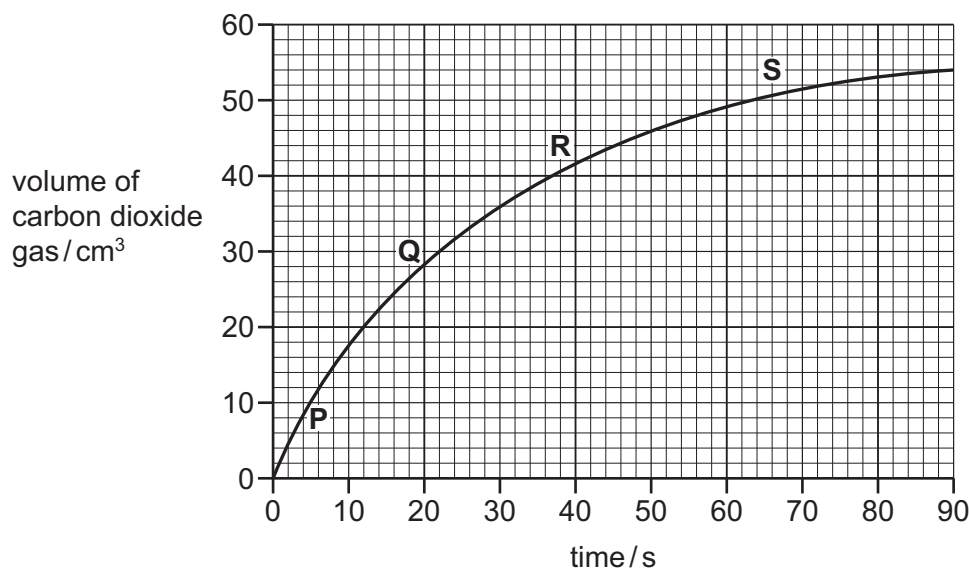


- 1 A student investigated the reaction of calcium carbonate with an excess of dilute hydrochloric acid by measuring the volume of carbon dioxide produced at 10 second intervals.



The results are shown on the graph.



- (a) How long did it take from the start of the experiment to collect 30 cm<sup>3</sup> of carbon dioxide?

..... s [1]

- (b) At which point on the graph, **P**, **Q**, **R** or **S**, was the rate of reaction fastest?  
Use the graph to explain your answer.

.....  
..... [2]

- (c) When 0.225 g of calcium carbonate is used, 54.0 cm<sup>3</sup> of carbon dioxide is formed.

Determine the mass of calcium carbonate needed to form 216 cm<sup>3</sup> of carbon dioxide.

mass of calcium carbonate = ..... g [1]

- (d) What effect do the following have on the rate of this reaction?

- (i) Increasing the temperature of the reaction mixture.  
All other conditions are kept the same.

..... [1]

- (ii) Using larger pieces of calcium carbonate.  
All other conditions are kept the same.

..... [1]

[Total: 6]

- 2 Oxides of nitrogen are formed when ammonia is heated with oxygen in the presence of a catalyst.

- (a) Suggest why a catalyst is used.

..... [1]

- (b) State **one** other process which puts oxides of nitrogen into the atmosphere.

..... [1]

- (c) State **one** adverse effect of oxides of nitrogen on health.

..... [1]

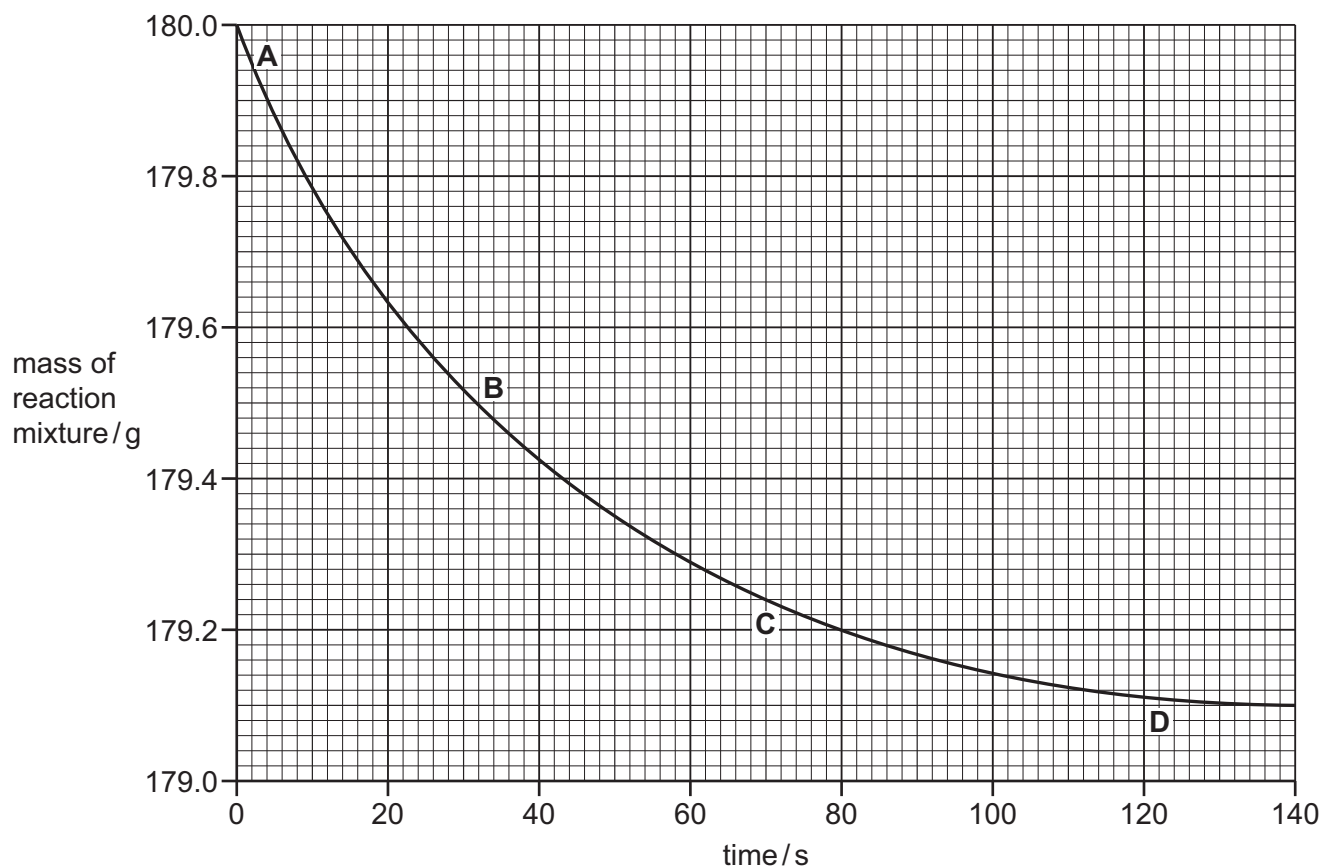
[Total: 3]

- 3 A student investigated the reaction of magnesium carbonate with an excess of dilute hydrochloric acid.



