

( Factors affecting rate of reaction (temperature, concentration, pressure, surface area, catalysts) )

Q1. ( 2018 )

Plan an investigation to show how the concentration of the sodium thiosulfate solution affects the rate of the reaction with dilute hydrochloric acid.

Your plan should give valid results.

**[6 marks]**

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Q2. ( 2018 )

A pressure of 100 atmospheres is used instead of atmospheric pressure.

The higher pressure gives a greater yield of methanol **and** an increased rate of reaction.

Explain why.

**[4 marks]**

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Q3. a). ( 2019 )

Student **A** investigated the effect of the particle size of manganese dioxide on the rate of the reaction.

This is the method used.

1. Measure 25 cm<sup>3</sup> of 0.3 mol/dm<sup>3</sup> hydrogen peroxide solution into a conical flask.
2. Add a spatula of fine manganese dioxide powder to the conical flask.
3. Measure the volume of gas produced every minute for 10 minutes.
4. Repeat steps 1 to 3 with some coarse manganese dioxide lumps.

The method student **A** used did **not** give valid results.

What **two** improvements could student **A** make to the method to give valid results?

**[2 marks]**

Tick (✓) **two** boxes.

Measure the increase in mass of the conical flask and contents.

☐

Measure the volume of gas produced every 2 minutes.

☐

Place the conical flask in a water bath at constant temperature.

☐

Use 0.05 mol/dm<sup>3</sup> hydrogen peroxide solution.

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Use a mass of 1 g manganese dioxide each time.

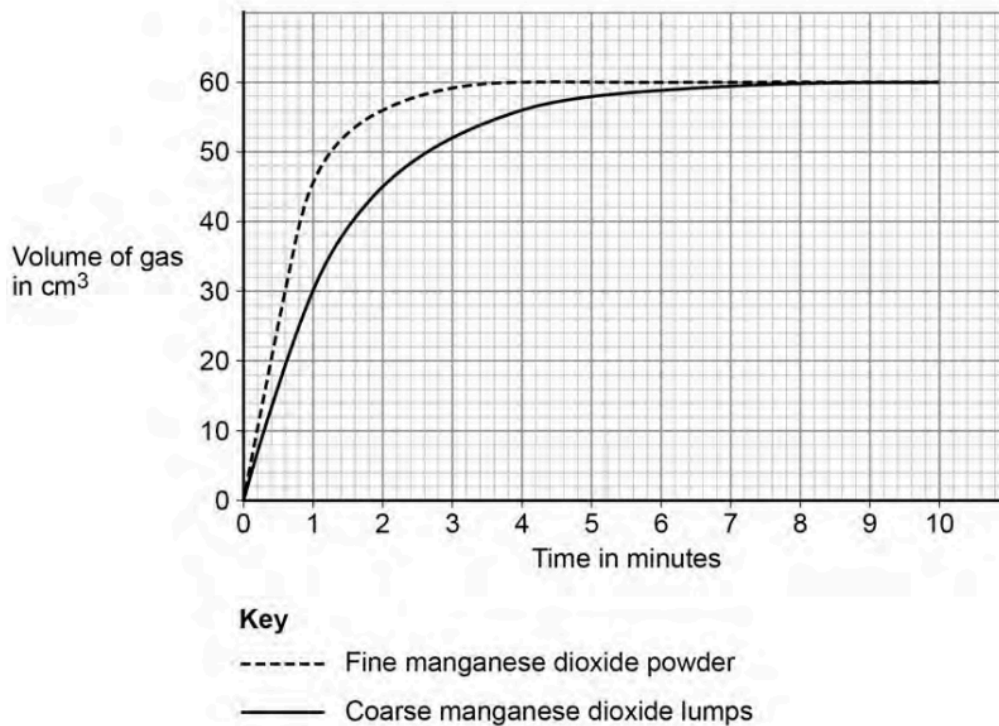
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Q3. b). ( 2019 )

Student **B** used a method which gave valid results.

**Figure 9** shows student **B**'s results.

**Figure 9**



Determine the mean rate of reaction in cm<sup>3</sup>/s between 2 and 4 minutes for coarse manganese dioxide lumps.

Give your answer to 2 significant figures.

Use data from **Figure 9**.

**[3 marks]**

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Mean rate of reaction = \_\_\_\_\_ cm<sup>3</sup>/s

Hydrogen peroxide molecules must collide with manganese dioxide particles for catalysis to take place.

Student **B** repeated the experiment with coarse lumps of manganese dioxide.

Student **B** used the same volume of  $0.2 \text{ mol/dm}^3$  hydrogen peroxide instead of  $0.3 \text{ mol/dm}^3$  hydrogen peroxide.

