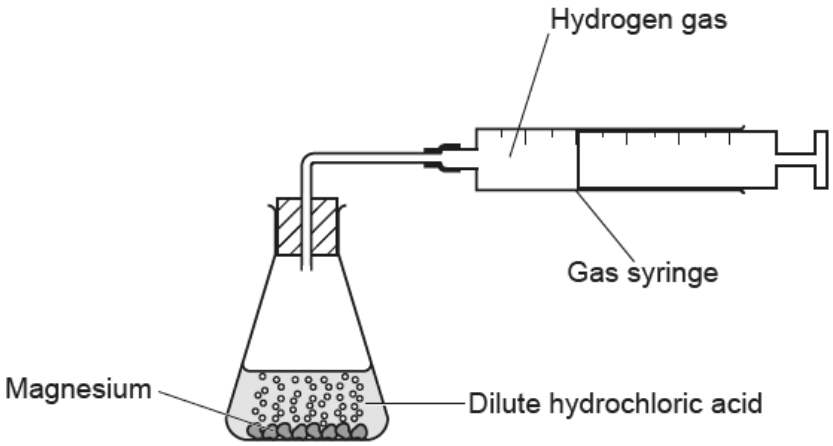
Controlling reactions – 2021/20 GCSE Gateway Chemistry Combined Science A

1. Nov/2021/Paper_J250/04/No.17

A student investigates the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.

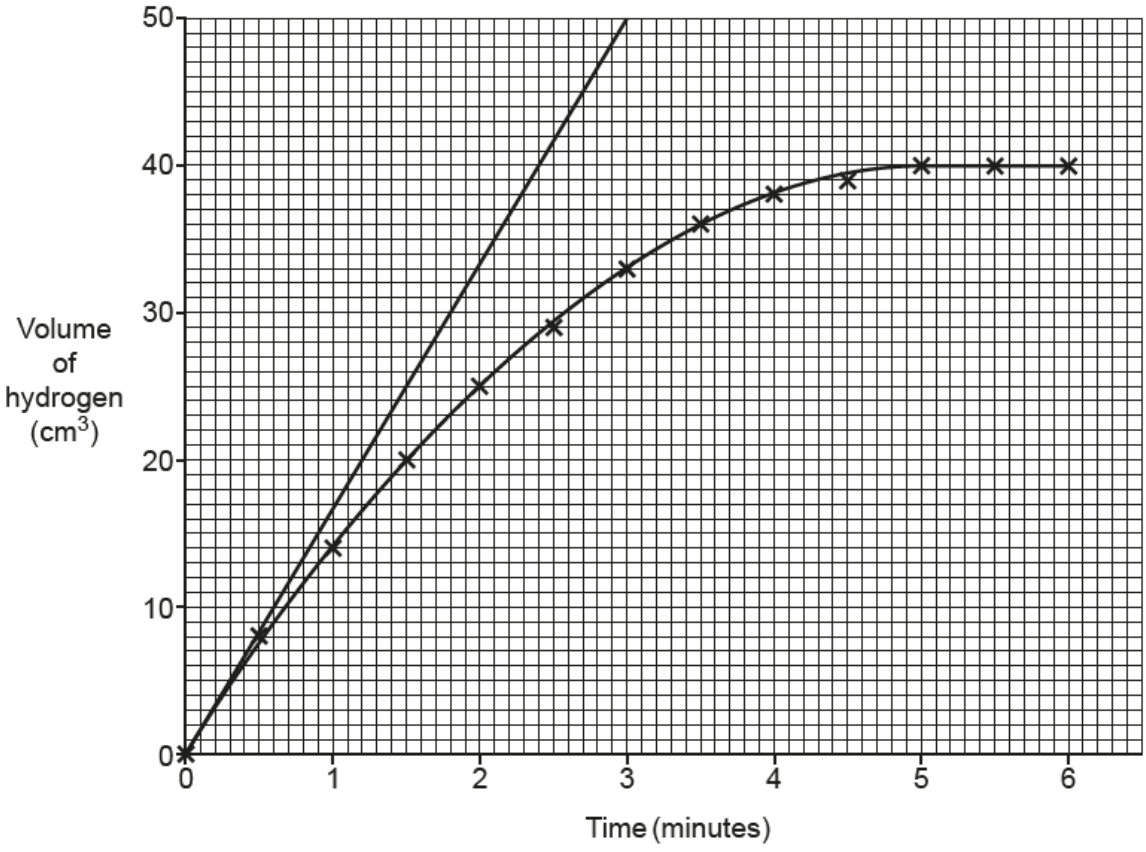
The diagram shows the equipment they use.



