1 An enzyme present in peppermint plants is a catalyst for the oxidation of limonene.

State what is meant by the term *catalyst*.
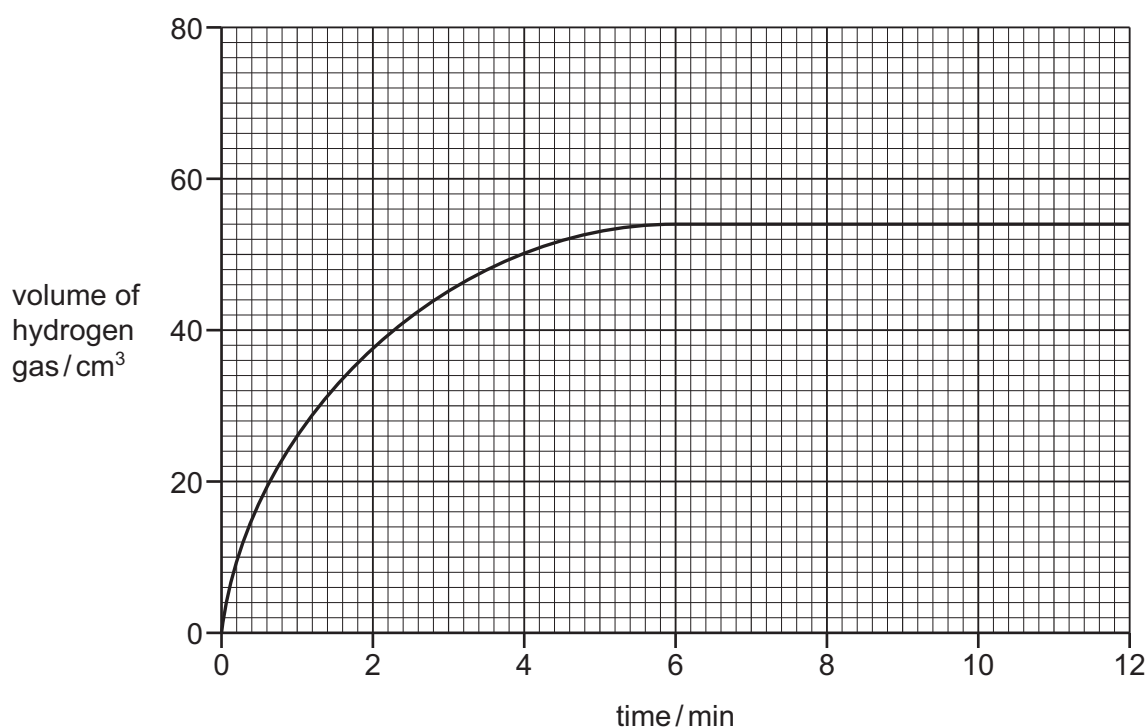
....

.... [1]

[Total: 1]

2 When zinc reacts with hydrochloric acid, hydrogen gas is produced.

The graph shows how the volume of hydrogen gas produced changes with time when an excess of zinc is reacted with $0.2\,mol\,/\,dm^3$ hydrochloric acid.

The experiment is repeated using the same volume of $0.1\,mol\,/\,dm^3$ hydrochloric acid.
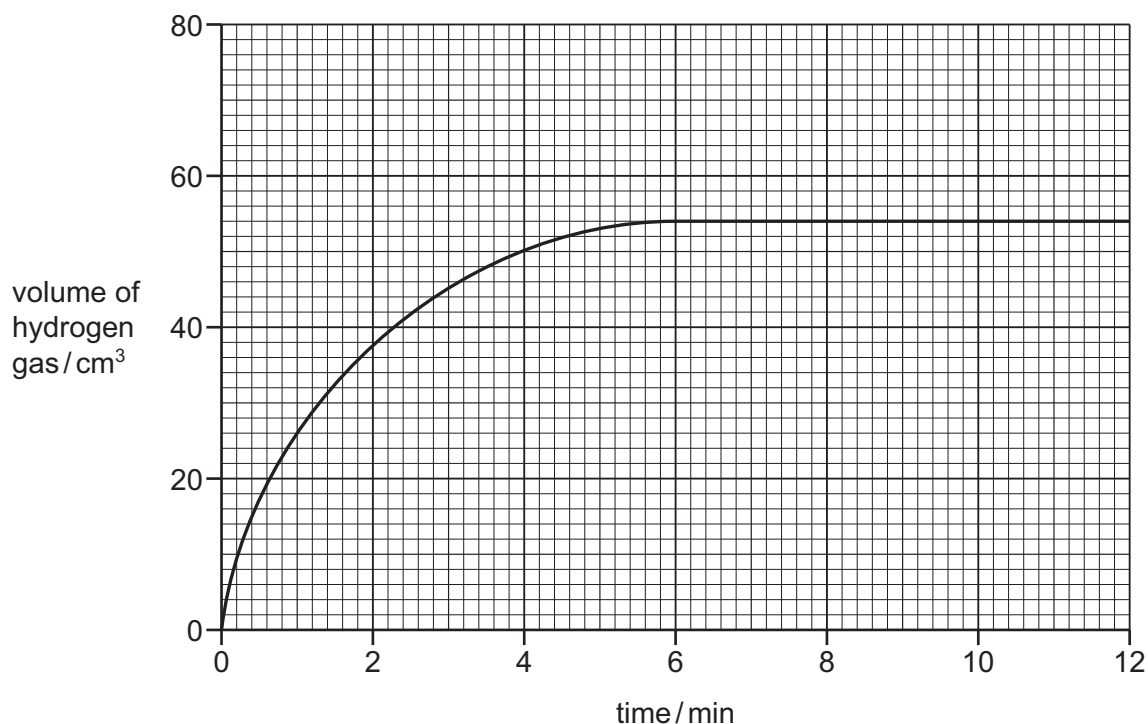All other conditions are kept the same.

