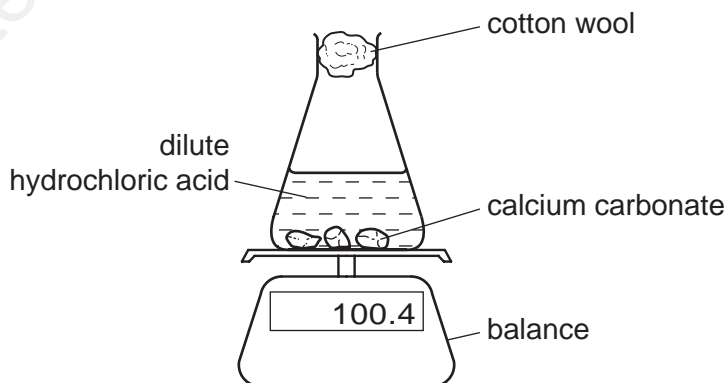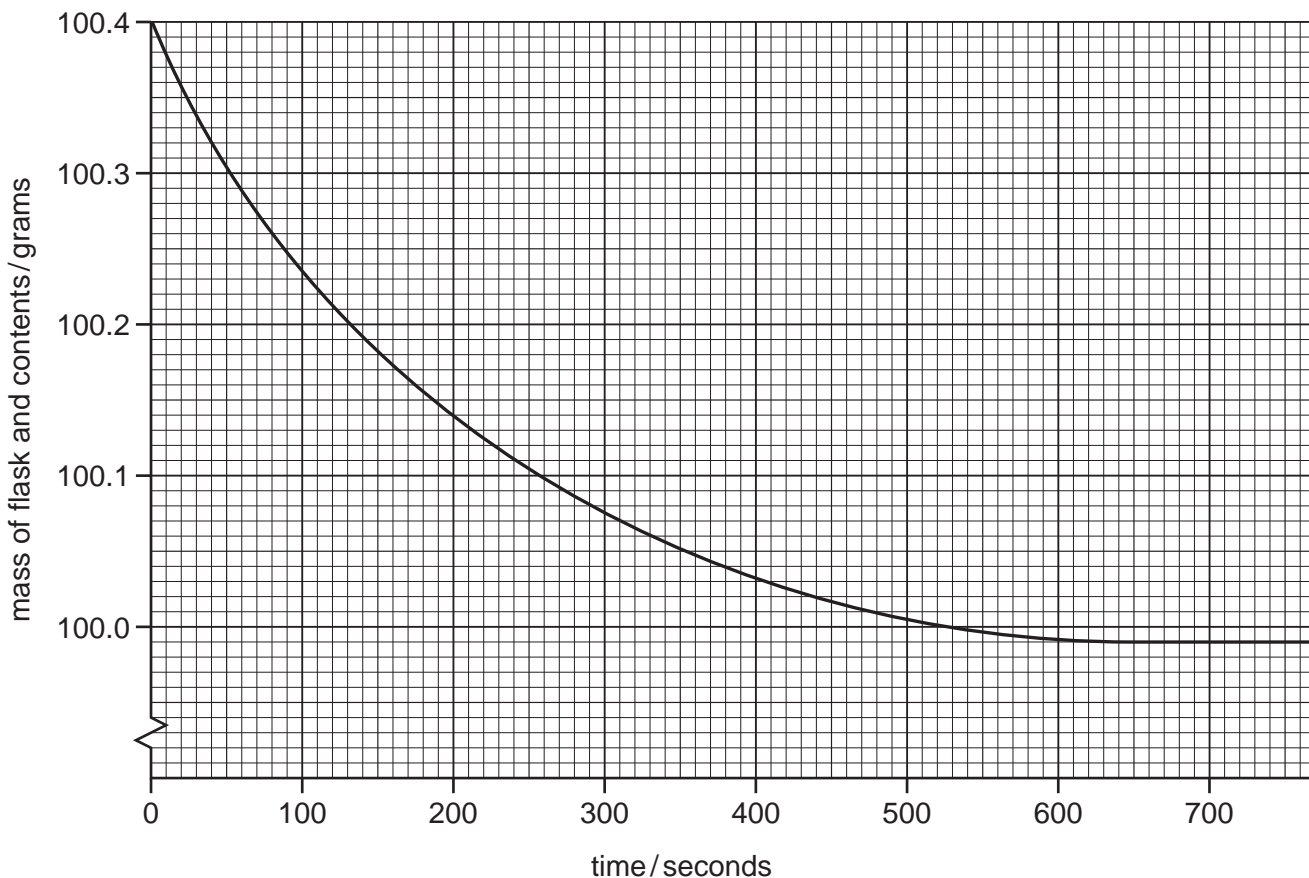5 A student used the apparatus shown below to investigate the rate of reaction of calcium carbonate with dilute hydrochloric acid.