The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

The results are shown on the graph.



- (a) Determine the mass of the reaction mixture after 58 seconds.

..... [1]

- (b) At which point on the graph, **A**, **B**, **C**, or **D**, was the rate of reaction the fastest?  
Use the graph to explain your answer.

..... [2]

- (c) When 0.42 g of magnesium carbonate is used, 120 cm<sup>3</sup> of carbon dioxide is formed.

Determine the volume of carbon dioxide produced when 1.26 g of magnesium carbonate reacts completely.

volume of carbon dioxide = ..... cm<sup>3</sup> [1]

- (d) What effect do the following have on the rate of this reaction?

- (i) • Decreasing the concentration of the acid.  
All other conditions are kept the same.

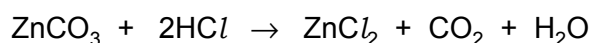
..... [1]

- (ii) • Using smaller pieces of magnesium carbonate.  
All other conditions are kept the same.

..... [1]

[Total: 6]

- 4 A student investigated the reaction between zinc carbonate and an excess of dilute hydrochloric acid.



The rate of reaction can be found by measuring the decrease in the mass of the reaction mixture over time.

- (a) Describe **one** other practical method for measuring the rate of this reaction.

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

- (b) When 6.25 g of zinc carbonate is used, 2.20 g of carbon dioxide is formed.

Calculate the mass of zinc carbonate that forms 11.00 g of carbon dioxide.

mass of zinc carbonate = ..... g [1]

- (c) What effect do the following have on the rate of this reaction?

- (i) Decreasing the temperature of the reaction mixture.  
All other conditions are kept the same.

..... [1]

- (ii) Increasing the concentration of hydrochloric acid.  
All other conditions are kept the same.

..... [1]

[Total: 6]

Limestone is added to the blast furnace. The limestone is converted into calcium oxide and carbon dioxide. The reaction is endothermic.



- (a) What type of chemical reaction is this?

..... [1]

- (b) What type of oxide is calcium oxide?  
Give a reason for your answer.

.....

..... [2]

[Total: 3]

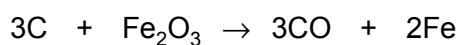
- 6 The compound  $\text{XeO}_3\text{F}_2$  readily undergoes reduction.

What is meant by the term *reduction*?

..... [1]

[Total: 1]

- 7 In the hotter parts of a blast furnace, carbon reacts with iron(III) oxide present in the iron ore.



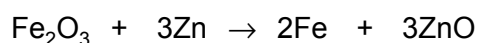
How does this equation show that carbon is oxidised?

.....

..... [1]

[Total: 1]

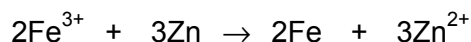
- 8 Iron can be obtained by heating iron(III) oxide with zinc powder.



(a) What can be deduced about the reactivity of zinc from this reaction?

..... [1]

(b) The ionic equation for this reaction is shown.



Identify the oxidising agent in this reaction.

Explain your answer in terms of electron transfer.

oxidising agent .....

explanation .....

..... [2]

[Total: 3]

9 Ethanol can be oxidised by hydrogen peroxide to form ethanal,  $\text{CH}_3\text{CHO}$ . A catalyst for this reaction is  $\text{Fe}^{3+}$ .

What is meant by the term *catalyst*?

.....

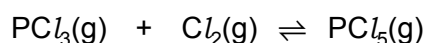
.....

..... [2]

[Total: 2]

10 Gaseous phosphorus(III) chloride,  $\text{PCl}_3$ , reacts with gaseous chlorine to form gaseous phosphorus(V) chloride,  $\text{PCl}_5$ .

Under certain conditions the reaction reaches equilibrium.



State and explain the effect, if any, on the **position of equilibrium** if the pressure is increased. All other conditions are unchanged.

.....

.....

..... [2]

[Total: 2]

11 When aqueous ammonia is added to aqueous iron(II) sulfate a green precipitate is seen. This green precipitate turns red-brown at the surface.

(a) Name the green precipitate.

..... [1]

(b) Suggest why the green precipitate turns red-brown at the surface.

.....  
 ..... [2]

(c) State what happens when an excess of aqueous ammonia is added to the green precipitate.

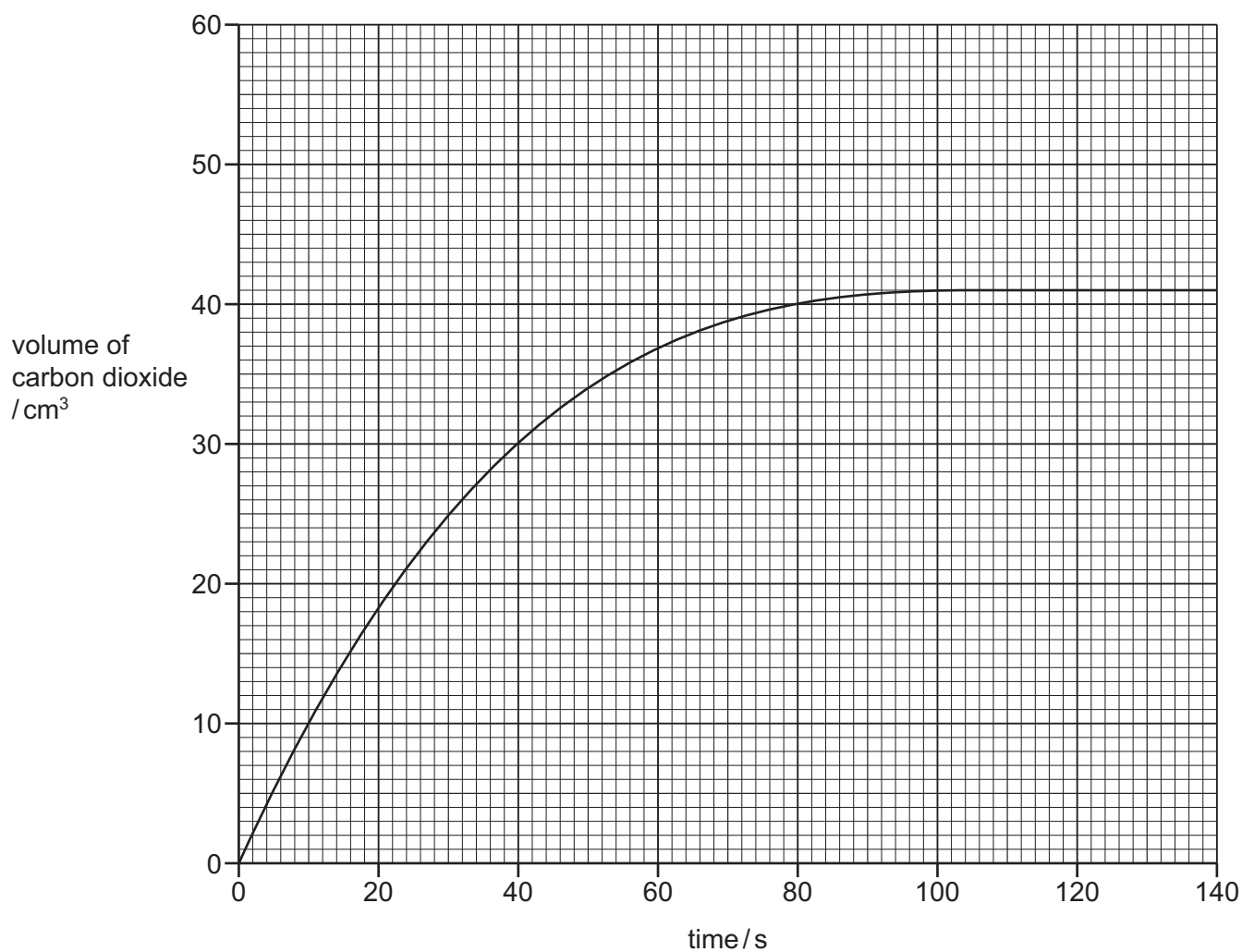
..... [1]

