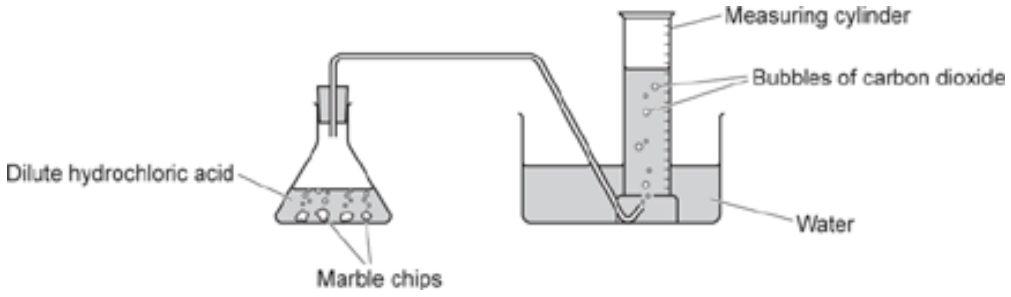
1(a). A student investigates the reaction between marble chips and dilute hydrochloric acid.

The diagram shows their experiment.



The student measures the volume of carbon dioxide gas collected in the measuring cylinder every 30 seconds.

Which other piece of equipment could the student use to measure the volume of carbon dioxide gas collected?

Tick (✓) **one** box.

Balance ☐

Beaker ☐

Gas syringe ☐

Pipette ☐

[1]

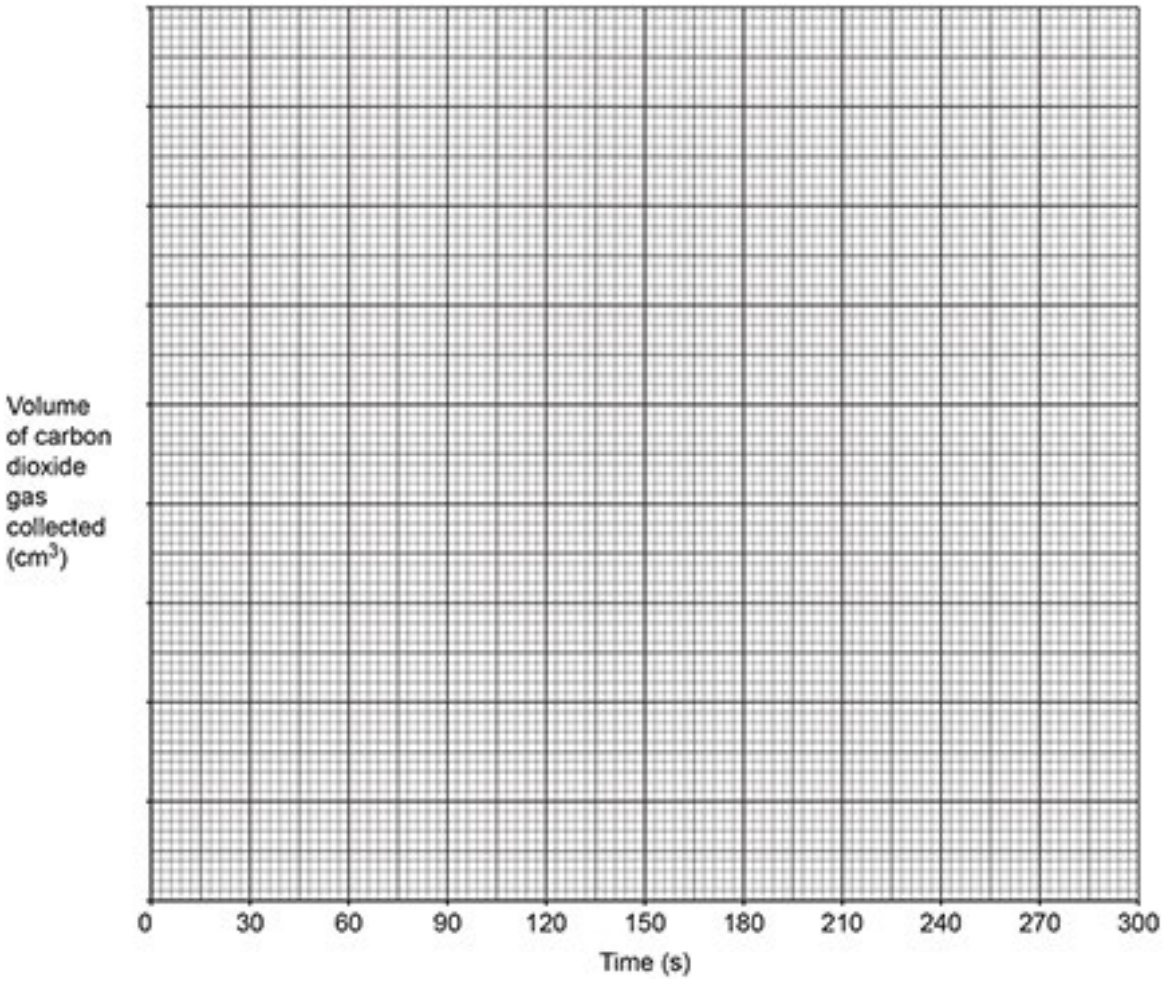
(b). The table shows the student's results.