$$CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$$

(a) Use the information in the equation to suggest why the mass of the flask and contents decreases with time.

....

.... [1]

(b) The graph shows how the mass of the flask and its contents changes with time.

(c) How does the speed (rate) of this reaction change when

    (i) the temperature is increased, ... [1]

    (ii) smaller pieces of calcium carbonate are used? .... [1]

(d) Complete the following sentence using words from the list.

    combustion   expansion   large   rapid   slow   small

    In flour mills there is often the risk of an explosion due to the rapid ....

    of the very .... particles which have a very

    ....surface area to react. [3]

MARKING SCHEME:

(a) carbon dioxide released / gas is released / gas is formed; [1]

NOT: we get carbon dioxide, calcium chloride and water

(b) (i) 615 s; [1]

ALLOW: in numbers in range 600–630 s

(ii) X on or near the line at beginning of experiment; [1]

ALLOW: on or near line up to 50 s

(iii) shallower curve at initial rate; [1]

starts levelling off at 100.2 g; [1]

ALLOW: (beginning to) level off between 100.15 and 100.25 g

(c) (i) increases / goes faster; [1]

NOT: takes less time / becomes fast / reaction increases
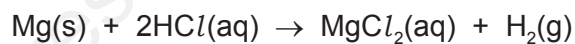
(ii) increases / goes faster; [1]

NOT: takes less time / becomes fast / reaction increases

(d) combustion;

small;

large; [3]