[Total: 4]

- 12** A student investigates the rate of reaction of large pieces of magnesium carbonate with an excess of dilute nitric acid.



The graph shows how the volume of carbon dioxide changes with time.



- (a) After how many seconds did the reaction finish?

..... s [1]

- (b) From the graph, deduce the volume of carbon dioxide produced during the first 50 seconds of the experiment.

..... cm<sup>3</sup> [1]

- (c) The experiment is repeated using smaller pieces of the same mass of magnesium carbonate. All other conditions are kept the same.

Draw a line **on the grid** for the experiment using smaller pieces of magnesium carbonate. [2]

- (d) How does increasing the temperature affect the rate of this reaction? All other conditions are kept the same.

..... [1]

- (e) How does decreasing the concentration of nitric acid affect the rate of this reaction? All other conditions are kept the same.

..... [1]

[Total: 6]

**13** Living organisms respire. Water is produced during respiration.

- (a) Name the other product of respiration.

..... [1]

- (b) Describe a chemical test for water.

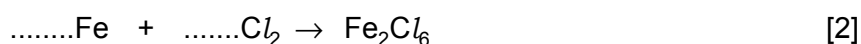
test .....

observations..... [2]

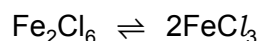
[Total: 3]

**14** Iron reacts with chlorine to form iron(III) chloride, Fe<sub>2</sub>Cl<sub>6</sub>.

- (a) Balance the chemical equation for this reaction.



- (b) At 400 °C Fe<sub>2</sub>Cl<sub>6</sub> molecules decompose.



What is meant by the symbol  $\rightleftharpoons$  ?

..... [1]



[Total: 3]

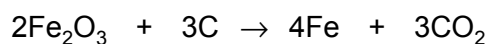
**15** Iron can be extracted from iron ore by reduction with carbon in a blast furnace.

- (a) Which **one** of these substances is an ore of iron?  
Draw a circle around the correct answer.

**bauxite      graphite      hematite      limestone**

[1]

- (b) The equation shows one of the reactions occurring in the blast furnace.



How does this equation show that  $\text{Fe}_2\text{O}_3$  is reduced?

.....

.....

[1]

[Total: 2]

**16** The equation shows the effect of heat on anhydrous zinc sulfate.



- (a) What type of chemical reaction is this?  
Tick **one** box.

addition ☐

decomposition ☐

displacement ☐

oxidation ☐

[1]

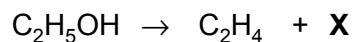
- (b) When 12.60 g of anhydrous zinc sulfate is heated, the mass of zinc oxide formed is 6.34 g.

Calculate the mass of zinc oxide formed when 63.0 g of anhydrous zinc sulfate is heated.

mass of zinc oxide = ..... g [1]

[Total: 2]

- 17 Ethanol can be converted into ethene by passing ethanol vapour over a catalyst of aluminium oxide.



- (a) Identify compound X.

..... [1]

- (b) Explain why a catalyst is used.

..... [1]

- (c) Draw the structure of a molecule of ethanol. Show all of the atoms and all of the bonds.

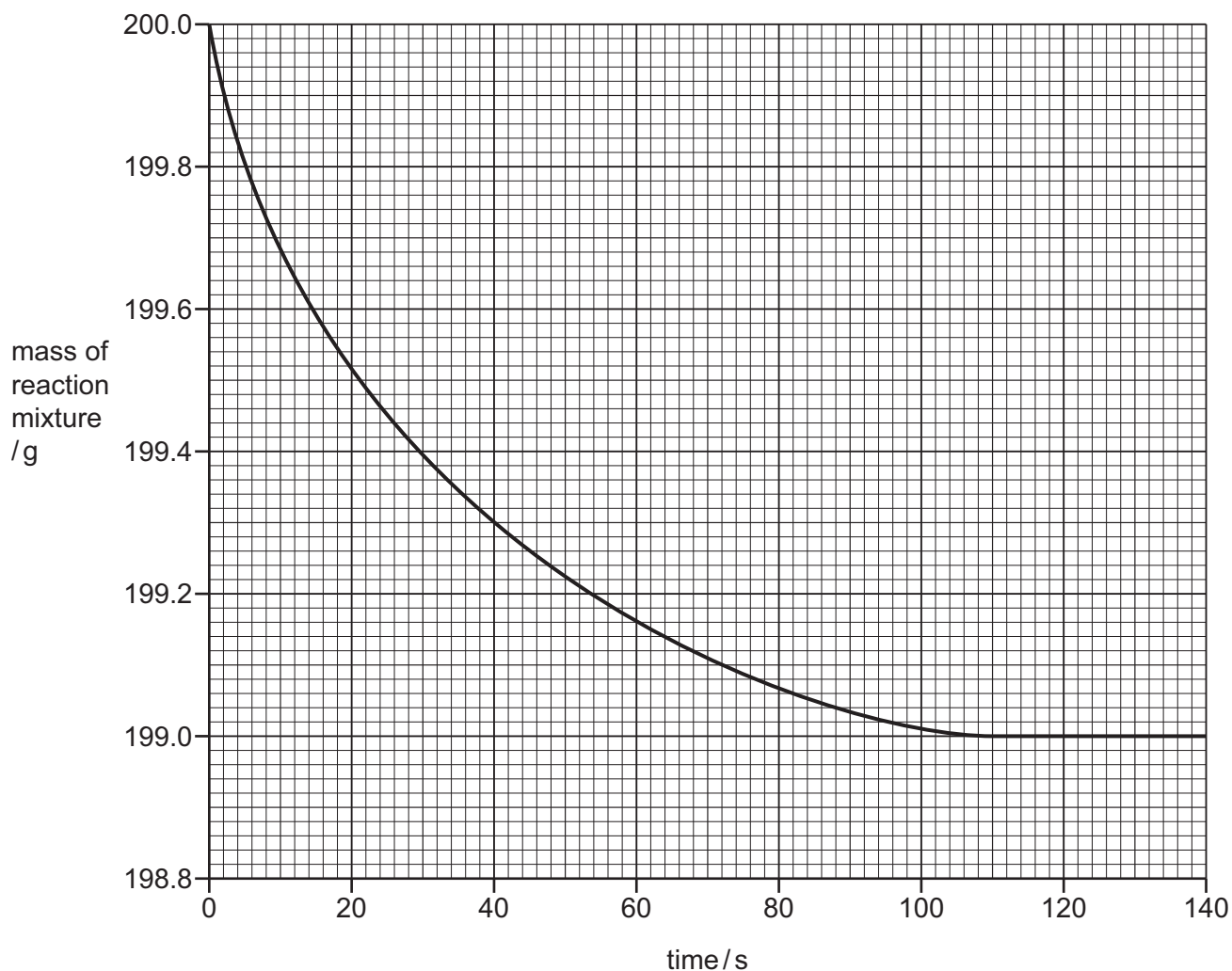
[1]

