

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

Q1. (2018)

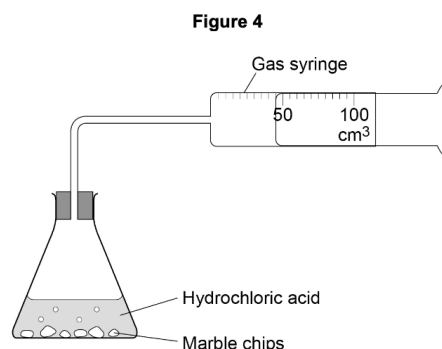
0 5

A student investigated the effect of the size of marble chips on the rate of the reaction between marble chips and hydrochloric acid.

This is the method used.

1. Add 10 g of marble chips into the flask.
2. Add 50 cm³ of hydrochloric acid, connect the gas syringe and start a timer.
3. Record the volume of gas produced every 10 seconds.

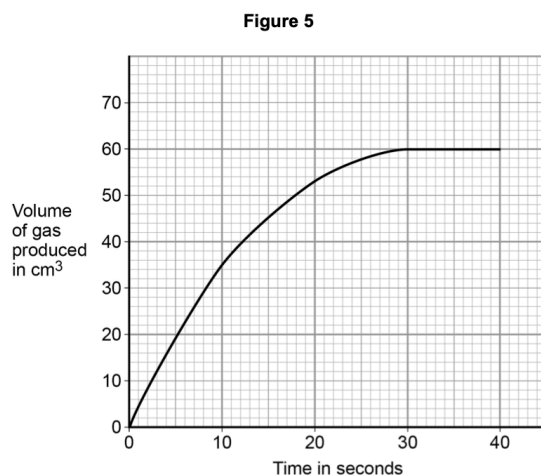
Figure 4 shows the apparatus.

**A)****0 5 . 1**

Complete the equation for the reaction.

[2 marks]**B)**

Figure 5 shows the student's results.

**0 5 . 2**

Describe the trend shown in **Figure 5**

Use values in your answer.

[3 marks]**C)****0 5 . 3**

Describe how you would use **Figure 5** to find the rate of the reaction at 15 seconds.

You do **not** need to do a calculation.

[2 marks]

D)

0 5 . 4 Give the units for the rate of this reaction.

[1 mark]

E)

Table 3 shows the results of the investigation.

Table 3

Relative size of marble chips	Volume of gas produced in cm ³ after given time in seconds					
	10 s	20 s	30 s	40 s	50 s	60 s
Small	35	53	60	60	60	60
Medium	21	39	51	58	60	60
Large	14	29	39	48	58	60

0 5 . 5 Give **one** conclusion about how the size of the marble chips affects the rate of the reaction.

[1 mark]

F)

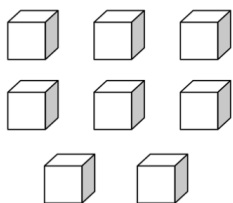
0 5 . 6 Suggest why all three sizes of marble chips produce a maximum volume of 60 cm³ of gas.

[1 mark]

G)

0 5 . 7 Figure 6 shows eight small cubes, each 1 cm x 1 cm x 1 cm, and one large cube, 2 cm x 2 cm x 2 cm

Figure 6

Total volume of small cubes = 8 cm³Volume of large cube = 8 cm³Total surface area of small cubes = 48 cm²

Calculate the surface area of the large cube.

[2 marks]

Surface area of the large cube = _____ cm²

H)

0 5 . 8 Explain why the size of the marble chips affects the rate of the reaction.

Give your answer in terms of 'collision theory'.

[2 marks]

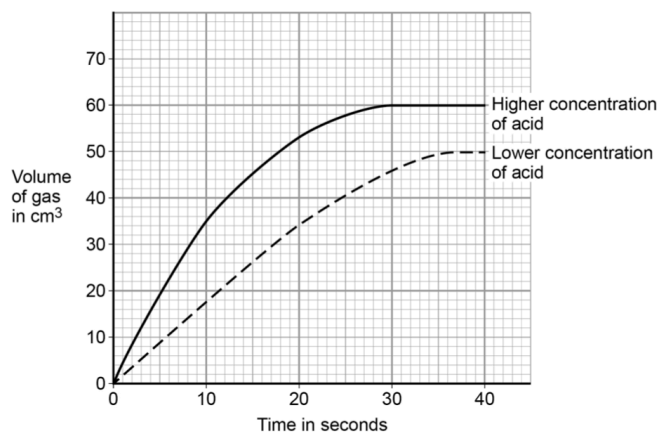
I)

0 5 9

The student repeated the investigation with small marble chips using hydrochloric acid with a lower concentration.