4 A student investigated the reaction of magnesium with dilute hydrochloric acid.

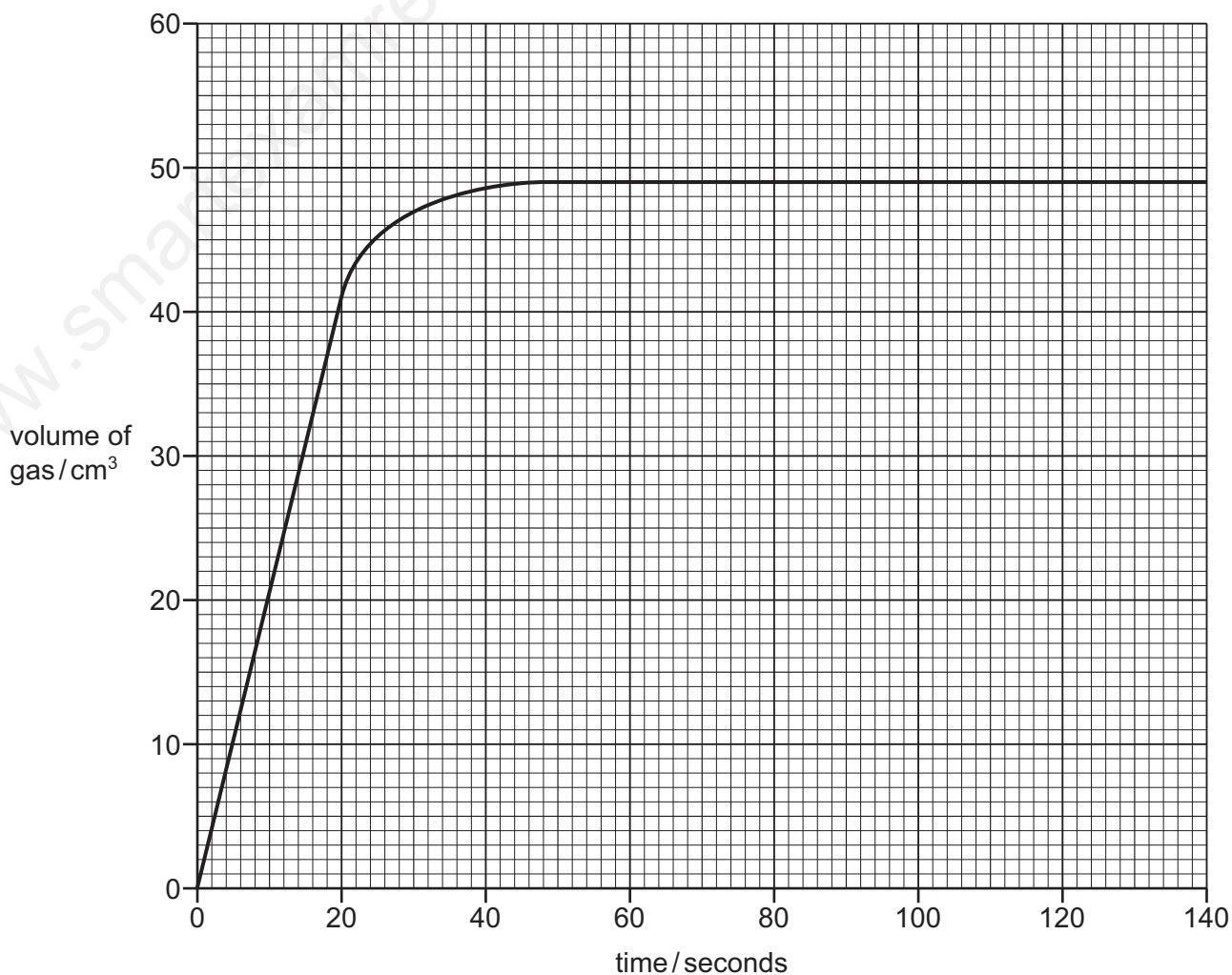$$Mg(s) \ + \ 2HCl(aq) \ \rightarrow \ MgCl_2(aq) \ + \ H_2(g)$$

She measured the volume of gas given off at various times during the reaction.

(a) Complete the diagram of the apparatus she would use to measure the volume of the gas given off.
Label the apparatus.

flask

hydrochloric acid
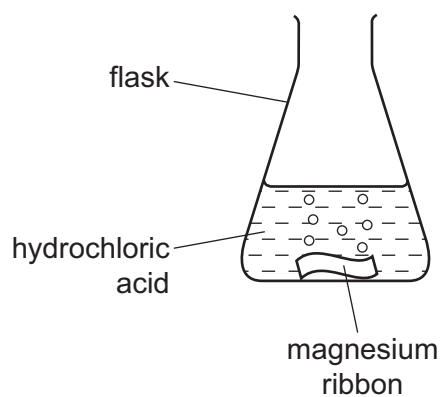
magnesium ribbon

[3]

(b) The student carried out the reaction at 25 °C using magnesium ribbon.
Her results are shown below.

(i) How long does it take for the reaction to stop?

.... seconds [1]

(ii) What is the volume of hydrogen made after 20 seconds?

.... cm^3 [1]

(iii) On the grid above, draw a line to show how the volume of gas changes when the experiment is carried out at 15 °C and all other conditions remain the same.   [2]

(iv) The student repeated the experiment using magnesium powder. All other conditions remain the same.

How does the rate of reaction with magnesium powder compare with the rate of reaction with magnesium ribbon?