[Total: 3]

- 18 A student investigates the rate of reaction of small pieces of calcium carbonate with an excess of hydrochloric acid of concentration  $1 \text{ mol/dm}^3$ .



The graph shows how the mass of the reaction mixture changes with time.



(a) State why the reaction mixture decreases in mass.

..... [1]

(b) Calculate the loss in mass during the first 40 seconds of the experiment.

..... g [1]

(c) The experiment is repeated using hydrochloric acid of concentration  $2 \text{ mol/dm}^3$ . All other conditions are kept the same.

Draw a line **on the grid** for the experiment using hydrochloric acid of concentration  $2 \text{ mol/dm}^3$ .

[2]

- (d) In the experiment, when 2.00 g of calcium carbonate is used, the loss in mass of the reaction mixture is 0.88 g.  
All other conditions are kept the same.

Calculate the loss in mass when 0.50 g of calcium carbonate is used.

loss in mass = ..... g [1]

- (e) The experiment is repeated using the same mass of different sized pieces of calcium carbonate.  
All other conditions are kept the same.

The sizes of the pieces of calcium carbonate are:

- powder
- small pieces
- large pieces

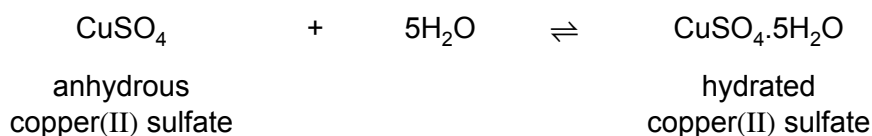
Complete the table by writing the sizes of the pieces of calcium carbonate in the first column.

size of pieces of calcium carbonate	initial rate of loss in mass in g/s
	0.005
	0.030
	0.100

[1]

[Total: 6]

- 19 Anhydrous copper(II) sulfate is used to test for water.



- (a) What is meant by the symbol  $\rightleftharpoons$ ?

..... [1]

- (b) How can hydrated copper(II) sulfate be changed into anhydrous copper(II) sulfate?

..... [1]

[Total: 2]

- 20 Sulfur dioxide is a pollutant in the air.

- (a) State **one** source of sulfur dioxide in the air.

..... [1]

- (b) Sulfur dioxide is oxidised to sulfur trioxide in the air.  
Oxides of nitrogen act as catalysts for this reaction.

What is meant by the term *catalyst*?

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

- (c) Sulfur trioxide dissolves in rainwater to form acid rain.

Which **one** of the following pH values could be the pH of acid rain?  
Draw a circle around the correct answer.

pH 4      pH 7      pH 9      pH 13 [1]

- (d) State **one** adverse effect of acid rain on buildings.

..... [1]

[Total: 4]

- 21** A student does experiments to show that hydrochloric acid is a strong acid and ethanoic acid is a weak acid. The student adds an excess of hydrochloric acid and an excess of ethanoic acid to separate samples of lumps of calcium carbonate.

Only the identity of the acid is changed between the experiments. All other conditions are kept the same.

- (a) State **two** observations which would show that hydrochloric acid is a stronger acid than ethanoic acid.

1 .....  
2 ..... [2]

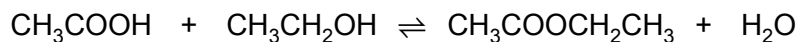
- (b) The student uses the same size container and checks that the pressure is the same for each experiment.

State **three** other conditions which must be kept the same to ensure fair testing.

1 .....  
2 .....  
3 ..... [3]

[Total: 5]

- 22** The reaction between ethanoic acid and ethanol reaches equilibrium.



- (a)** The reaction between ethanoic acid and ethanol is exothermic.

State and explain the effect, if any, of increasing the temperature on the amount of ester at equilibrium.

.....

.....

..... [2]

- (b)** State and explain the effect, if any, of removing water from the mixture on the amount of ester at equilibrium.

.....

.....

..... [2]

[Total: 4]

- 23** Concentrated sulfuric acid is a catalyst for the reaction between ethanoic acid and ethanol.

What is meant by the term *catalyst* ?

.....

..... [2]

[Total: 2]

- 24** The rate of a reaction can be increased by increasing the temperature.

Explain why increasing the temperature increases the rate of reaction.

.....

.....

.....

.....

.....

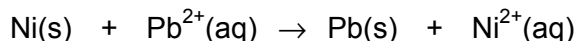
..... [4]

[Total: 4]

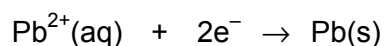
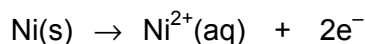
**25** Displacement reactions occur between metals and metal ions.

Displacement reactions can be used to determine the order of reactivity of metals such as lead (Pb), nickel (Ni), and silver (Ag).

The ionic equation for a displacement reaction is shown.



The ionic half-equations for this reaction are shown.



The ionic half-equations show that electrons are donated by nickel atoms and accepted by lead ions.

**(a)**

- (i)** Identify the reducing agent in the displacement reaction. Give a reason for your answer.

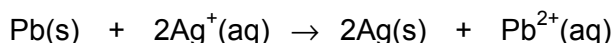
reducing agent .....

reason ..... [2]

- (ii)** What is the general term given to the type of reaction in which electrons are transferred from one species to another?

..... [1]

**(b)** The ionic equation for another displacement reaction is shown.



Write the **two** ionic half-equations for this reaction.

1 .....