Figure 7 shows the volume of gas produced during the first 40 seconds.

Figure 7



Explain why the results for the lower concentration of acid are different from the results for the higher concentration of acid.

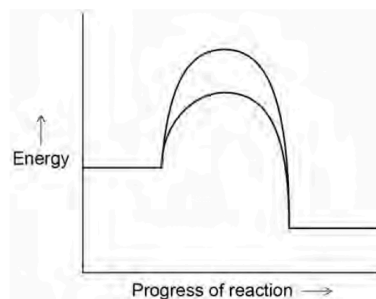
[3 marks]

Q2. (2019)

Copper is used as a catalyst.

Figure 1 shows reaction profiles for a reaction with and without a catalyst.

Figure 1



0 4 3

How do the reaction profiles show that using a catalyst does **not** affect the overall energy change for the reaction?

[1 mark]

Tick (✓) **one** box.

Both reaction profiles show exothermic reactions.

☐

Both reaction profiles start at the same energy level and end at the same energy level.

☐

Both reaction profiles show the activation energy.

☐

The activation energy for the uncatalysed reaction is much lower than for the catalysed reaction.

☐

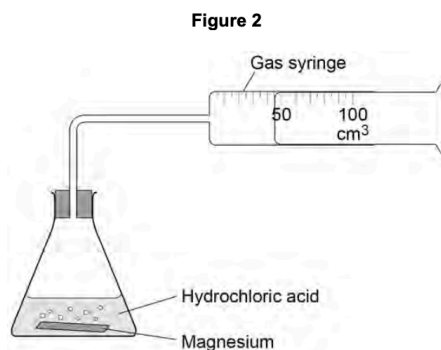
Q3. (2019)

0 5

This question is about magnesium.

A student investigated the rate of the reaction between magnesium and hydrochloric acid.

Figure 2 shows the apparatus.



A)

0 5 . 3

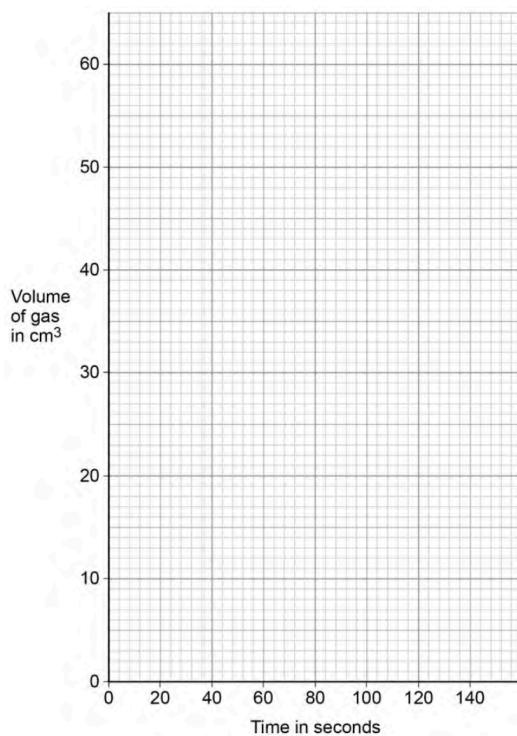
Table 2 shows the student's results.

Table 2

Time in seconds	0	10	35	50	95	120	140
Volume of gas in cm ³	0.0	12.5	36.0	43.5	59.0	60.0	60.0

Plot the data from Table 2 on Figure 3.

Draw a line of best fit.

[3 marks]**Figure 3**

B)

0 5 . 4

Describe the changes in the rate of this reaction.

[3 marks]

Q4. (2020)

0 2

Some students investigated the effect of temperature on the rate of reaction.