.. [1]

MARKING SCHEME:

(a)	(gas) syringe or measuring cylinder correctly labelled;		
	(gas) tube leading from closed apparatus to flask or from inverted measuring cylinder with mouth underwater to flask;		
	COND workable apparatus and apparatus airtight / no gaps in apparatus;	**3**	
(b)(i)	44–48 (seconds);	**1**	
(b)(ii)	41 (cm^3);	**1**	
(b)(iii)	initial gradient less than the original line AND starting at 0–0;		
	ends up at same final volume;	**2**	
(b)(iv)	increased (rate) / faster (rate) / quicker;	**1**	

4 A student investigated the rate of reaction of zinc with dilute hydrochloric acid.
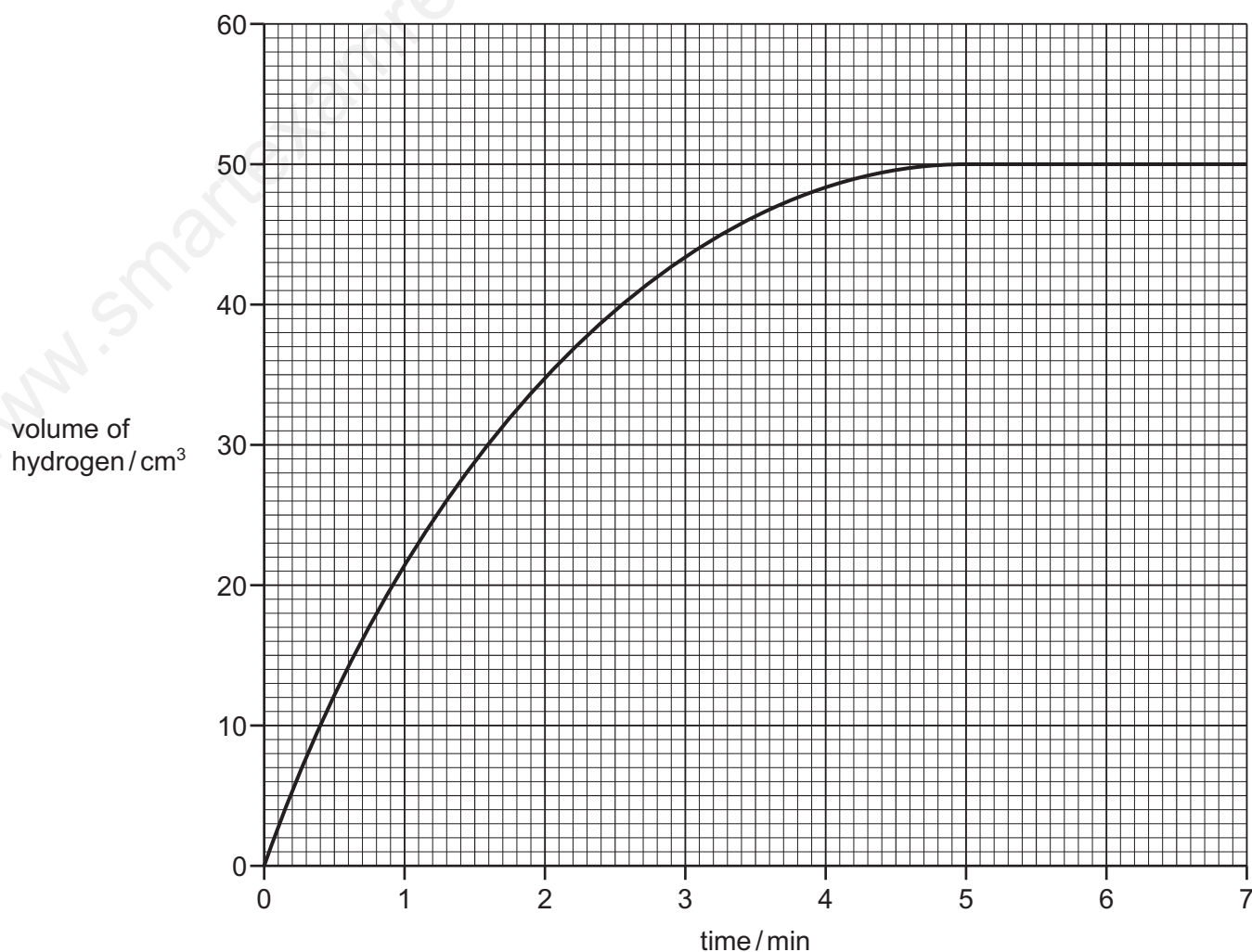
$$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$$
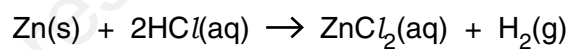
(a) Complete the labelling of the apparatus by filling in the two boxes.