2 ..... [2]

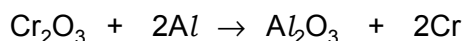
- (c)** Use the information in **(a)** and **(b)** to put the three metals lead, nickel and silver in order of reactivity.

	most reactive  ↑  least reactive

[1]

[Total: 6]

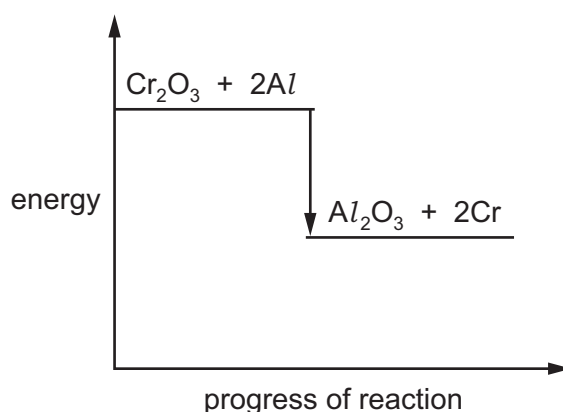
- 26** Chromium can be manufactured by the reduction of chromium(III) oxide,  $\text{Cr}_2\text{O}_3$ , with aluminium.



- (a) How does this equation show that chromium(III) oxide is reduced?

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

- (b) The energy level diagram for this reaction is shown.



Explain how this diagram shows that the reaction is exothermic.

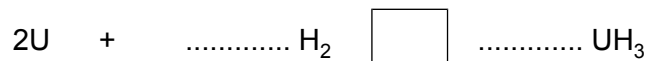
.....  
 ..... [1]

[Total: 2]

- 27** Uranium reacts with hydrogen to form uranium hydride,  $\text{UH}_3$ .  
 The reaction is reversible.

Complete the chemical equation for this reaction by:

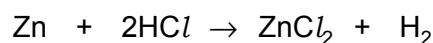
- balancing the equation
- drawing the symbol for a reversible reaction in the box.



[3]

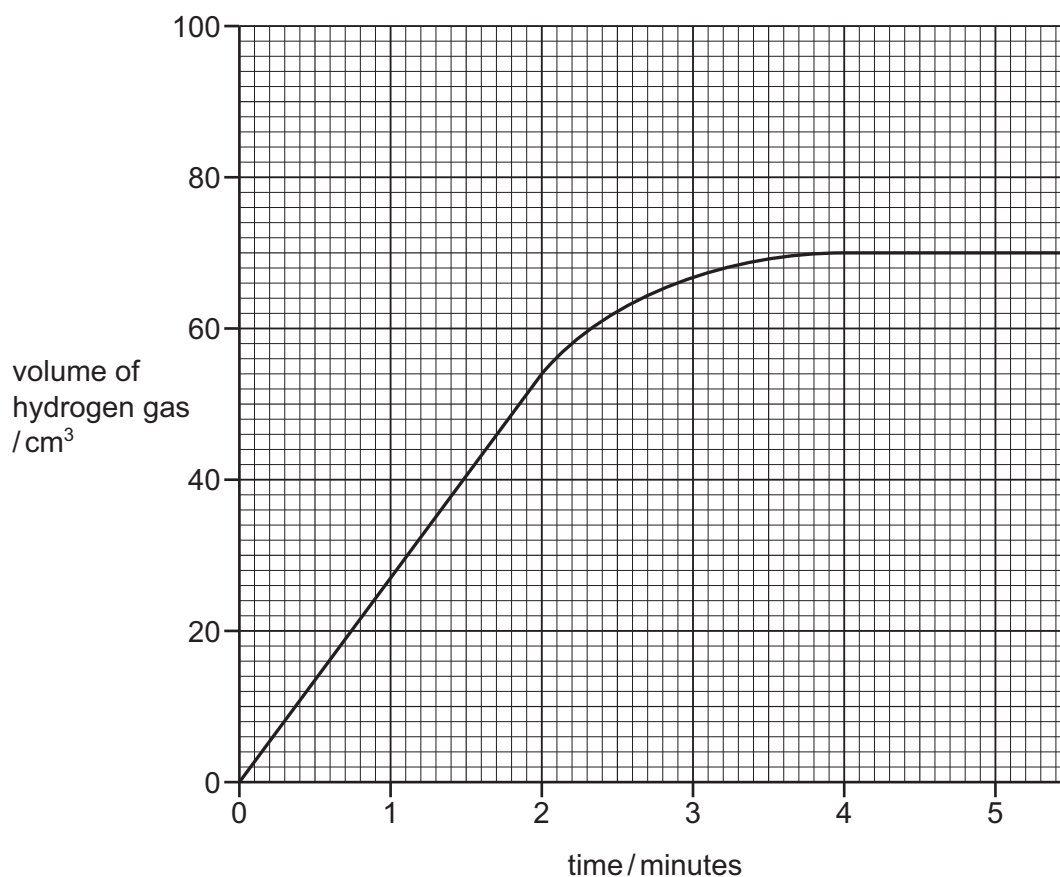
[Total: 3]

- 28** A student investigated the reaction between zinc and dilute hydrochloric acid by measuring the volume of hydrogen gas produced at one minute intervals.





The graph shows the results using small pieces of zinc and dilute hydrochloric acid.



- (a) Deduce the volume of hydrogen gas produced in the first two minutes of the reaction.

..... cm<sup>3</sup> [1]

- (b) Draw a letter **S** on the graph to show where the reaction is slowing down but has **not** stopped completely. [1]

- (c) Draw a line **on the grid** to show how the volume of hydrogen gas changes with time when the reaction is repeated with a catalyst. All other conditions are kept the same. [1]

- (d) State the effect on the rate of this reaction of decreasing the temperature at which the reaction is done. All other conditions are kept the same. [1]

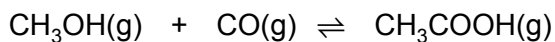
..... [1]

- (e) State the effect on the rate of this reaction of using zinc powder instead of small pieces of zinc. All other conditions are kept the same. [1]

..... [1]

[Total: 5]

- 29 Ethanoic acid is manufactured from methanol and carbon monoxide.



The process is done at 200 °C and 30 atmospheres pressure.

The forward reaction is exothermic.

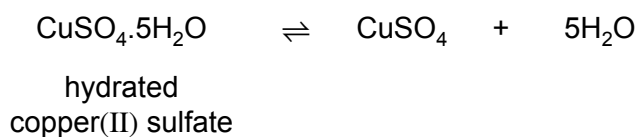
Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield of CH <sub>3</sub> COOH(g)
adding a catalyst		no change
increasing the temperature		
decreasing the pressure	decreases	

[4]

[Total: 4]

- 30 A sample of solid hydrated copper(II) sulfate is heated gently in a test-tube.



Solid hydrated copper(II) sulfate is blue.