A)

0 2 . 1

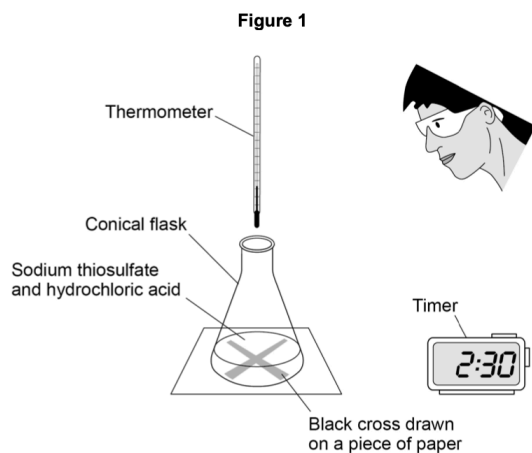
The students reacted sodium thiosulfate solution with hydrochloric acid.

This is the method used.

1. Use a beaker to measure 50 cm³ of heated sodium thiosulfate solution into a conical flask.
2. Measure the temperature of the room.
3. Put the conical flask on a black cross drawn on a piece of paper.
4. Start a timer.
5. Use the same beaker to measure 10 cm³ of hydrochloric acid into the conical flask.
6. Stop the timer when the cross is no longer visible.

The students repeated the experiment at a different room temperature.

Figure 1 shows the apparatus.



The method contains errors and does **not** produce accurate results.

Describe a method the students should use to produce accurate results.

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

[6 marks]

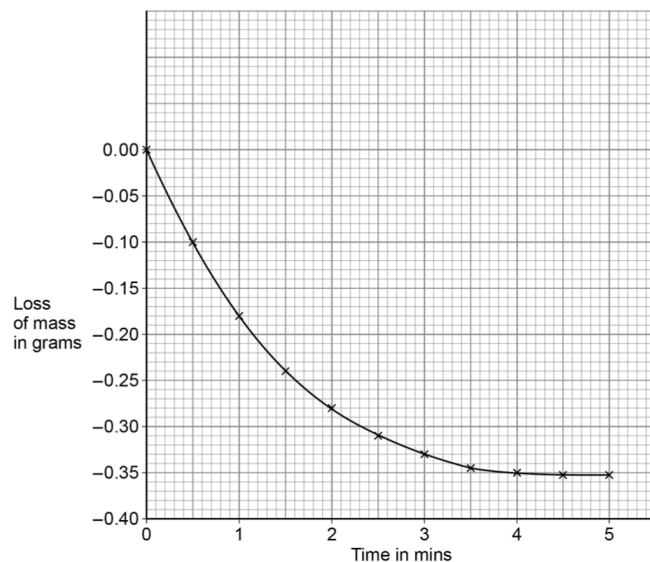
B)

Some students investigated the effect of temperature on the rate of a different reaction.

They recorded the loss of mass from their apparatus at 40 °C

Figure 2 shows the results.

Figure 2



0 2 . 2 Calculate the mean rate of reaction between 1 minute and 3 minutes at 40 °C

Use Figure 2 and the equation:

$$\text{Mean rate of reaction} = \frac{\text{change in mass of gas in g}}{\text{time in mins}}$$

[3 marks]

Mean rate of reaction = _____ g/min

C)

0 2 . 3 Draw a curve on Figure 2 for the results you would expect at a temperature of 50 °C instead of 40 °C

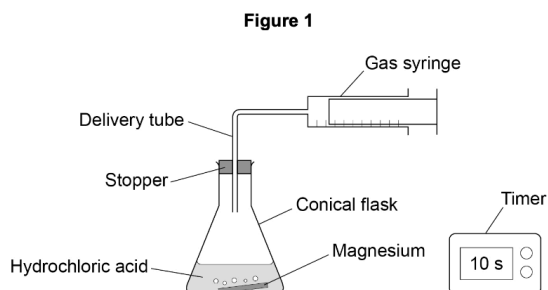
[2 marks]

Q5. (2021)

0 1

A student investigated the reaction between magnesium and excess hydrochloric acid.

Figure 1 shows the apparatus.



This is the method used.

1. Pour 50 cm³ of hydrochloric acid into a conical flask.
2. Add a piece of magnesium.
3. Insert stopper and delivery tube and start a timer.
4. Collect the gas produced in a gas syringe.
5. Record the volume of gas produced every 20 seconds for 2 minutes.
6. Repeat steps 1 to 5 with higher concentrations of hydrochloric acid.