thermometer

water bath at 20 °C

dilute hydrochloric acid
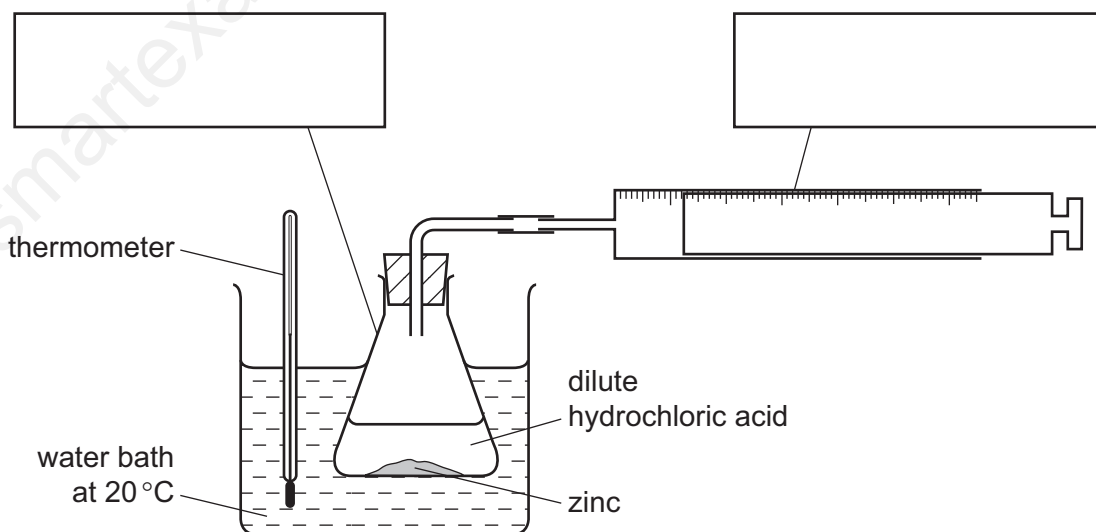
zinc

[2]

(b) The student carried out the reaction at 20 °C using small pieces of zinc. She measured the volume of hydrogen given off as the reaction proceeded.

(i) Describe how the volume of hydrogen changes with time.

....

....[2]

(ii) At what time did the reaction stop?

....[1]

(iii) What volume of gas was produced over the first two minutes of the reaction?

....[1]

(iv) On the graph above draw a line to show how the volume of hydrogen changes when the reaction was carried out at 30 °C. All other conditions remain the same.   [2]

**(c)** How does the rate of reaction change when larger pieces of zinc are used?

All other conditions remain the same.

....[1]

MARKING SCHEME:

(a)	(left box) flask / Erlenmeyer; (right box) (gas) syringe;	**2**
(b)(i)	increases; then levels off / rate of increase less / stops / slows down / stays constant;	**2**
(b)(ii)	values between 4.6 and 4.9 (min);	**1**
(b)(iii)	35 (cm^3);	**1**
(b)(iv)	initial gradient steeper; levelling off to same final volume;	**2**
(c)	(rate) decreases / slower / less / takes more time;	**1**

**7** When magnesium reacts with hydrochloric acid, the products are aqueous magnesium chloride and hydrogen.

$$Mg(s) \ + \ 2HCl(aq) \ \rightarrow \ MgCl_2(aq) \ + \ H_2(g)$$
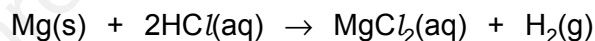
A student used the apparatus shown to follow the progress of this reaction.

