <sup>3</sup>	Volume of water in cm <sup>3</sup>	Time in seconds
1	50	0	45
2	40	10	60
3	30	20	80
4	20	30	130
5	15	35	180
6	10	40	255

Why is it important for the student to add the water before the acid in experiments 2 to 6?

(1)

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.....

.....

(d) Sulfur dioxide gas is given off in the reaction.

Suggest a safety precaution that the student should take when doing this experiment.

Explain your answer.

(2)

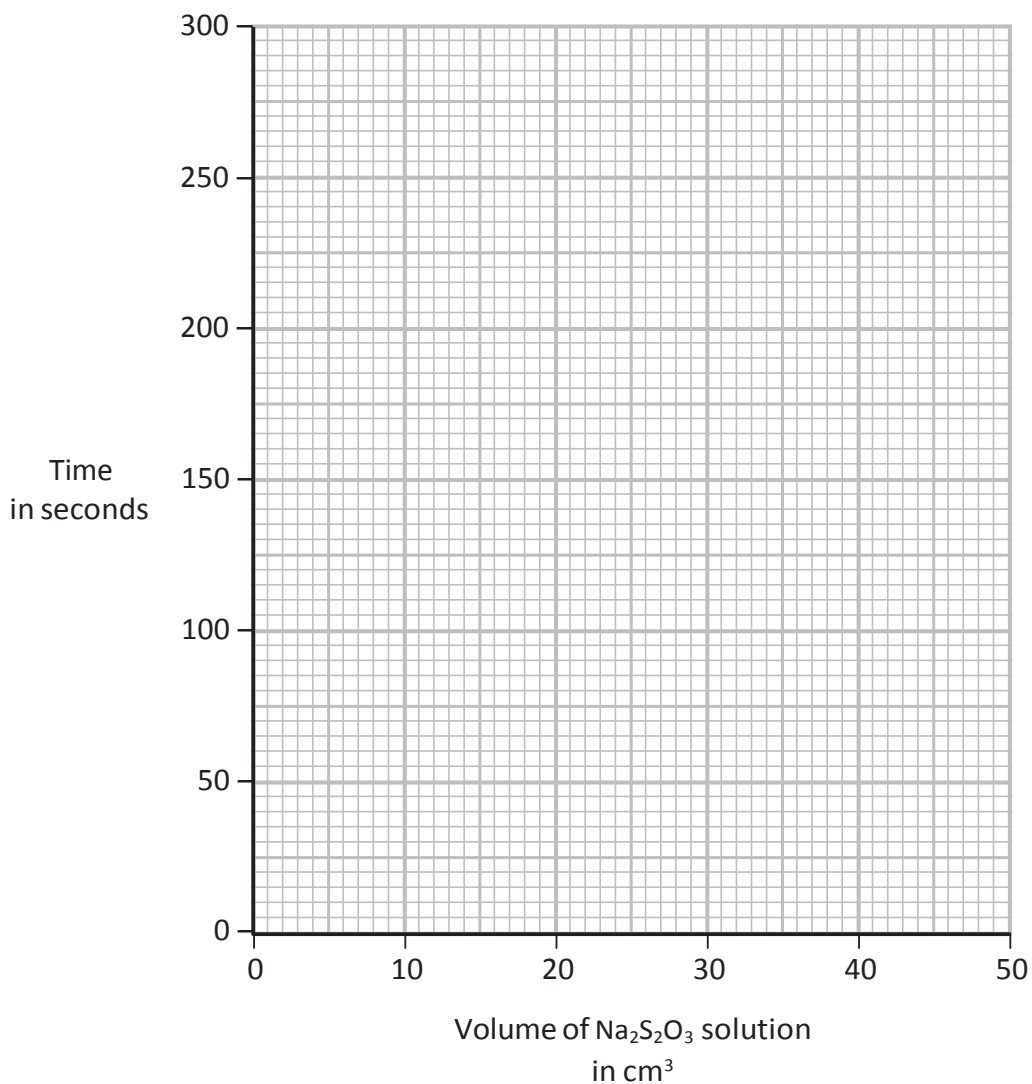
precaution.....

explanation.....

.....

(e) (i) Plot the student's results on the grid and draw a curve of best fit.

(3)



(ii) On the grid, sketch the curve that you would expect if the investigation were repeated at 40 °C.

Assume all other factors remain constant.

(2)

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**(Total for Question 3 = 10 marks)**