The student measures the total volume of hydrogen gas produced every 30 seconds.

The student plots a graph of their results.

They want to calculate the rate of reaction at the start of the reaction. They draw a tangent on the graph at the start of the reaction.



(a) The gradient of the tangent gives the rate of reaction. Use the tangent to calculate the rate of reaction at the start of the reaction.

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

Rate of reaction = ... cm^3 / minute **[3]**

(b) What happens to the **rate of reaction** as the reaction progresses?

Explain your answer using ideas about particles and collisions.

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

(c) Another student repeats the experiment.

They increase the concentration of the dilute hydrochloric acid. They keep everything else in the experiment the same.

(i) Does the gradient of the graph at the start of this student's reaction decrease, increase or stay the same compared to the first student's experiment?

Tick (✓) **one** box.

Decrease ☐

Increase ☐

Stay the same ☐

Give a reason for your answer.

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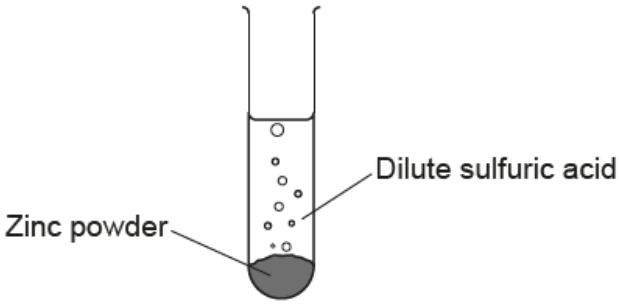
..... **[1]**

(ii) Write down the volume of hydrogen gas that is produced at the end of this reaction.

Volume = ... cm^3 **[1]**

2. Nov/2021/Paper_J250/04/No.18

A student investigates the reaction between zinc and dilute sulfuric acid.



The student observes that bubbles are produced slowly during the reaction.

They want to find a catalyst for the reaction. They repeat the experiment, but each time they add a small piece of a different metal, **R**, **S** and **T**.

Look at the student's results.

Metal	Appearance of metal at start of reaction	Observations
R	silvery-white	fast bubbling the silvery-white metal disappears
S	reddish-brown	fast bubbling the metal remains reddish-brown
T	dark grey	slow bubbling the metal remains dark grey

State if the metals, **R**, **S** and **T** are catalysts or not.

Explain your answers using the information in the table and your knowledge of catalysts.

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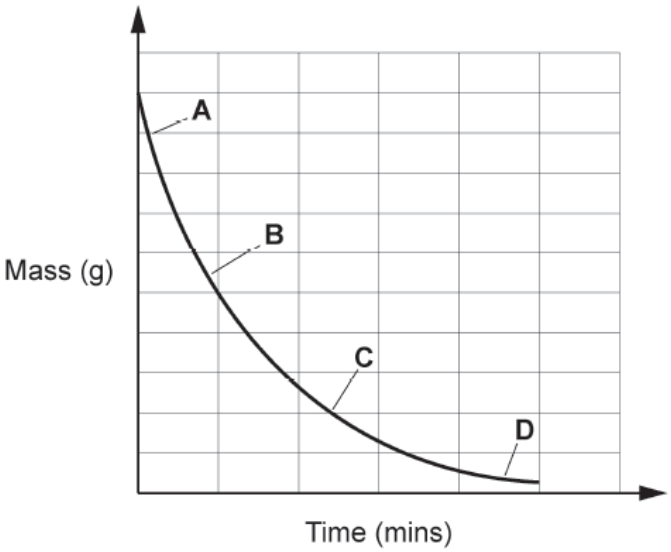
..... **[4]**

3. Nov/2020/Paper_J250/04/No.8

Marble chips react with dilute hydrochloric acid and release a gas.

The graph shows how the mass of the reactants changes as the reaction progresses.



Which letter shows where the rate of reaction is highest?