Time (s)	Volume of carbon dioxide gas collected (cm^3)
0	0
30	30
60	46
90	56
120	65
150	72
180	76
210	79
240	80
270	80

i. Plot the results from the table on the graph.

[3]

ii. Draw a curve of best fit.



[1]

iii. State the time when the reaction stops.

Time = ... s **[1]**

iv. The student observes that there are still some marble chips in the conical flask when the reaction stops.

Explain why the reaction stops.

---

[1]

(c). A Student reacts dilute hydrochloric acid with magnesium.

The student does two experiments.

In each experiment they use the **same**

- concentration of dilute hydrochloric acid
- mass of magnesium.

The table shows their results.

	Experiment 1	**Experiment 2**
Magnesium	large pieces	small pieces
Temperature of dilute hydrochloric acid (°C)	20	42
Reaction time (s)	225	25

Describe and explain the difference in the rate of reaction between the two experiments. Use the student's results and the reacting particle model.

State how the student's experiment could be improved.

---

[6]

2. Two chemicals react together over time to make a cloudy precipitate.

What is the best method for determining the rate of reaction?

A Measure the loss in mass using a balance.
B Use a gas syringe.
C Use a pH meter.
D Use the disappearing cross experiment.

Your answer ☐ **[1]**

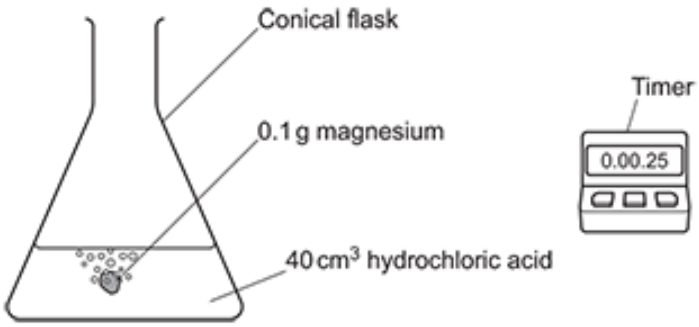
3. Which change would **decrease** the rate of a chemical reaction?

A Adding a catalyst
B Increasing the concentration of the solution
C Increasing the size of the solid pieces
D Increasing the temperature

Your answer ☐ **[1]**

4(a). A teacher investigates the reaction between hydrochloric acid and magnesium.

The diagram shows the teacher's experiment.



- The teacher uses five different concentrations of hydrochloric acid.
- Each time they react the hydrochloric acid with 0.1 g of magnesium ribbon.
- They repeat the experiment with 0.1 g of magnesium powder.

The table shows the teacher's results.

	Time for magnesium to react (s)	
Concentration of hydrochloric acid (mol / dm^3)	**Magnesium ribbon**	**Magnesium powder**
0.5	201	117
1.0	158	89
1.5	77	48
2.0	51	24
2.5	37	16

The teacher says that the reaction is faster with magnesium powder than with magnesium ribbon.

Use the results to explain why the teacher is **correct**.

[2]

(b).

i. Describe how the rate of reaction changes when the concentration of the hydrochloric acid **increases**.

[1]

ii. Explain your answer to **(i)** using ideas about particles.

[2]

(c). The teacher used 0.1 g of magnesium.

0.1 g of magnesium reacts with hydrochloric acid to make 0.008 g of hydrogen gas.

A student suggests that the rate of reaction could be investigated by measuring the loss in mass during the reaction.

Suggest why this method would **not** work well.

[1]

5. The table shows information about the physical properties of four elements, **W**, **X**, **Y** and **Z**.

	W	**X**	**Y**	**Z**
Density (g / cm^3)	0.97	7.87	0.003	1.74
Melting point (°C)	98	1538	–102	650
Conducts electricity?	✓	✓	✗	✓

One of the elements is a transition metal.

i. Compare the physical and chemical properties of Group 1 metals and transition metals.
Use the information in the table, and your own knowledge.

[3]

ii. Transition metals can be used as catalysts.

What is meant by a catalyst?

[2]

6. Why do marble chips react faster with **warm** hydrochloric acid than with cold hydrochloric acid?

A The warm hydrochloric acid acts as a catalyst.
B The warm hydrochloric acid has more crowded particles.
C The warm hydrochloric acid has particles with more energy.
D The warm hydrochloric acid has particles that move slower.

Your answer ☐ **[1]**

END OF QUESTION PAPER