On the grid, draw the graph for the experiment using $0.1\,mol\,/\,dm^3$ hydrochloric acid.   [2]

[Total: 2]

3 When zinc reacts with hydrochloric acid, hydrogen gas is produced.

The graph shows how the volume of hydrogen gas produced changes with time when an excess of zinc is reacted with $0.2 \, mol/dm^3$ hydrochloric acid.

What volume of hydrogen gas was released in the first **two** minutes of the reaction?

.... [1]

[Total: 1]

4   When zinc reacts with hydrochloric acid, hydrogen gas is produced.

The graph shows how the volume of hydrogen gas produced changes with time when an excess of zinc is reacted with $0.2\,mol/dm^3$ hydrochloric acid.
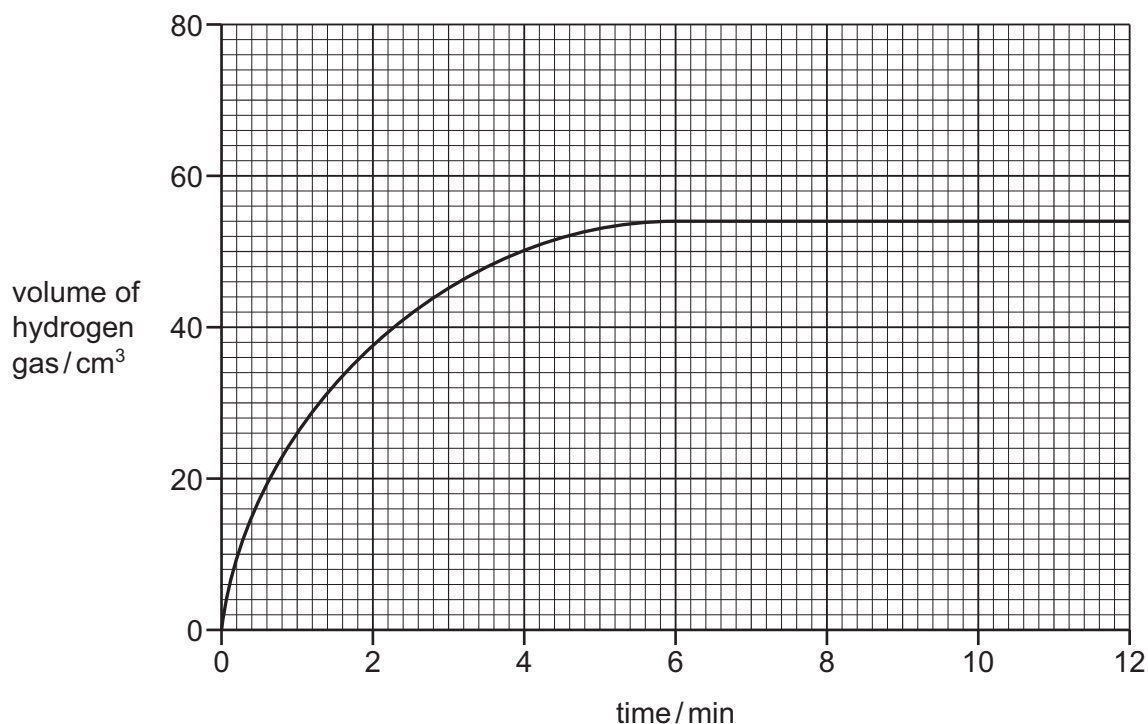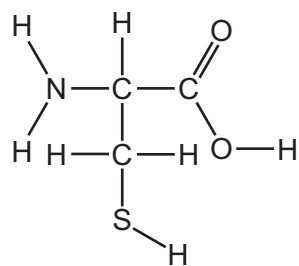

Explain why the volume of hydrogen gas remains constant after six minutes.