Your answer ☐ **[1]**

4. Nov/2020/Paper_J250/04/No.18

A student investigates the rate of a reaction at different concentrations.

Fig. 18.1 shows the apparatus he uses.

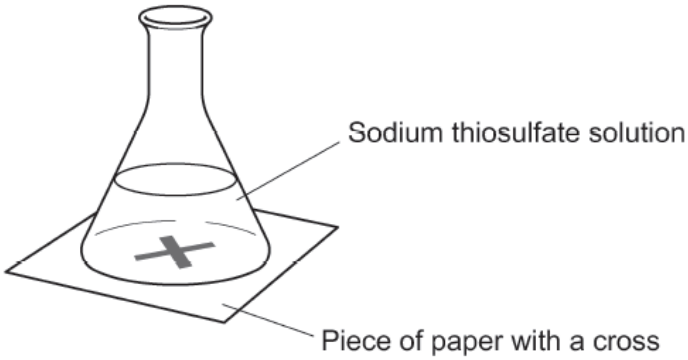


Fig. 18.1

The student adds dilute hydrochloric acid to the sodium thiosulfate solution. He times how long it takes for the cross to disappear. This is the reaction time.

The student repeats the experiment at different concentrations of sodium thiosulfate solution.

The concentration of hydrochloric acid is the same in each experiment.

He plots the results of the experiment on a graph, as shown in **Fig. 18.2**.

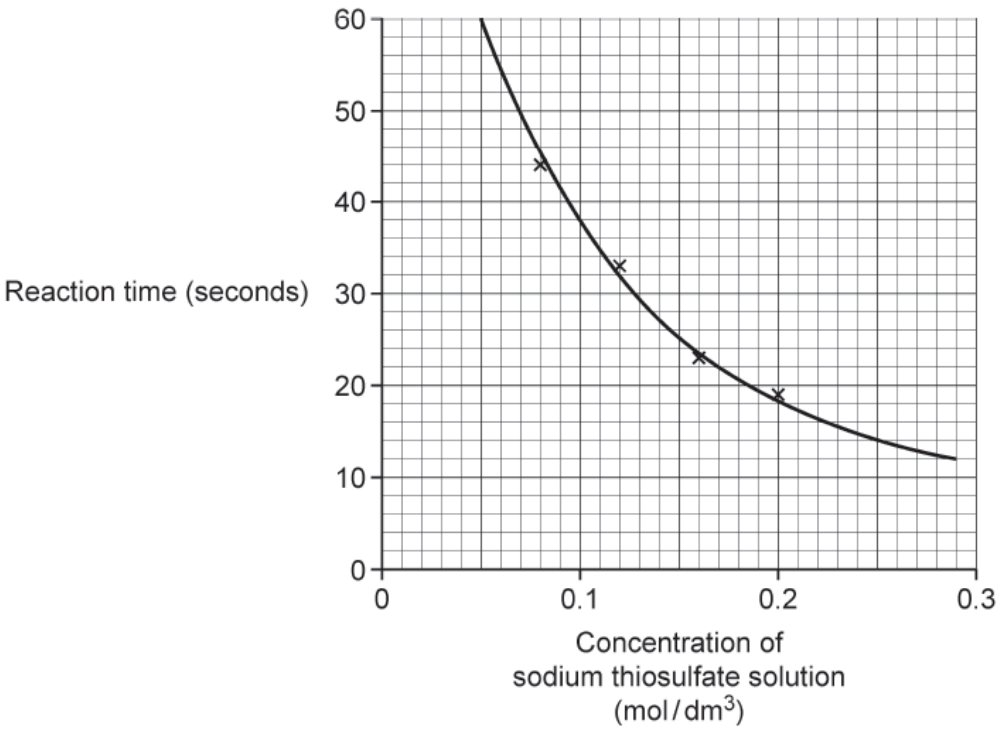


Fig. 18.2

(a) Look at the equation for the reaction.

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

Which product in the reaction makes the cross disappear?

Tick (✓) **one** box.

$NaCl(aq)$ ☐

$S(s)$ ☐

$SO_2(g)$ ☐

[1]

(b) The rate of reaction can be calculated using the equation:

$$\text{Rate of reaction} = \frac{1}{\text{reaction time}}$$

Use the graph in **Fig. 18.2** to calculate the rate of reaction when the concentration of sodium thiosulfate solution is $0.25\,mol/dm^3$.