dilute
hydrochloric acid
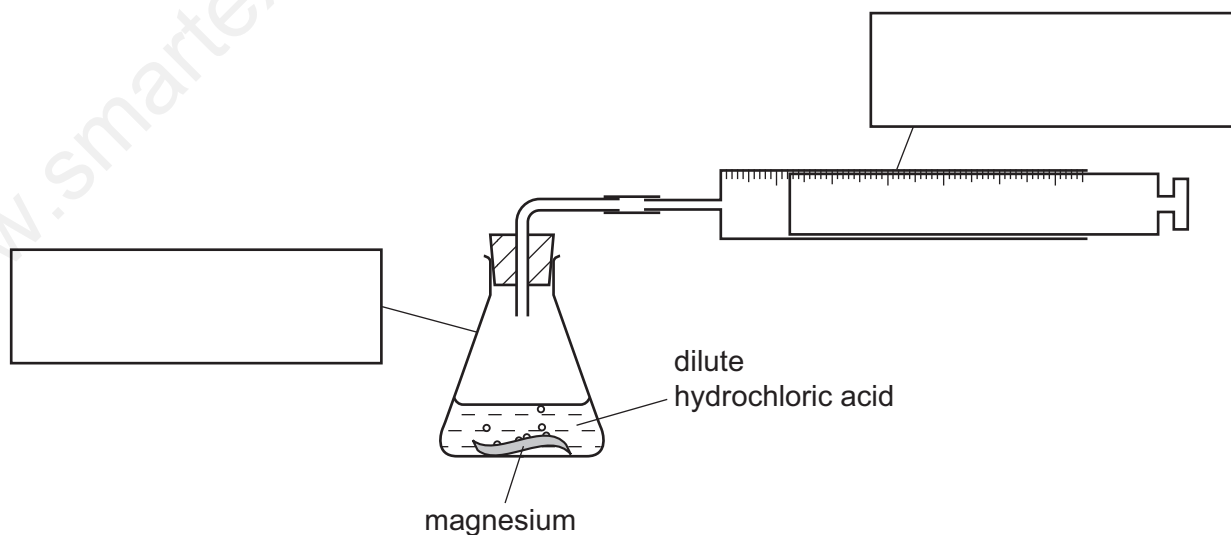
magnesium

(a) Complete the diagram by putting the correct labels in the boxes.

[2]

(b) The student conducted two experiments using the same mass of magnesium in each experiment and two different concentrations of hydrochloric acid. The hydrochloric acid was in excess. All other conditions were kept constant.
The student measured the volume of hydrogen produced over a period of time. The graph shows the results.
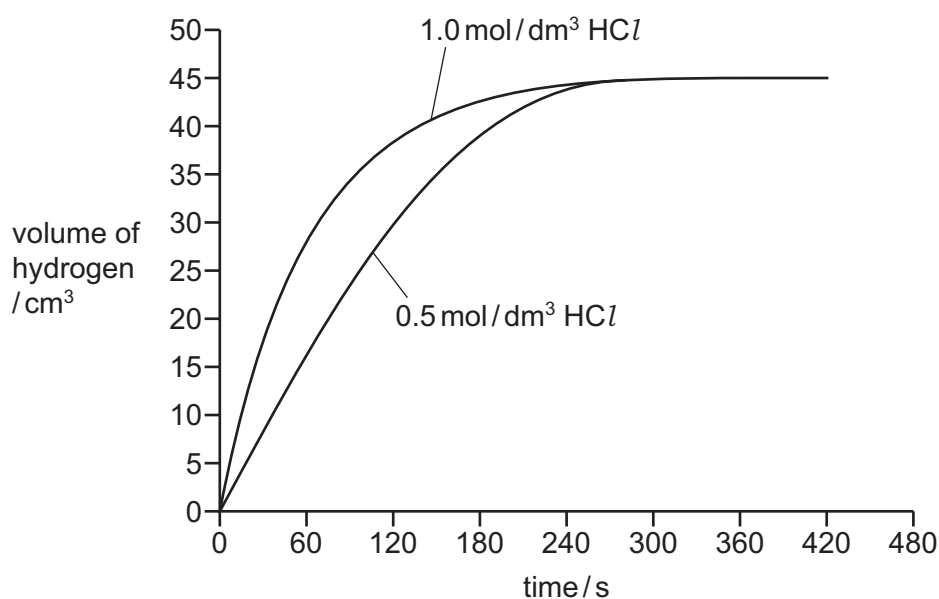
(i) Which concentration of hydrochloric acid gave the faster initial rate of reaction?