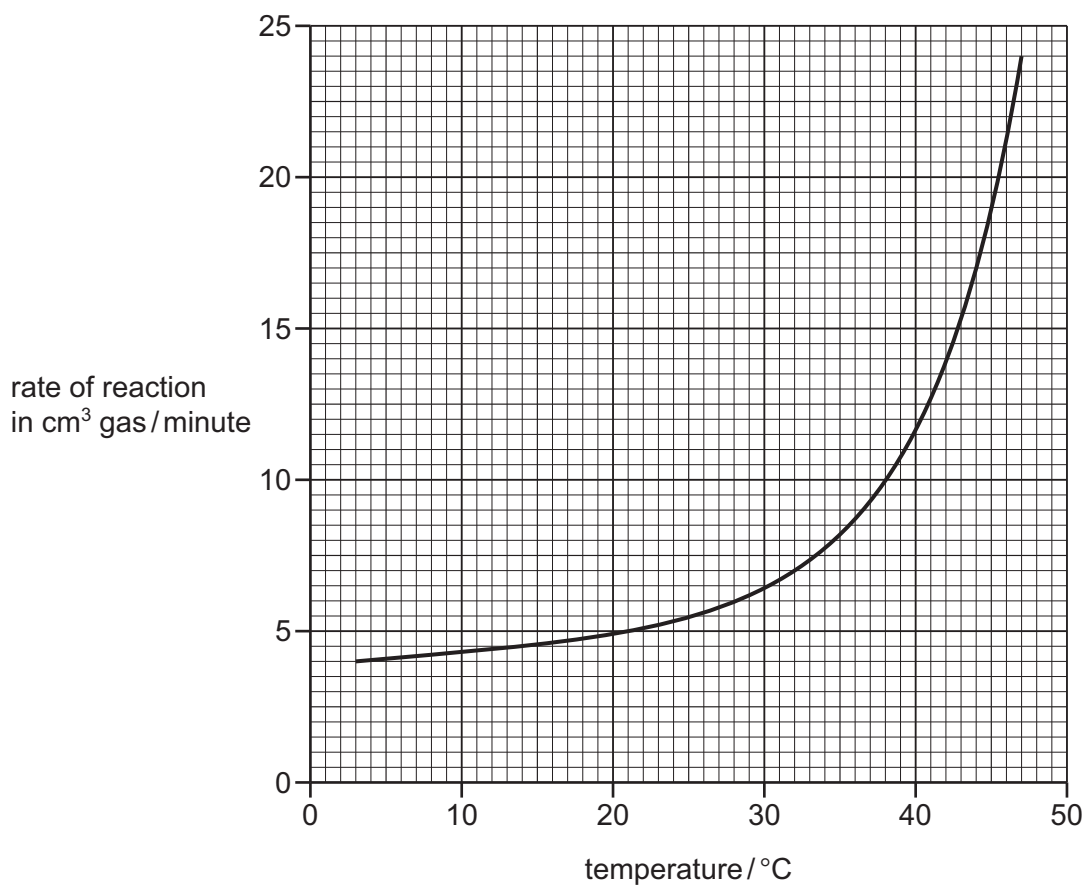
Describe **two** observations when the sample of solid hydrated copper(II) sulfate is heated gently in a test-tube.

1 .....

2 ..... [2]

[Total: 2]

- 31 The graph shows the effect of temperature on the rate of reaction of dilute hydrochloric acid with zinc powder.



The experiments were repeated using small lumps of zinc instead of zinc powder.  
All other conditions were kept the same.

**On the grid**, draw a graph to show how the rate of reaction changes with temperature when small lumps of zinc are used instead of zinc powder. [2]

[Total: 2]

- 32 Hydroiodic acid can be used for the reduction of some carboxylic acids.

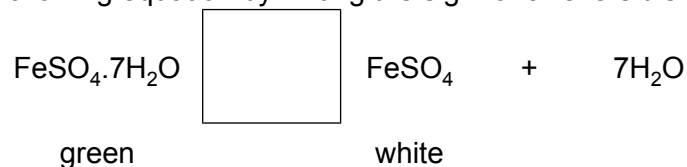
What is meant by the term *reduction*?

..... [1]

[Total: 1]

- 33 When green iron(II) sulfate is heated it loses its water of crystallisation.  
The reaction is reversible.

(a) Complete the following equation by writing the sign for a reversible reaction in the box.



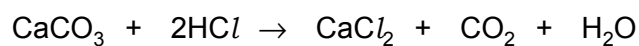
[1]

(b) Use the information in the equation to suggest how to change white iron(II) sulfate into green iron(II) sulfate.

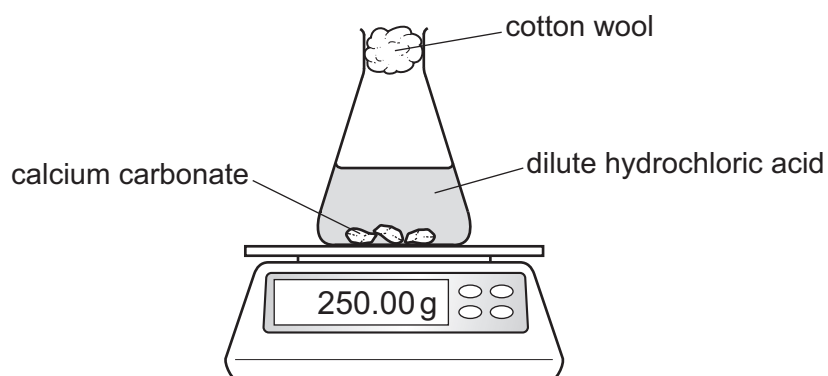
..... [1]

[Total: 2]

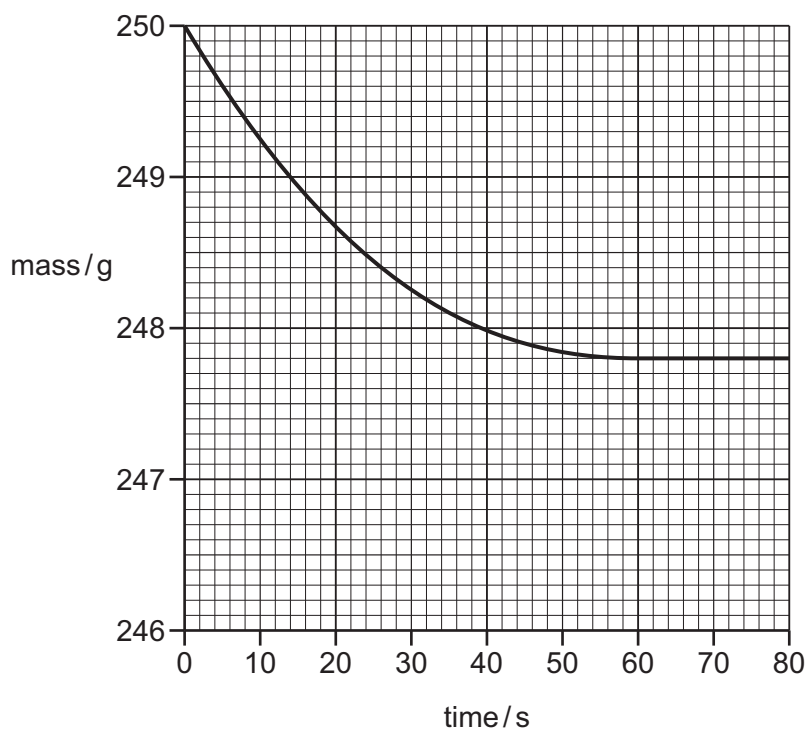
34 A student investigates the reaction of calcium carbonate with dilute hydrochloric acid.