A)

0 1 . 1

Give the independent variable and **one** control variable in this investigation.

[2 marks]

Independent variable _____

Control variable _____

B)

Table 1 shows the results from the first experiment using hydrochloric acid with a low concentration.

Table 1

Time in seconds	0	20	40	60	80	100	120
Volume of gas in cm ³	0	48	72	90	97	98	98

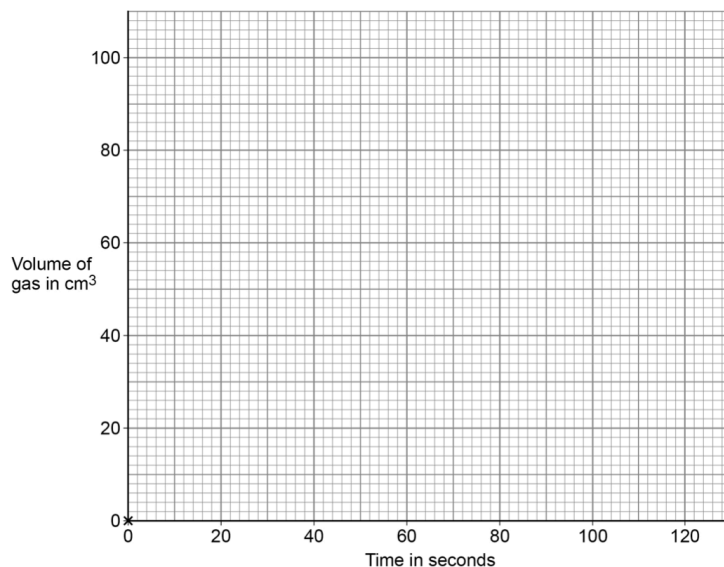
0 1 . 2 Complete Figure 2.

You should:

- plot the data from Table 1 (the point 0,0 has been plotted for you)
- draw a line of best fit.

[3 marks]

Figure 2



C)

0 1 . 3 How does the **rate** of this reaction change with time?

Use Table 1.

[1 mark]

Tick (✓) **one** box.

The rate decreases.

☐

The rate stays the same.

☐

The rate increases.

☐

D)

0 1 . 4 The student repeated the experiment using hydrochloric acid with a higher concentration.

Which statement is correct?

[1 mark]

Tick (✓) **one** box.

The activation energy for the reaction was higher.

☐

The magnesium reacted more quickly.

☐

The reaction finished at the same time.

☐

The total volume of gas collected was smaller.

☐

E)

0 1 . 5 Temperature also affects the rate of the reaction.

Explain how increasing the temperature affects the **rate** of the reaction.

You should refer to particles and collisions.

[3 marks]

Q6. (2021)

0 6 . 2 A catalyst is used in the reaction.

Explain how a catalyst increases the rate of a reaction.

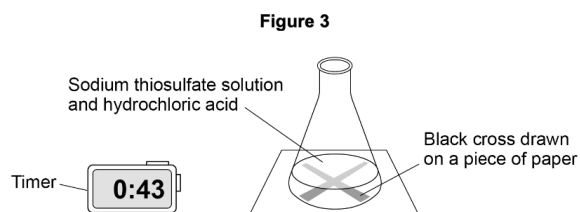
[2 marks]

Q7. (2022)

A teacher demonstrated the reaction between sodium thiosulfate solution and hydrochloric acid.

Figure 3 shows the experiment.

The experiment was done in a fume cupboard.



This is the method the teacher used.

1. Pour 50 cm³ of sodium thiosulfate solution into a conical flask.
2. Put the conical flask on a black cross drawn on a piece of paper.
3. Pour 10 cm³ of hydrochloric acid into the conical flask and start a timer.
4. Stop the timer when the cross can no longer be seen.
5. Repeat the experiment at different temperatures.

A)

0 3 . 2 What type of variable is time in this reaction?

[1 mark]

Tick (✓) **one** box.

- Control ☐
- Dependent ☐
- Independent ☐

B)

0 3 . 3 Table 1 shows the results.

