2 A student used the reaction of magnesium with hydrochloric acid to determine the volume of 1 mol of hydrogen gas at room temperature and pressure (r.t.p.).

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

Procedure

Step **1** Weigh 0.030 g of magnesium ribbon.

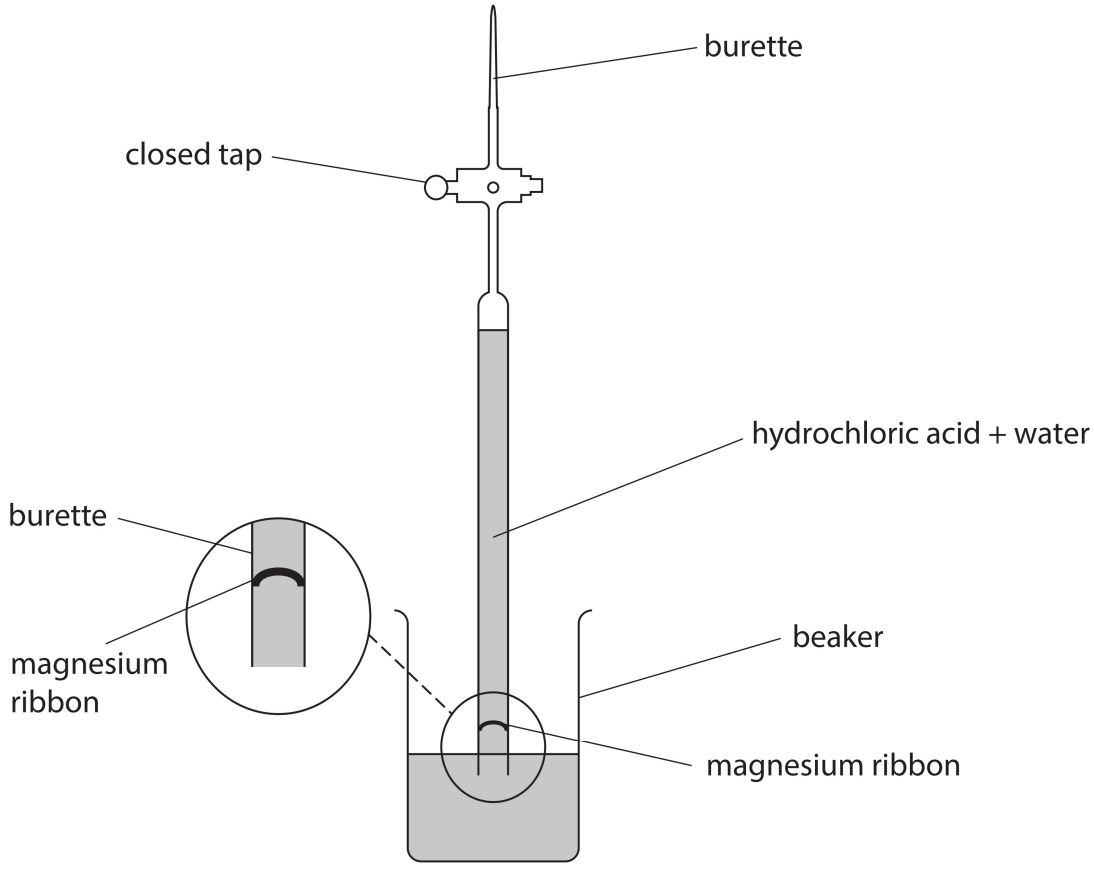
Step **2** Add approximately 25 cm^3 of 2.0 mol dm^{-3} hydrochloric acid into a burette and carefully add 25 cm^3 of water on top.

Step **3** Push the magnesium ribbon into the open end of the burette so that it stays in position.

Step **4** Quickly invert the burette. Clamp the burette vertically and take the burette reading.

Step **5** Wait for the magnesium to start reacting. Take the final burette reading after all the magnesium has reacted.

A diagram of the experiment is shown.



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(a) Explain why the volume of hydrochloric acid added to the burette in Step **2** does not need to be exact.

You must include a calculation.

(3)

(b) State why the magnesium does not start reacting as soon as the burette is inverted in Step **4**.

(1)

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(c) The diagram shows the burette readings from Steps **4** and **5**.

Burette reading from Step **4**	Burette reading from Step **5**
	

Record the burette readings, and hence the volume of hydrogen gas produced in the experiment.

(2)

Burette reading in Step **4** / cm^3	
Burette reading in Step **5** / cm^3	
Volume of hydrogen gas / cm^3	

(d) Calculate the volume of 1 mol of hydrogen gas at r.t.p., in cm^3, using your answer to (c), the reaction equation and the mass of magnesium (0.030 g) used in the procedure.

(2)

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

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(e) The magnesium ribbon used in Step **1** contained a magnesium oxide impurity of up to 2% by mass.

Explain whether this magnesium oxide impurity could account for any difference in your answer to (d) from the Data Book value of 24 000 cm^3.

No calculation is required.

(2)

(f) Two readings were taken to measure the mass of magnesium used in the experiment. The uncertainty in each reading was 0.0025 g.

(i) Calculate the percentage uncertainty in the mass of magnesium used in the experiment.

(1)

(ii) The student wanted to reduce the percentage uncertainty by using double the mass of magnesium.

Give the reason why the experiment outlined in the procedure could **not** be conducted successfully using double the mass of magnesium.

(1)

(Total for Question 2 = 12 marks)

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