Give your answer to **2** decimal places.

Rate of reaction = ... /s **[3]**

(c) **(i)** Describe the trend shown by the graph in **Fig. 18.2**.

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

(ii) State how the rate of reaction changes as the sodium thiosulfate concentration changes.

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

(d) Another student investigates the effect of temperature on the rate of reaction.

She calculates the rate of reaction at different temperatures, as shown in the table.

Temperature (°C)	Rate of reaction (/s)
30	0.015
40	0.030
50	0.060
60	0.120

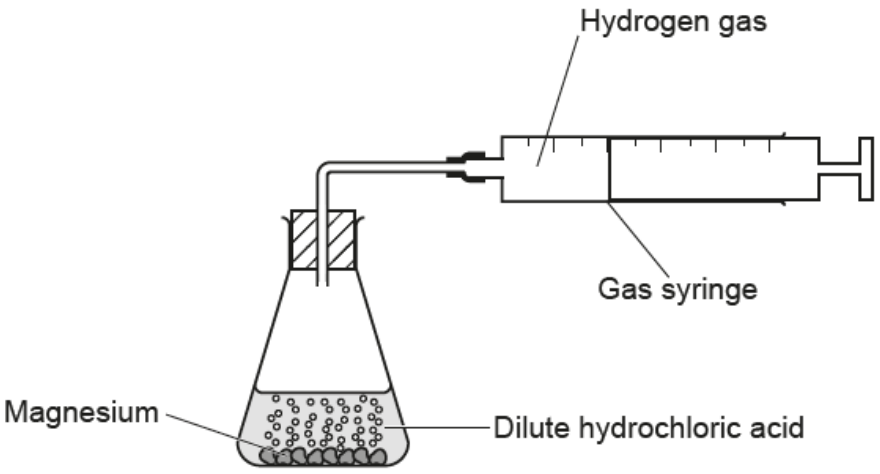
Predict the rate of reaction at 70 °C.

Predicted rate of reaction = ... /s **[1]**

5. Nov/2021/Paper_J250/10/No.11

A student investigates the rate of reaction between magnesium and an **excess** of dilute hydrochloric acid.

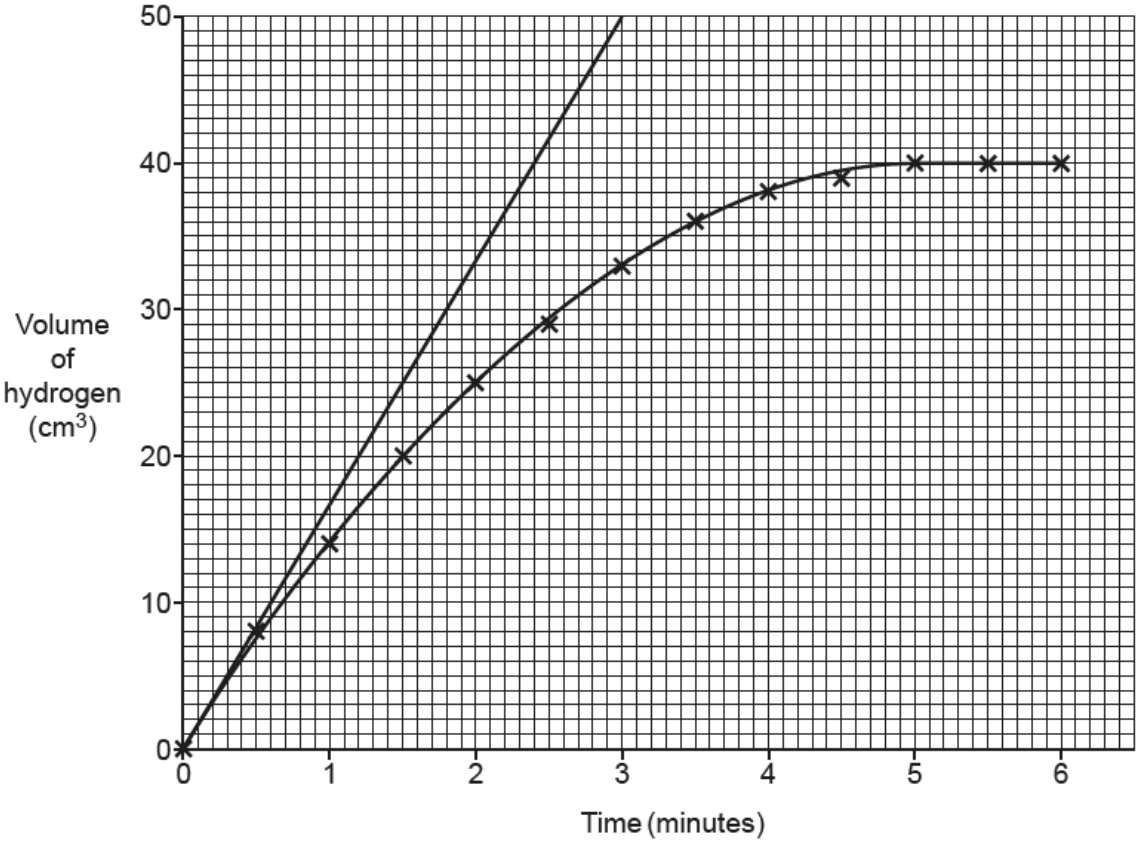
The diagram shows the equipment they use.