Table 1

Temperature in °C	Time in seconds
19	82
32	48
45	43
52	15
63	7
73	3

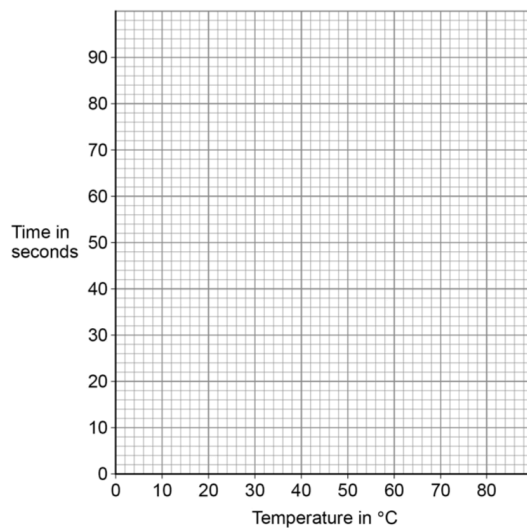
Complete **Figure 4**.

You should:

- plot the data from **Table 1** on **Figure 4**
- draw a line of best fit.

[3 marks]

Figure 4



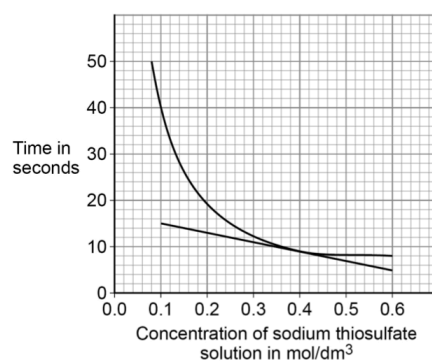
Q8. (2022)

0 3 . 4

A student investigated the effect of concentration of sodium thiosulfate on the time taken for the reaction at room temperature.

Figure 5 shows the results with a tangent drawn at 0.4 mol/dm³

Figure 5



Calculate the gradient (slope) of the tangent at 0.4 mol/dm³

Give the unit.

[4 marks]

Gradient = _____

Unit = _____

Q9. (2022)

0 6 . 1 What type of substance is a catalyst in biological systems?

[1 mark]

Tick (✓) **one** box.

- | | |
|-------------|--------------------------|
| Algae | ☐ |
| Alkene | ☐ |
| Enzyme | ☐ |
| Formulation | ☐ |

Q10. (2022)

0 6 . 2 Explain how a catalyst increases the rate of a reaction.

[2 marks]

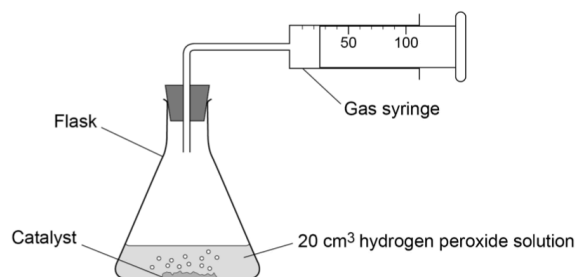
Q11. (2023)

0 6 A student investigated the rate of decomposition of hydrogen peroxide using three different catalysts:

- manganese dioxide
- copper oxide
- zinc oxide.

Figure 2 shows the apparatus.

Figure 2



This is the method used.

1. Measure 20 cm³ of hydrogen peroxide solution into a flask.
2. Add 0.5 g of manganese dioxide catalyst to the flask.
3. Attach a gas syringe to the flask.
4. Measure the volume of oxygen produced every 30 seconds for 180 seconds.
5. Repeat steps 1 to 4 two more times.
6. Repeat steps 1 to 5 using copper oxide catalyst.
7. Repeat steps 1 to 5 using zinc oxide catalyst.

A)

0 6 . 2 Using 10 cm³ of hydrogen peroxide solution gives less accurate results than using 20 cm³ of hydrogen peroxide solution of the same concentration.

Explain why.

[2 marks]

B)

0 6 . 3 Suggest **one** possible source of systematic error in the investigation.