.... [1]

[Total: 1]

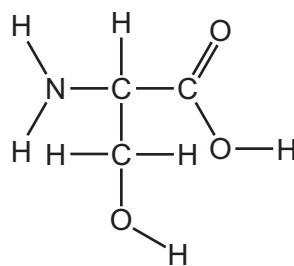5   The structures of two compounds, **A** and **B**, are shown.

compound **A**   compound **B**

Compounds **A** and **B** are formed in the body by enzyme-catalysed reactions.

What is the purpose of a catalyst?

.... [1]

[Total: 1]

6 The table gives some chemical properties of transition elements and their compounds, and of the Group I elements and their compounds.

chemical property	transition elements	Group I elements
ability to act as catalysts	yes	no
exist as coloured compounds	yes	no

Give **one** other chemical property shown by transition elements which is **not** shown by Group I elements.

.... [1]

[Total: 1]

7 The table gives some chemical properties of transition elements and their compounds, and of Group I elements and their compounds.

chemical property	transition elements	Group I elements
ability to act as catalysts	yes	no
exist as coloured compounds	yes	no

What is meant by the term catalyst?

....

....

.... [2]

[Total: 2]

8 A student investigates the rate of reaction of 1 g of iron powder with 25 cm^3 of hydrochloric acid of concentration 2.0 mol /dm^3. The temperature is 20 °C.

What effect do the following have on the initial rate of this reaction?

(a) Using hydrochloric acid of concentration 1.2 mol / dm^3.
All other conditions are kept the same.

.... [1]

(b) Using a piece of iron of mass 1 g.
All other conditions are kept the same.

.... [1]

(c) Carrying out the experiment at 25 °C.
All other conditions are kept the same.

.... [1]

[Total: 3]

9 Calcium carbonate (limestone) decomposes when heated.

$$CaCO_3 \quad \rightarrow \quad CaO \quad + \quad CO_2$$

The graph shows the volume of carbon dioxide produced when some small pieces of calcium carbonate are heated and decompose.
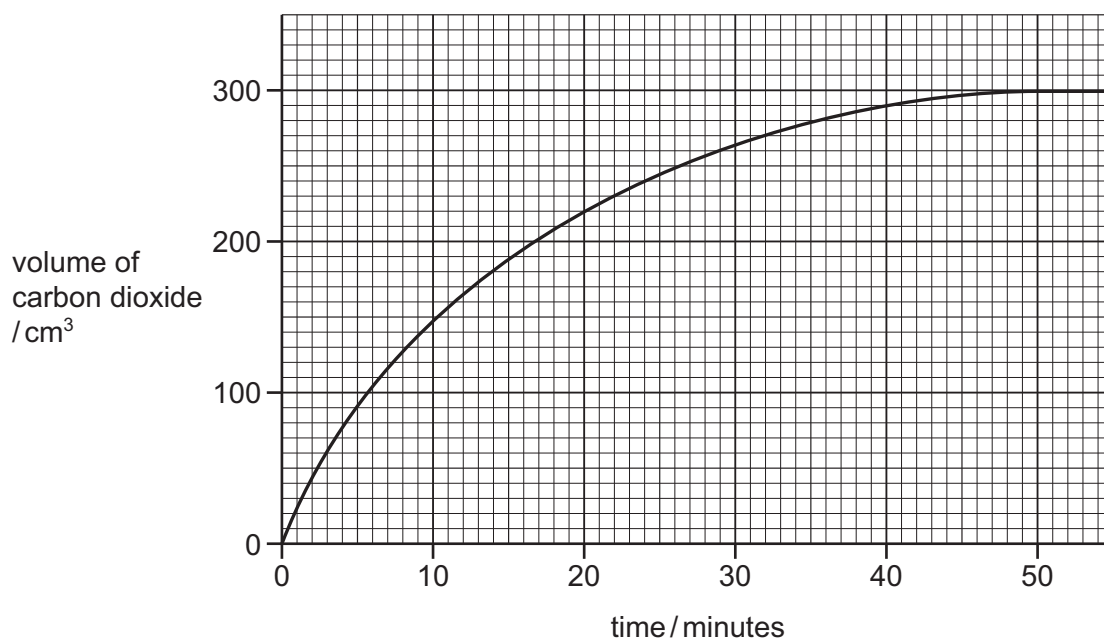
(a) Deduce the volume of carbon dioxide produced during the first 20 minutes of the decomposition.

.... [1]

(b) At what time was the reaction complete?