The student measures the total volume of hydrogen gas produced every 30 seconds.

The student plots a graph of their results.

They want to calculate the rate of reaction at the start of the reaction. They draw a tangent on the graph at the start of the reaction.


Volume of hydrogen (cm^3)
50
40
30
20
10
0
0
1
2
3
4
5
6
Time (minutes)

(a) The gradient of the tangent gives the rate of reaction. Use the tangent to calculate the rate of reaction at the start of the reaction.

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

Rate of reaction = ... cm^3 / minute **[3]**

(b) What happens to the **rate of reaction** as the reaction progresses?

Explain your answer using ideas about particles and collisions.

.....

.....

.....

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

(c) Another student repeats the experiment.

They increase the concentration of the dilute hydrochloric acid. They keep everything else in the experiment the same.

(i) Does the gradient of the graph at the start of this student's reaction decrease, increase or stay the same compared to the first student's experiment?

Tick (✓) **one** box.

Decrease ☐

Increase ☐

Stay the same ☐

Give a reason for your answer.

.....

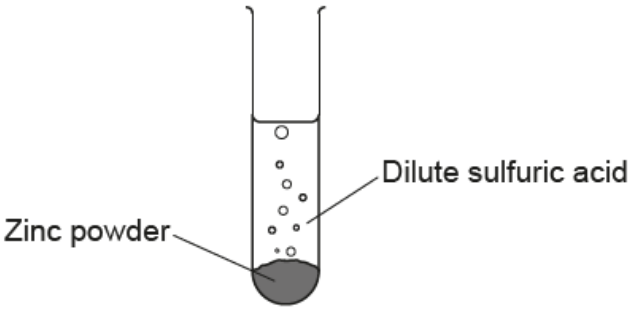
..... **[1]**

(ii) Write down the volume of hydrogen gas that is produced at the end of this reaction.

Volume = ... cm^3 **[1]**

6. Nov/2021/Paper_J250/10/No.12

A student investigates the reaction between zinc and dilute sulfuric acid.



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State if the metals, **R**, **S** and **T** are catalysts or not.

Explain your answers using the information in the table and your knowledge of catalysts.

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..... **[4]**

7. Nov/2021/Paper_J250/10/No.1

What is an example of a **biological** catalyst?

A A lipid

B An amino acid

C An enzyme

D A substrate

Your answer ☐ **[1]**

8. Nov/2021/Paper_J250/10/No.7

Look at the reaction.

$PCl_3(g) + Cl_2(g) \rightleftharpoons PCl_5(g)$

Which statement explains why the rate of reaction changes as the pressure **increases**?

A The energy of the particles increases.

B The particles collide with more force.

C The particles move faster.

D There are more particles in the same volume.

Your answer ☐ **[1]**

9. Nov/2021/Paper_J250/10/No.8

The rate of reaction of marble chips with dilute hydrochloric acid depends on the surface area of the marble chips.

Which surface area of the marble chips gives the **highest** rate of reaction?