[1 mark]

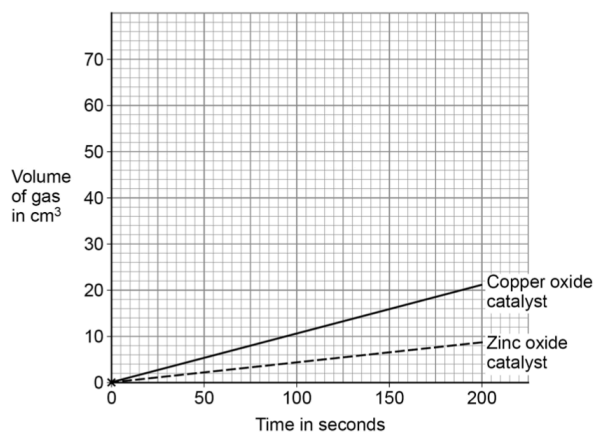
C)

Table 3 shows the results for manganese dioxide catalyst.

Table 3

Time in seconds	0	30	60	90	120	150	180
Volume of gas in cm ³	0	22	38	41	54	58	60

Figure 3 shows a graph of the results with copper oxide catalyst and with zinc oxide catalyst.

Figure 3

0 6 . 4 Complete **Figure 3**.

You should:

- plot the data from **Table 3**
- draw a line of best fit.

The first point has been plotted for you.

[3 marks]

D)

0 6 . 5 Which catalyst gives the fastest **rate** of reaction?

Give **one** reason for your answer.

Use the completed **Figure 3**.

[2 marks]

Catalyst _____

Reason _____

E)

0 6 . 6 The rate of reaction is **not** dependent on the volume of hydrogen peroxide solution.

Explain why.

[2 marks]

Q12. (2024)

A)

0 2

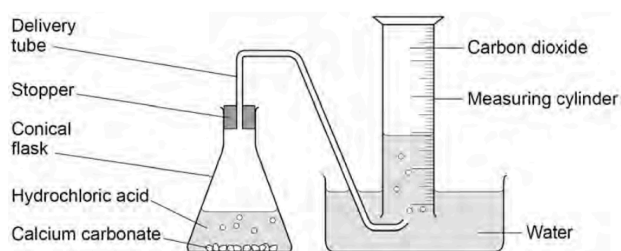
Some factors affect the rates of chemical reactions.

0 2 . 1

A student investigated the effect of changing the particle size of calcium carbonate on the rate of reaction with hydrochloric acid.

Figure 3 shows the apparatus.

Figure 3



Describe a method the student could use to produce valid results.

[6 marks]

B)

0 2 . 2

The student investigated the effect of increasing the temperature on the rate of a reaction.

Explain the effect of increasing the temperature on the rate of a reaction.

Refer to particles and collisions in your answer.

[3 marks]

Q13. (2024)

Catalysts affect the rate of reactions.

0 2 . 3

What is meant by a 'catalyst'?

[2 marks]

Q14. (2024)

0 2 . 4

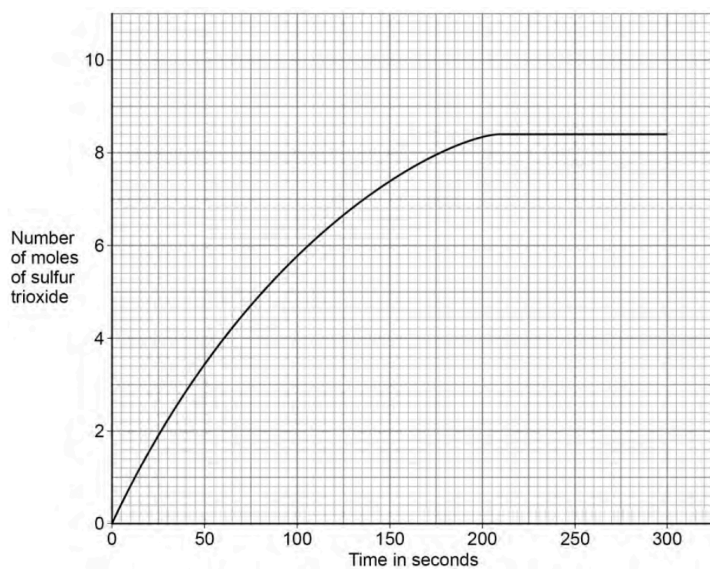
What are catalysts in biological systems called?

[1 mark]

Q15. (2024)

05.7 Figure 6 shows the results for sulfur trioxide.

Figure 6



Determine the rate of reaction at 60 seconds.

[4 marks]

Rate = _____ mol/s