.... [1]
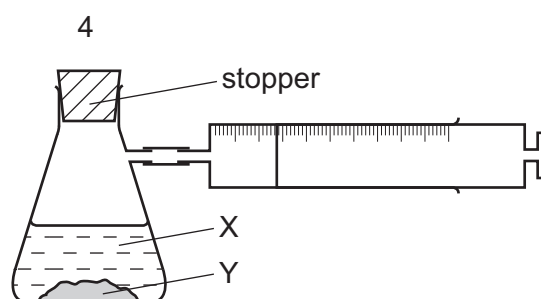
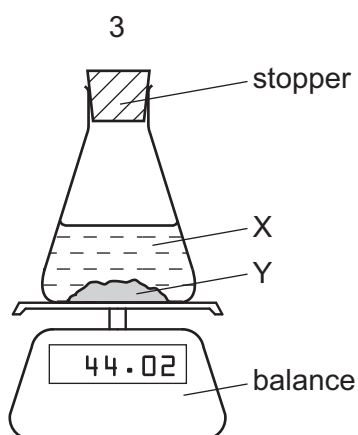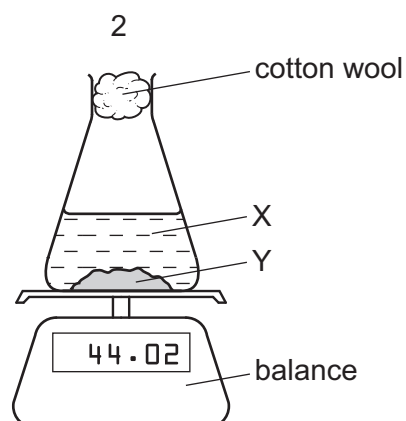**(c)** What would be the effect, if any, on the rate of reaction if the same mass of powdered calcium carbonate were used?

.... [1]

[Total: 3]

10 A liquid X reacts with solid Y to form a gas.

Which two diagrams show suitable methods for investigating the rate (speed) of the reaction?
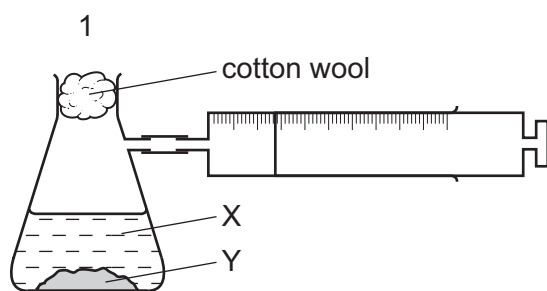
A 1 and 3   **B** 1 and 4   **C** 2 and 3   **D** 2 and 4

[1]

[Total: 1]

11 Which row explains why increasing temperature increases the rate of reaction?

	particles collide more often	particles collide with more energy
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

[1]

[Total: 1]

12 Calcium carbonate reacts with dilute hydrochloric acid.

The graph below shows how the mass of the reaction mixture changes with time.
The calcium carbonate was in excess and large pieces of calcium carbonate were used.
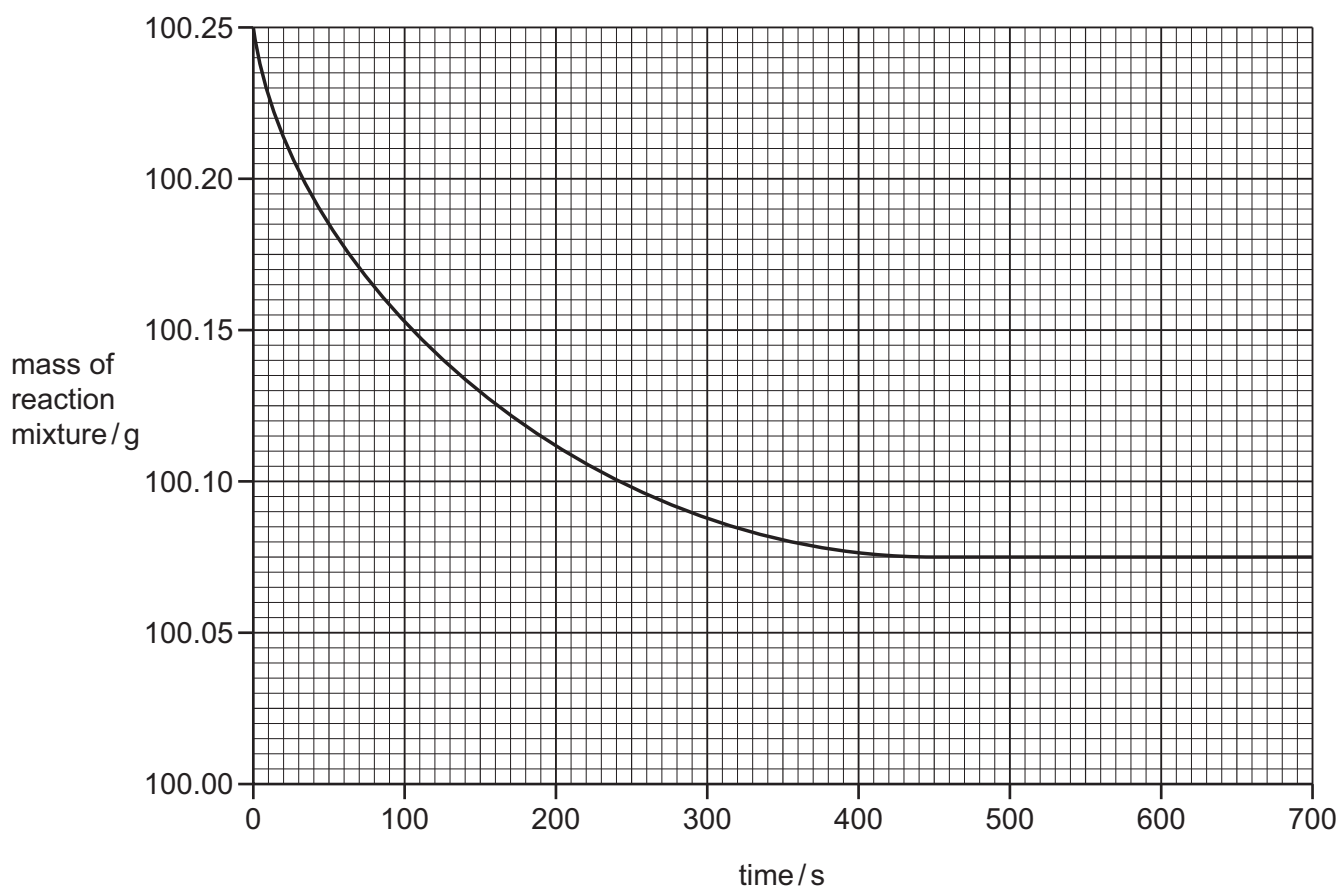
(a) At what time was the reaction just complete?