Use the graph to explain your answer.

....

.... [1]

(ii) Draw a curve **on the graph on page 16** to show how the volume of hydrogen would change if a third experiment was carried out using $1.5\,mol/dm^3$ hydrochloric acid and the same mass of magnesium.

[2]

(d) Explosions have occasionally been reported where tiny particles of metal dust escape into the air.

Explain why metal dust can form an explosive mixture with air.

....

.... [1]

MARKING SCHEME:

(a)	flask; (gas) syringe;
(b)(i)	1.0 (mol/dm^3) because the initial gradient is steeper/initial slope is steeper;
(b)(ii)	steeper gradient than curve for 1.0 mol/dm^3; same final volume;
(c)	any suitable use, e.g. fuel/reducing agent/making margarine/making ammonia/Haber process/fuel cells;
(d)	dust has a (very) high surface area;

(c) A student used the apparatus shown below for investigating the speed of the reaction between iron and sulphuric acid.

sulphuric acid

iron powder

water
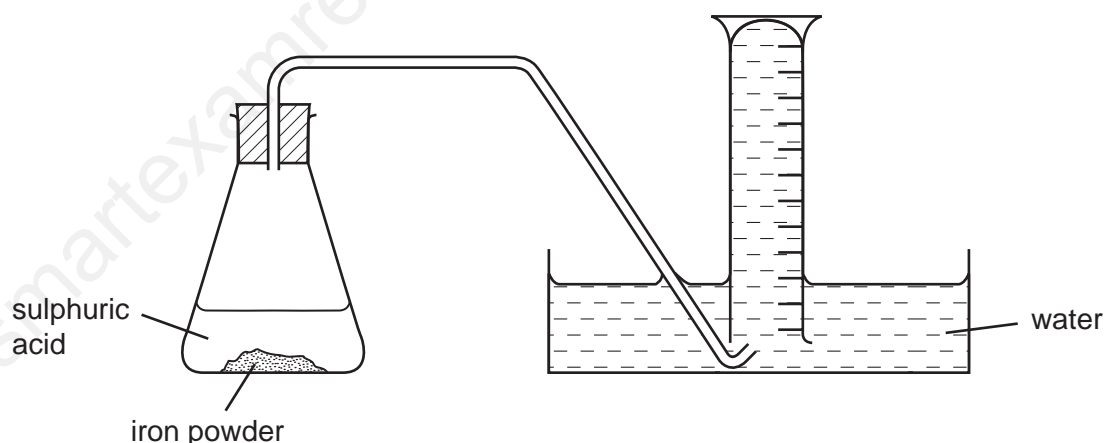
Describe how this apparatus can be used to investigate the speed of this reaction.

[3]

(d) The student repeated the experiment with different concentrations of sulphuric acid.
In each experiment the mass of iron powder was the same and the temperature was kept at 30°C.
The results are shown in the table.

concentration of sulphuric acid / moles per dm^3	speed of reaction /cm^3 hydrogen per second
0.4	4.2
0.8	8.5
1.6	17.0

(i) Use the information in the table to help you work out how the speed of the reaction is affected by the concentration of sulphuric acid.

[2]

(ii) What will happen to the speed of the reaction if lumps of iron are used instead of iron powder?

[1]

(iii) What will happen to the speed of the reaction if it is carried out at 20°C rather than at 30°C?

.... [1]

MARKING SCHEME:

(a) idea of measuring volume of gas/amount of gas;
 in measuring cylinder/tube;
 idea of measuring (volume of gas) with time/time intervals; [3]

(b)(i) doubling concentration doubles rate/rate proportional to concentration = 2
increasing concentration increases rate/speed = 1 [2]

 (ii) slower/decreases [1]

 (iii) slower/decreases [1]