The student measures the mass of the reaction mixture at 10 second intervals using the apparatus shown.



The graph shows the results when 5.0g of calcium carbonate is added to an **excess** of dilute hydrochloric acid.



- (a) Suggest why the reaction mixture decreases in mass as the reaction proceeds.

..... [1]

- (b) Calculate the loss of mass in grams when the reaction is complete.

loss in mass = ..... g [1]

- (c) The experiment is repeated using dilute hydrochloric acid of **twice** the concentration. All other conditions are kept the same.

**On the grid**, draw a graph to show how the mass changes with time using dilute hydrochloric acid of **twice** the concentration.

[2]

- (d) The original experiment is repeated at three different temperatures. All other conditions are kept the same. The three temperatures are 20 °C, 30 °C and 40 °C.

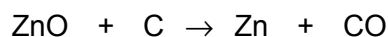
Complete the table by writing the temperatures in the first column.

temperature in °C	initial rate of reaction in g/s
	0.16
	0.64
	0.32

[1]

[Total: 5]

- 35 Zinc oxide is reduced by heating it with carbon.



How does this equation show that zinc oxide is reduced?

.....

.....

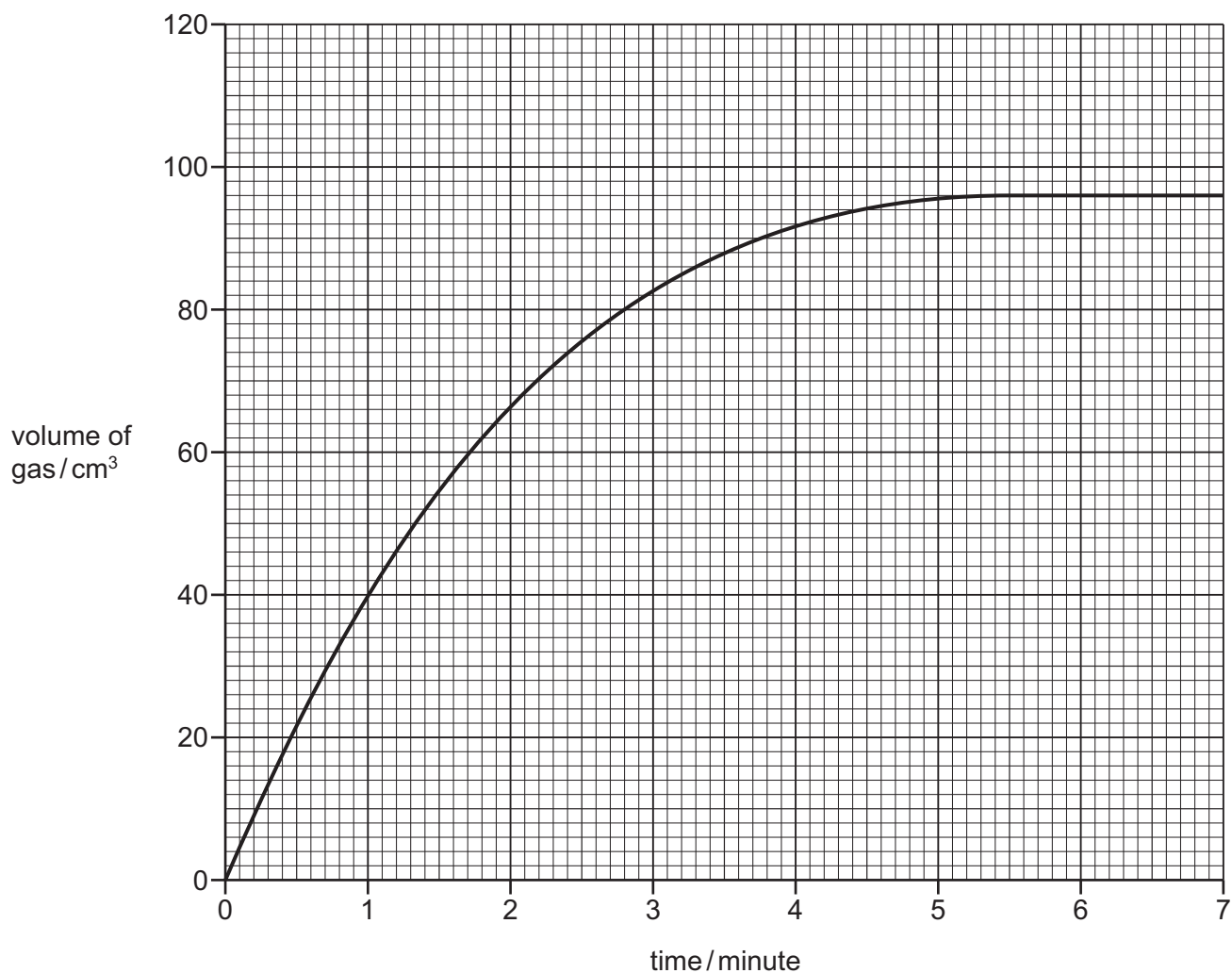
[1]

[Total: 1]

- 36 A student investigates the rate of reaction of iron powder with dilute hydrochloric acid.

The student collects and measures the gas produced during the reaction.

The graph shows the results the student obtained using dilute hydrochloric acid of concentration 0.2 mol/dm<sup>3</sup> and an **excess** of iron powder.



(a) Use the graph to deduce:

(i) the time that the reaction was complete

..... [1]

(ii) the volume of gas produced when the reaction was complete.

..... [1]

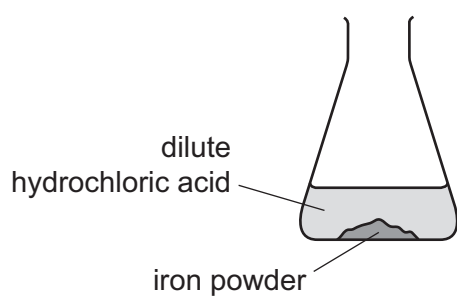
(b) The student repeated the experiment using a lower concentration of dilute hydrochloric acid. All other conditions were kept the same.

**On the grid**, draw a graph to show how the volume of gas changes with time when a lower concentration of dilute hydrochloric acid is used.

..... [2]

[Total: 4]

- 37 A student investigates the rate of reaction of iron powder with dilute hydrochloric acid.