.... [1]

(b) Calculate the total loss in mass of the reaction mixture in this experiment.

.... [1]

(c) How does the rate of reaction change when:

smaller pieces of calcium carbonate are used,

....

the temperature is decreased,

....

the concentration of hydrochloric acid is decreased?

....

[3]

[Total: 5]

13 A student investigated the rate of reaction of methanol with hydrochloric acid.
The graph below shows how the concentration of hydrochloric acid changes with time.
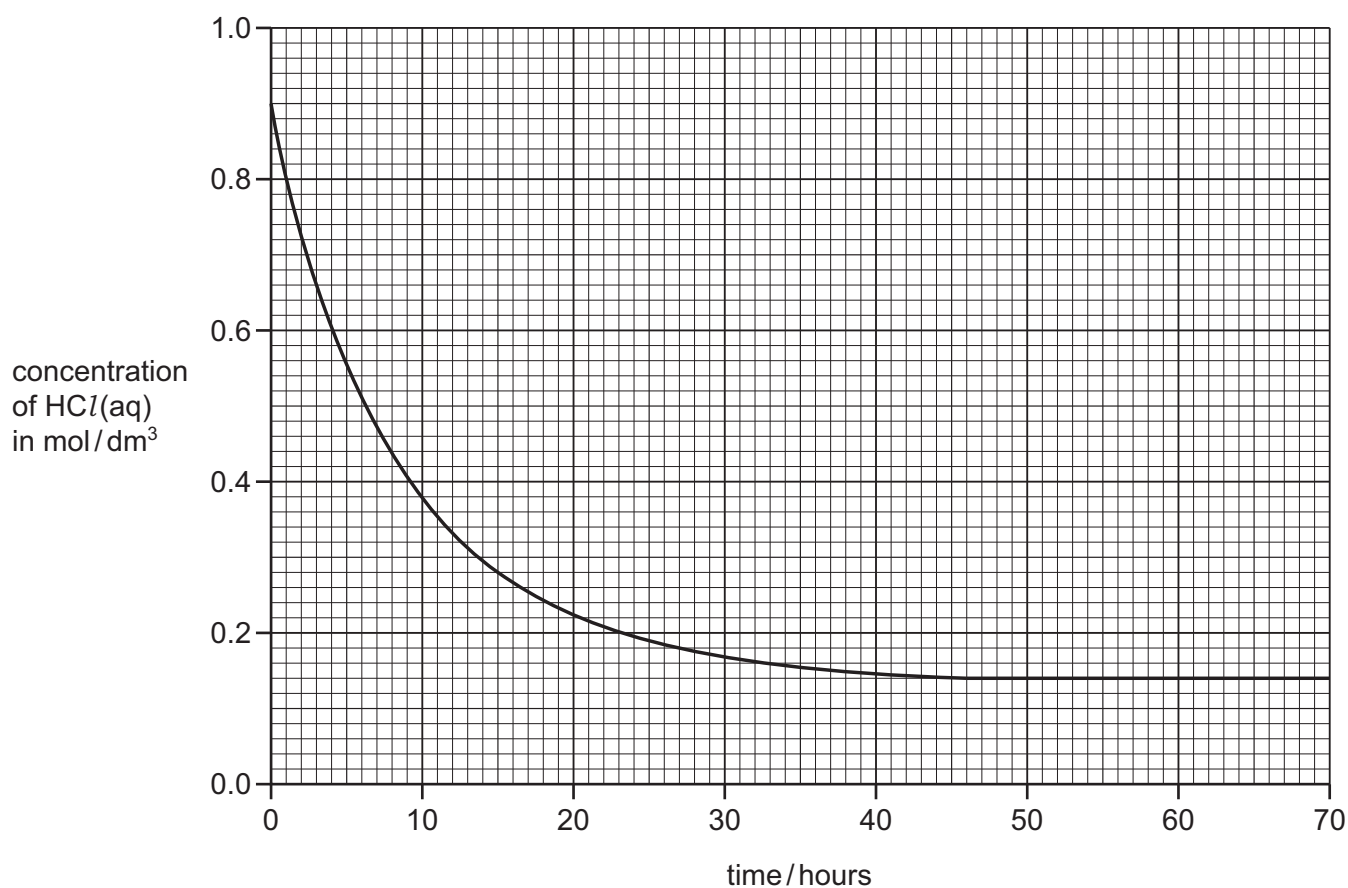
(a) Describe how the concentration of hydrochloric acid changes with time.