A $0.673\,mm^2$

B $1030\,mm^2$

C $2.18 \times 10^3\,mm^2$

D $4.98 \times 10^{-2}\,mm^2$

Your answer ☐ **[1]**

10. Nov/2021/Paper_J250/10/No.12

A student investigates the rate of a reaction at different concentrations.

Fig. 12.1 shows the apparatus he uses.

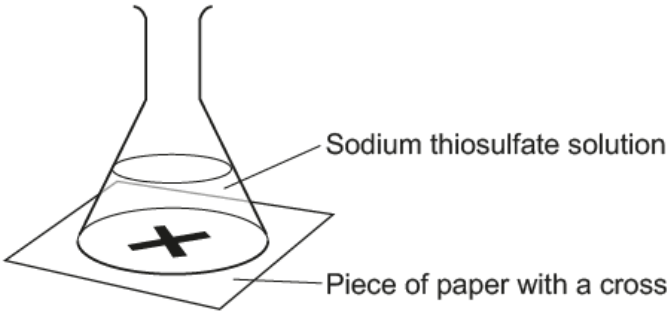

Fig. 12.1

The student adds dilute hydrochloric acid to the sodium thiosulfate solution. He times how long it takes for the cross to disappear. This is the reaction time.

The student repeats the experiment at different concentrations of sodium thiosulfate solution.

The concentration of hydrochloric acid is the same in each experiment.

He plots the results of the experiment on a graph, as shown in **Fig. 12.2**.

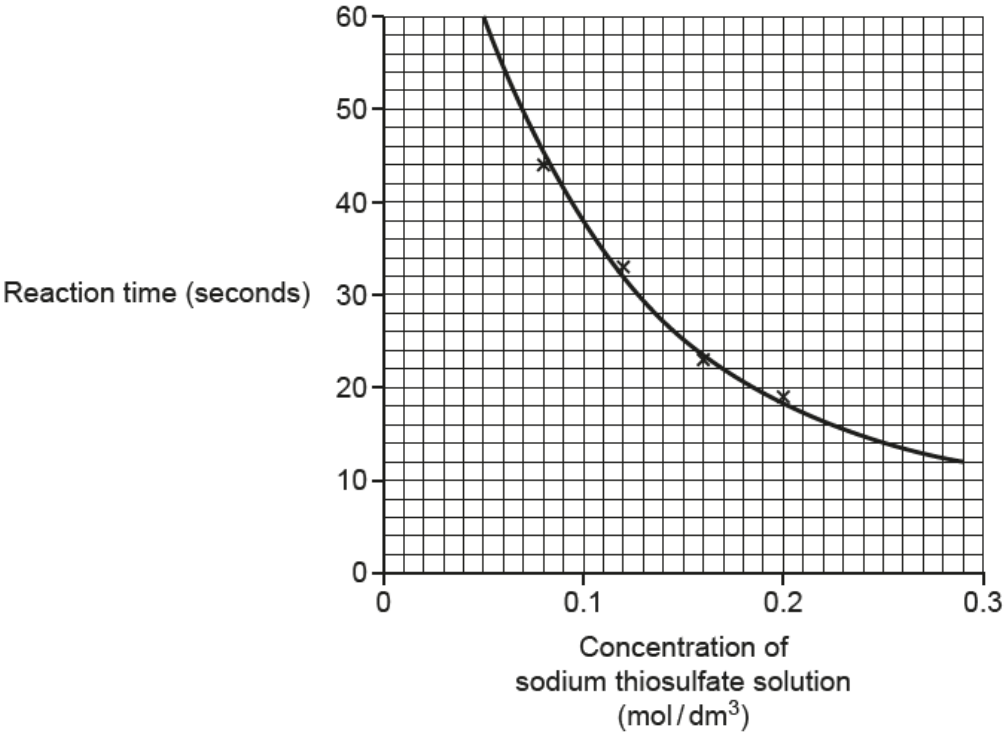

Fig. 12.2

(a) Look at the equation for the reaction.

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

Which product in the reaction makes the cross disappear?

Tick (✓) **one** box.