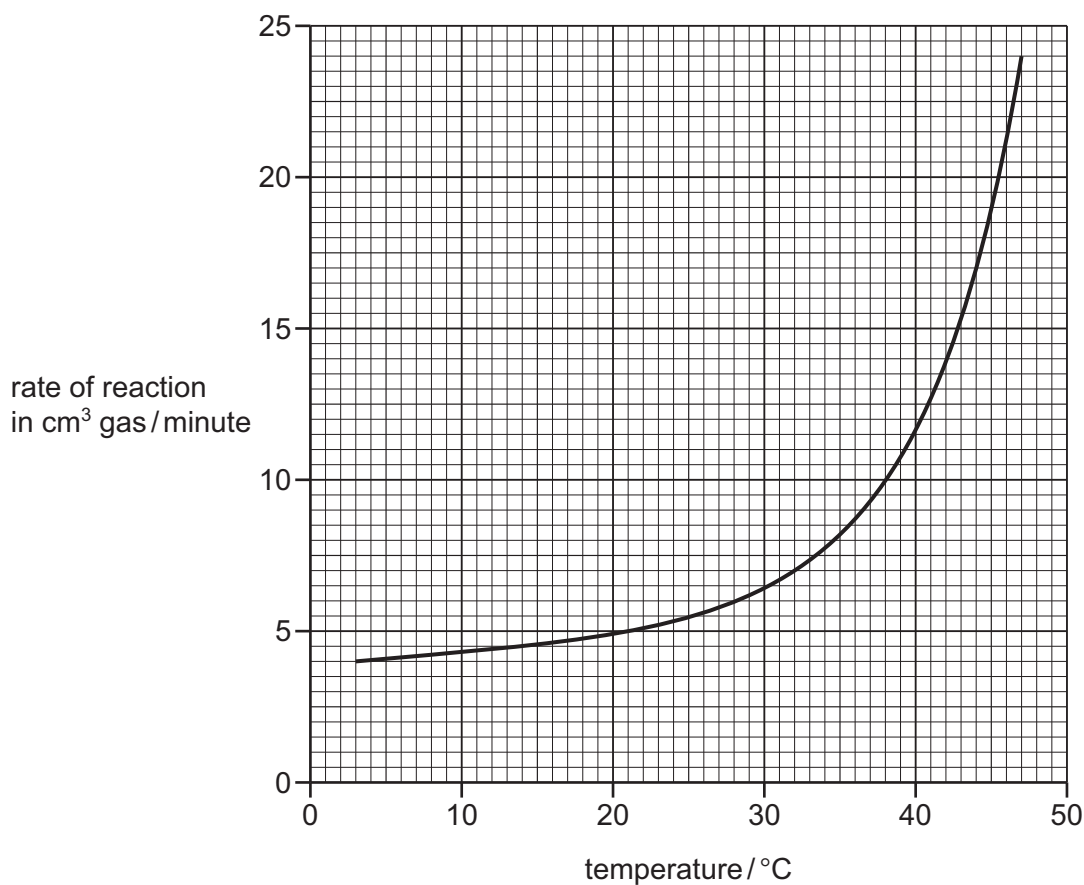
Complete the diagram to show the apparatus the student could use to collect and measure the gas produced.  
Label your diagram.

[3]

[Total: 3]



- 38 The graph shows the effect of temperature on the rate of reaction of dilute hydrochloric acid with zinc powder.

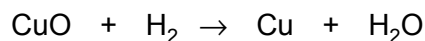


Determine the rate of reaction at 40 °C.

rate of reaction = .....cm<sup>3</sup> gas/minute [1]

[Total: 1]

- 39 Copper(II) oxide can be reduced by hydrogen.



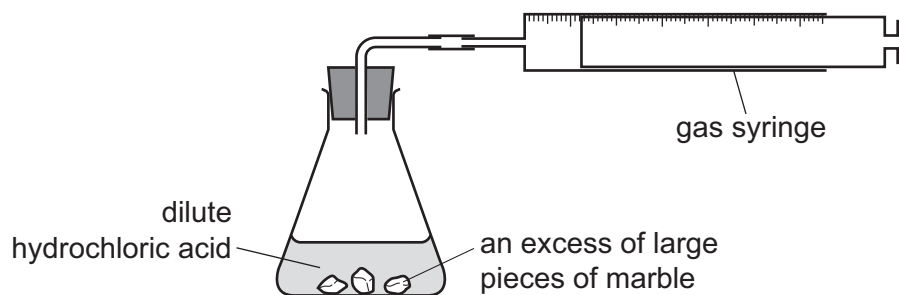
How does this equation show that copper(II) oxide is reduced?

.....

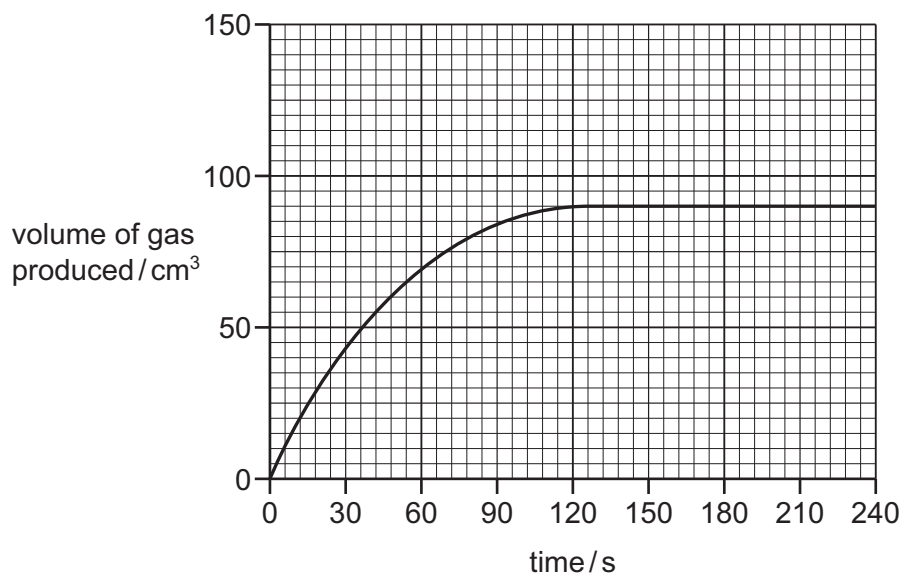
..... [1]

[Total: 1]

- 40 A student investigated the progress of the reaction between dilute hydrochloric acid, HCl, and an excess of large pieces of marble, CaCO<sub>3</sub>, using the apparatus shown.



A graph of the volume of gas produced against time is shown.



- (a) How does the shape of the graph show that the rate of reaction decreased as the reaction progressed?

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

- (b) Why did the rate of reaction decrease as the reaction progressed?

..... [1]

- (c) After how many seconds did the reaction finish?

..... s [1]

[Total: 3]