....

.... [2]

(b) Deduce the concentration of hydrochloric acid when the reaction had proceeded for 15 hours.

.... [1]

(c) At what time was the reaction just complete?

.... [1]

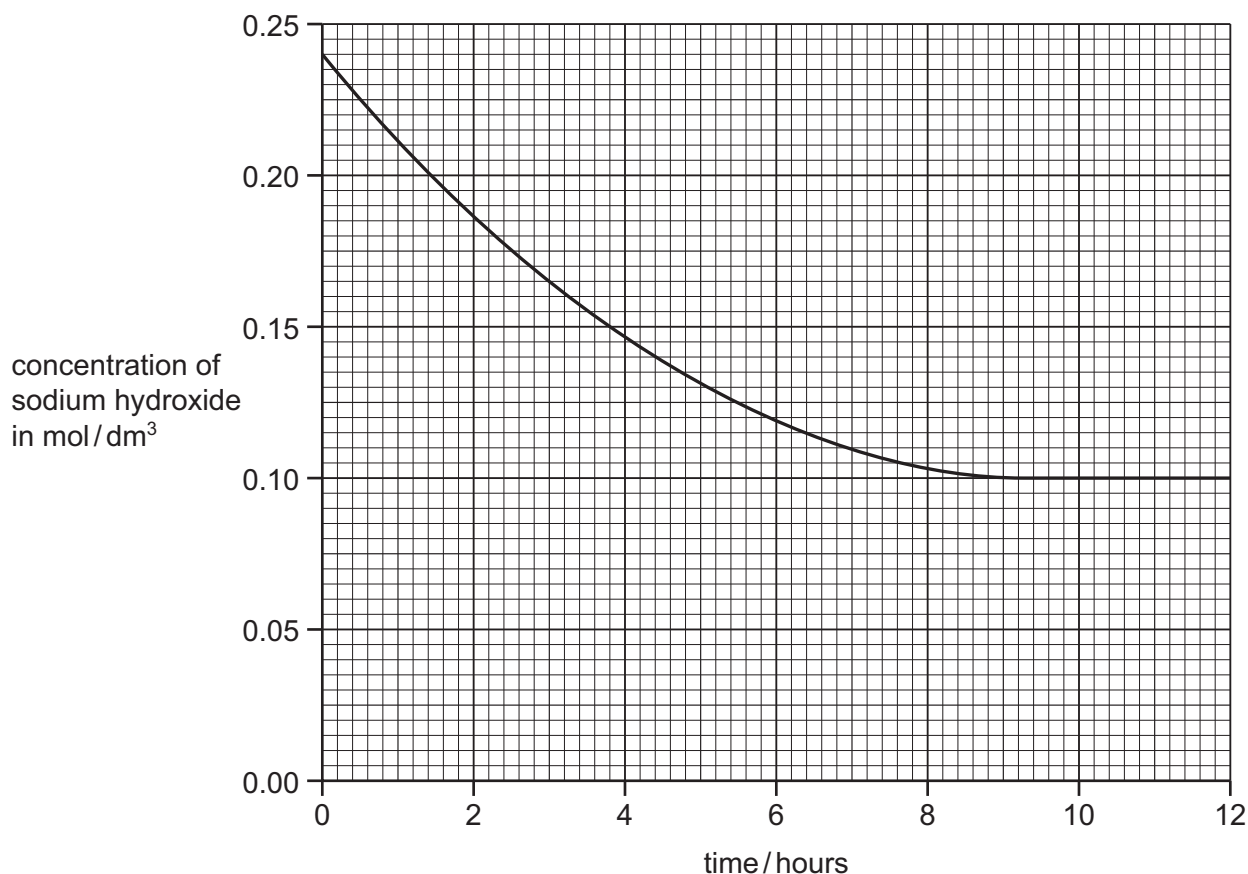**(d)** On the grid above, draw a line to show how the concentration of hydrochloric acid changes with time when the reaction takes place at a higher temperature.

[2]

[Total: 6]

14 The organic compound 1-bromobutane reacts with excess sodium hydroxide to form butan-1-ol. A scientist studied the rate of this reaction by finding out how the concentration of sodium hydroxide changed with time.
The graph below shows the results.