Sketch on **Figure 9** the curve you would expect to see.

Assume that the reaction is complete after 9 minutes.

**[2 marks]**

Q3. d). ( 2019 )

The rate of reaction is different when manganese dioxide is used as a fine powder rather than coarse lumps.

Explain why.

You should answer in terms of collision theory.

**[2 marks]**

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Q4. a). ( 2020 )

This question is about the rate of the reaction between hydrochloric acid and calcium carbonate.

A student investigated the effect of changing the size of calcium carbonate lumps on the rate of this reaction.

This is the method used.

1. Pour 40 cm<sup>3</sup> of hydrochloric acid into a conical flask.
2. Add 10.0 g of small calcium carbonate lumps to the conical flask.
3. Attach a gas syringe to the conical flask.
4. Measure the volume of gas produced every 30 seconds for 180 seconds.
5. Repeat steps 1 to 4 using 10.0 g of large calcium carbonate lumps.

The student calculated the number of moles of gas from each volume of gas measured.

**Table 4** shows the student's results for large calcium carbonate lumps.

**Table 4**

| Time in seconds | Number of moles of gas |
|-----------------|------------------------|
| 0               | 0.0000                 |
| 30              | 0.0011                 |
| 60              | 0.0020                 |
| 90              | 0.0028                 |
| 120             | 0.0034                 |
| 150             | 0.0038                 |
| 180             | 0.0040                 |

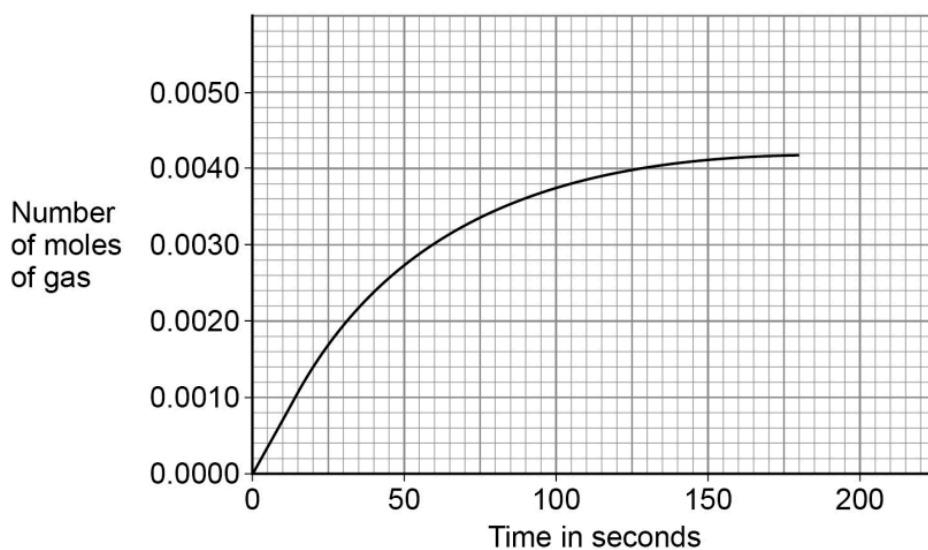
The student plotted the results for small calcium carbonate lumps on **Figure 4**.

Complete **Figure 4**.

You should:

- plot the data for large calcium carbonate lumps from **Table 4**
- draw a line of best fit.

[3 marks]

**Figure 4**

Determine the mean rate of reaction for **small** calcium carbonate lumps between 20 seconds and 105 seconds.

Give the unit.

Use **Figure 4**.

**[4 marks]**

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Mean rate of reaction = \_\_\_\_\_ Unit \_\_\_\_\_

Q4. c). ( 2020 )

The student concluded that the large calcium carbonate lumps reacted more slowly than the small calcium carbonate lumps.

How do the student's results show that this conclusion is correct?

**[1 mark]**

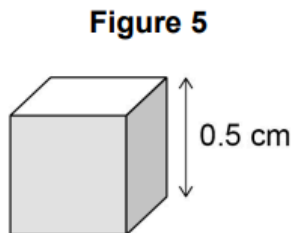
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Q5. a). ( 2020 )

The difference in the rates of reaction of large lumps and of small lumps of calcium carbonate depends on the surface area to volume ratios of the lumps.

**Figure 5** shows a cube of calcium carbonate.



Calculate the surface area to volume ratio of the cube in **Figure 5**.

Give your answer as the simplest whole number ratio.

**[3 marks]**

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Surface area : volume = \_\_\_\_\_ : \_\_\_\_\_

Q5. b). ( 2020 )

A larger cube of calcium carbonate has sides of 5 cm

Describe how the surface area to volume ratio of this larger cube differs from that of the cube shown in **Figure 5**.

**[1 mark]**

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