$NaCl(aq)$ ☐

$S(s)$ ☐

$SO_2(g)$ ☐

[1]

(b) The rate of reaction can be calculated using the equation:

$$\text{Rate of reaction} = \frac{1}{\text{reaction time}}$$

Use the graph in **Fig. 12.2** to calculate the rate of reaction when the concentration of sodium thiosulfate solution is $0.25\,mol/dm^3$.

Give your answer to **2** decimal places.

Rate of reaction = ... /s **[3]**

(c) **(i)** Describe the trend shown by the graph in **Fig. 12.2**.

.....

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

(ii) State how the rate of reaction changes as the sodium thiosulfate concentration changes.

.....

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

(d) Another student investigates the effect of temperature on the rate of reaction.

She calculates the rate of reaction at different temperatures, as shown in the table.

Temperature (°C)	Rate of reaction (/s)
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60	0.120

Predict the rate of reaction at 70 °C.

Predicted rate of reaction = ... /s **[1]**

11. Nov/2021/Paper_J250/10/No.13

Hydrogen peroxide solution decomposes slowly to form water and oxygen.

Look at the equation for the reaction.

$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$

This reaction, shown in **Fig. 13.1**, is very slow.

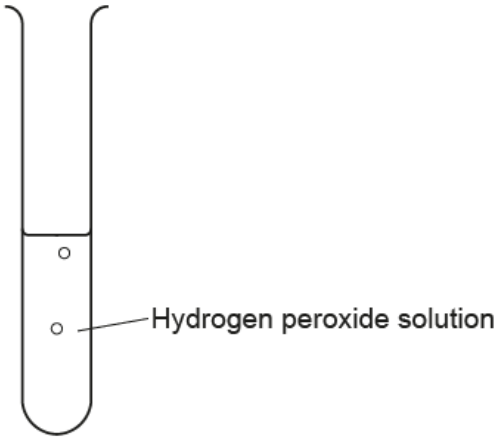

Fig. 13.1

A student thinks that adding manganese(IV) oxide, MnO_2, will catalyse the decomposition reaction.

Her experiment is shown in **Fig. 13.2**.

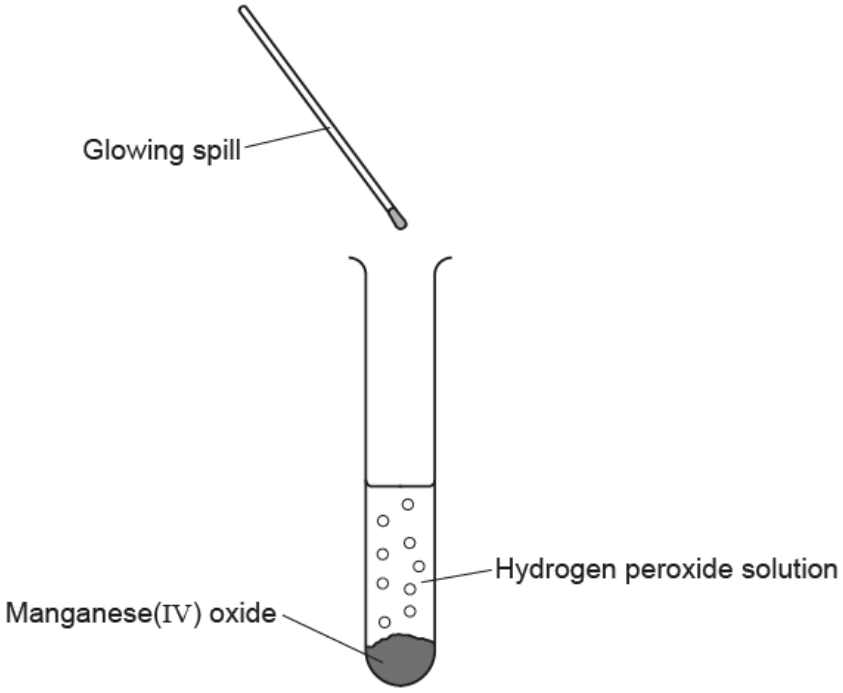

Fig. 13.2

When she puts the glowing spill into the test tube in **Fig. 13.2** the spill relights.

The student separates the manganese(IV) oxide from the reaction mixture.

She adds this manganese(IV) oxide to a new solution of hydrogen peroxide.

Predict the results of this experiment if manganese(IV) oxide **is** a catalyst.

Explain your answer.

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..... **[4]**