(a) Describe how the concentration of sodium hydroxide changes with time.

....

.... [2]

(b) Determine the time it took for the concentration of sodium hydroxide to fall to 0.15 mol / dm^3.

.... [1]

(c) At what time was the reaction complete?

.... [1]

(d) On the grid above, draw a line to show how the concentration of sodium hydroxide changes when the concentration of 1-bromobutane in the reaction mixture is increased.
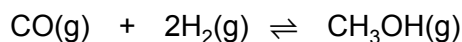All other conditions remain the same.

[2]

(e) Increasing the concentration of 1-bromobutane increases the rate of this reaction.
Suggest **one** other way of increasing the rate of this reaction.

.... [1]

[Total: 7]

15 Methanol is made industrially by reacting carbon monoxide with hydrogen. The gases react at a temperature of 250 °C and a pressure of 75 atmospheres.

$$CO(g) \ + \ 2H_2(g) \ \rightleftharpoons \ CH_3OH(g)$$

The forward reaction is exothermic.

(a) Suggest a source of hydrogen for this industrial process.

.... [1]

(b) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the reverse reaction	effect on the equilibrium yield of $CH_3OH(g)$
adding a catalyst		no change
increasing the temperature	increases	
decreasing the pressure		

[4]

[Total: 5]

16 Hydrogen gas reacts with iodine gas. The equation is shown.

$$H_2(g) \ + \ I_2(g) \ \rightleftharpoons \ 2HI(g)$$
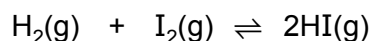
The reaction is reversible and can reach equilibrium.

The graph shows how the concentration of hydrogen iodide, HI, changes after hydrogen gas and iodine gas are mixed together in a sealed container.
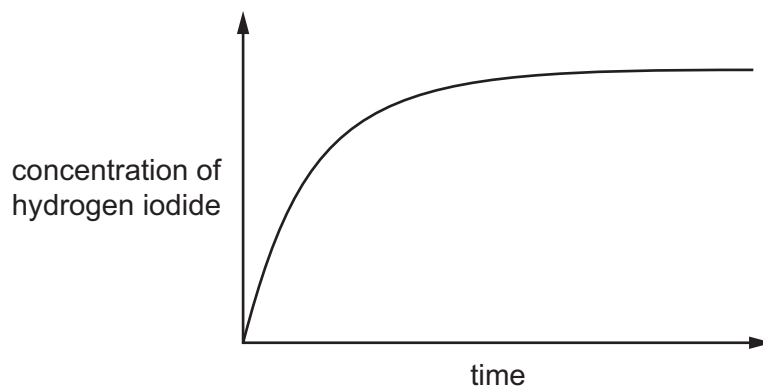
(a) When is the rate of reaction fastest?

....

.... [1]

(b) The reaction was repeated at the same temperature and pressure but in the presence of a catalyst.

Draw a graph on the same axes to show how the concentration of hydrogen iodide changes with time in the presence of a catalyst.

[2]

[Total: 3]

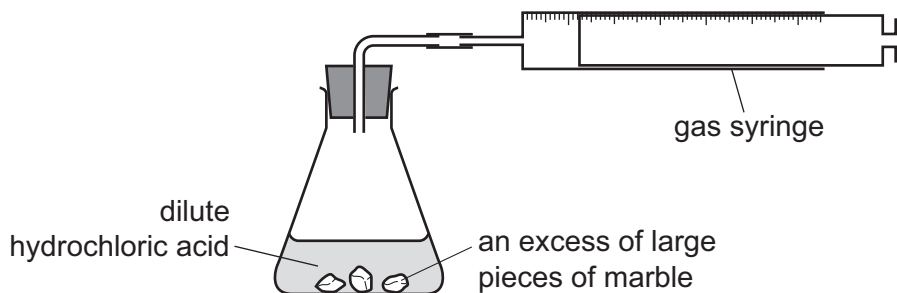**17** A student investigated the progress of the reaction between dilute hydrochloric acid, HCl, and an excess of large pieces of marble, $CaCO_3$, using the apparatus shown.

A graph of the volume of gas produced against time is shown.
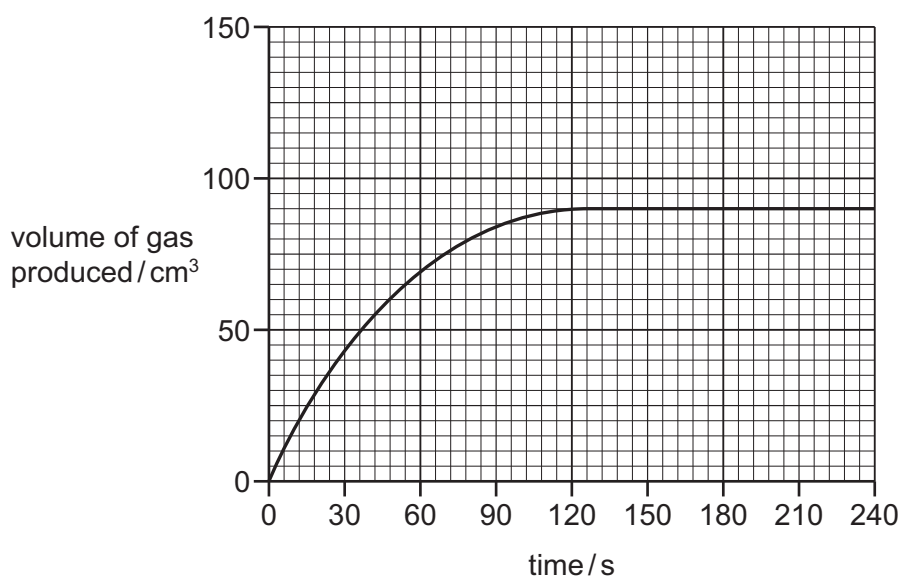
The experiment was repeated using the same mass of smaller pieces of marble. All other conditions were kept the same.

Draw a graph **on the grid** to show the progress of the reaction using the smaller pieces of marble. [2]

[Total: 2]

18 Hydrogen gas reacts with iodine gas. The equation is shown.

$$H_2(g) \ + \ I_2(g) \ \rightleftharpoons \ 2HI(g)$$
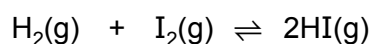
The reaction is reversible and can reach equilibrium.

A mixture of hydrogen gas and iodine gas is allowed to reach equilibrium.

(a) Increasing the pressure of a gas increases its concentration.

State and explain the effect of increasing the pressure on the **rate** of the forward reaction.

....

....

.... [2]

(b) State and explain the effect of increasing the temperature on the **rate** of the reverse reaction.

....

....

....

....

.... [3]

[Total: 5]

19 A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The calcium carbonate was in excess.

gas syringe

lumps of calcium carbonate — dilute hydrochloric acid

The student repeated the experiment at a higher temperature. All other conditions were kept the same. The student found that the rate of reaction increased.

Explain, in terms of collisions, why the rate of reaction increased.

....

....

....

....

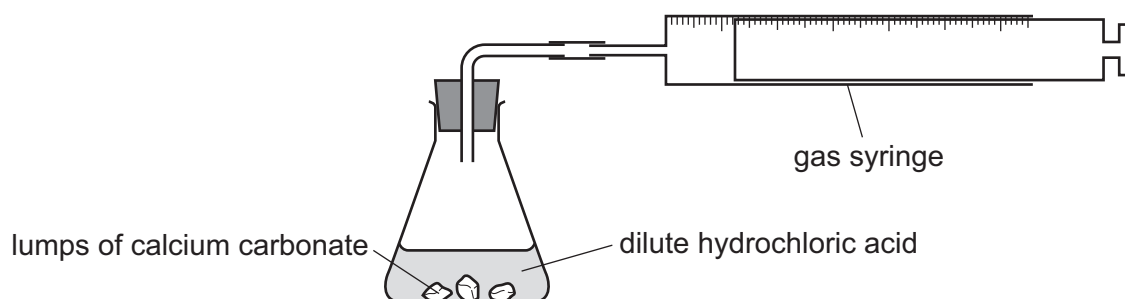.. [4]
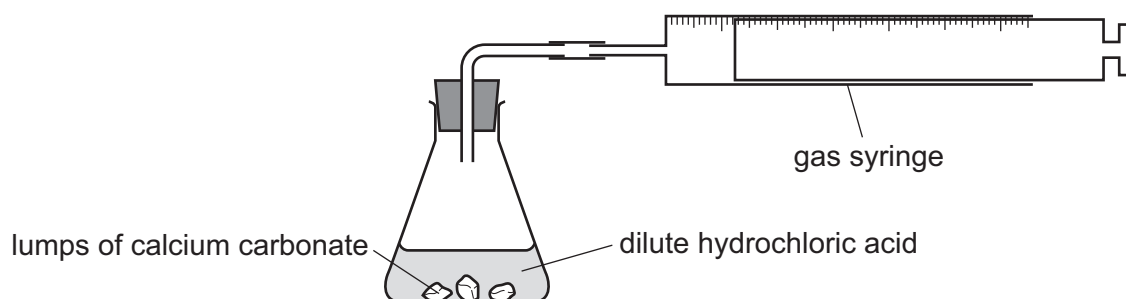
[Total: 4]

20 A student investigates the rate of reaction between lumps of calcium carbonate and dilute hydrochloric acid using the apparatus shown.

$$CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$$

The calcium carbonate was in excess.

gas syringe

lumps of calcium carbonate   dilute hydrochloric acid

What happens to the rate of reaction as the reaction proceeds? Explain your answer.

....

....

....

....   [3]

[Total: 3]