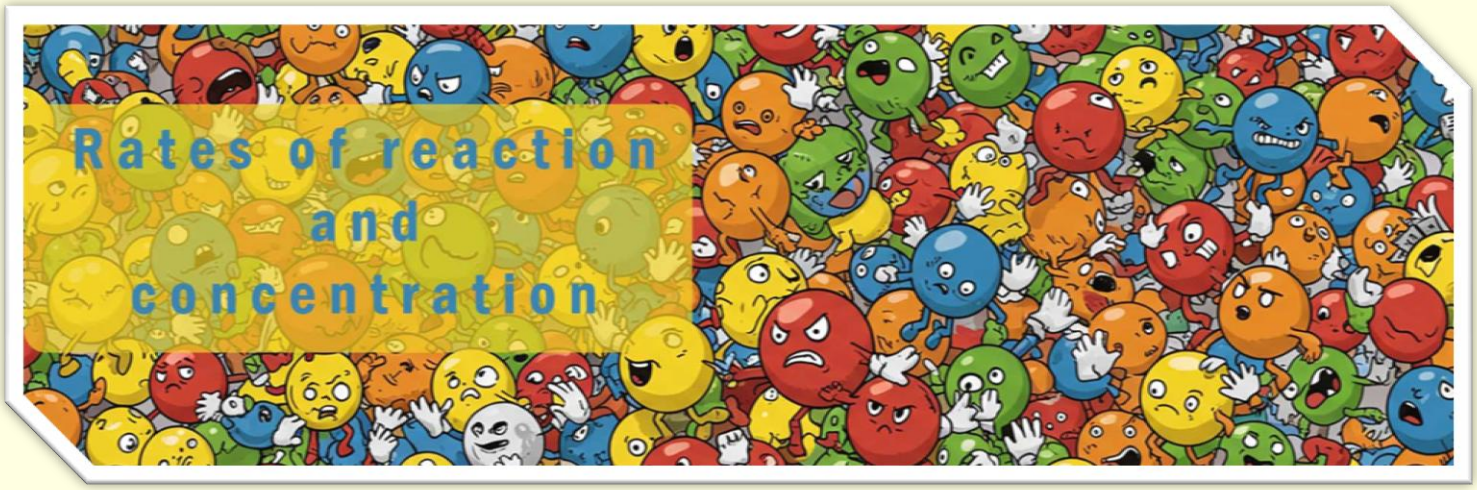

Answer all the questions then check your answers

1 A student was investigating how the concentration of hydrochloric acid affects the rate of reaction with 5 grams of calcium carbonate. Hydrochloric acid reacts with calcium carbonate according to the equations below:

Calcium carbonate (s)	+	Hydrochloric acid (aq)	→	calcium chloride (aq)	+	carbon dioxide(g)	+	water(l)
$CaCO_3(s)$	+	$2HCl(aq)$	→	$CaCl_2(aq)$	+	$CO_2(g)$	+	H_2O (l)

He decided to investigate the rate by measuring how quickly the carbon dioxide gas was released.

a Draw a diagram of the apparatus he could have used to measure the volume of gas released.

b He did two experiments, one using 1 molar hydrochloric acid and another experiment using 2 molar hydrochloric acid. His results are shown in the table below.

Time/s	Volume of hydrogen released in ml using 1M acid	Volume of hydrogen released in ml using 2M acid
60	15	30
120	22	40
180	30	45
240	35	48
300	40	50
360	44	50
420	45	50
480	47	50
540	48	50
600	50	50
660	50	50

i Plot these ***two*** sets of results on ***one*** graph. Plot a line graph of volume (vertical axis) against time (horizontal axis)

ii What do the gradients of the two curves tell you?

iii Using the equation:

$$\text{rate of reaction} = \frac{\text{change in amount of carbon dioxide}}{\text{Time in seconds}}$$

Calculate the rate of reaction for the first 5 minutes of the reaction.

iv What is happening to the rate of reaction as the time gets higher? Explain your answer in terms of collisions.

v For each reaction give a time when each stops. Give reasons for your answer.

c Explain why both reaction produced the same amount of hydrogen.

2 Draw the line on your graph to represent the line obtained when 3M acid is used.

Answers

1 A student was investigating how the concentration of hydrochloric acid affects the rate of reaction with 5 grams of calcium carbonate. Hydrochloric acid reacts with calcium carbonate according to the equations below:

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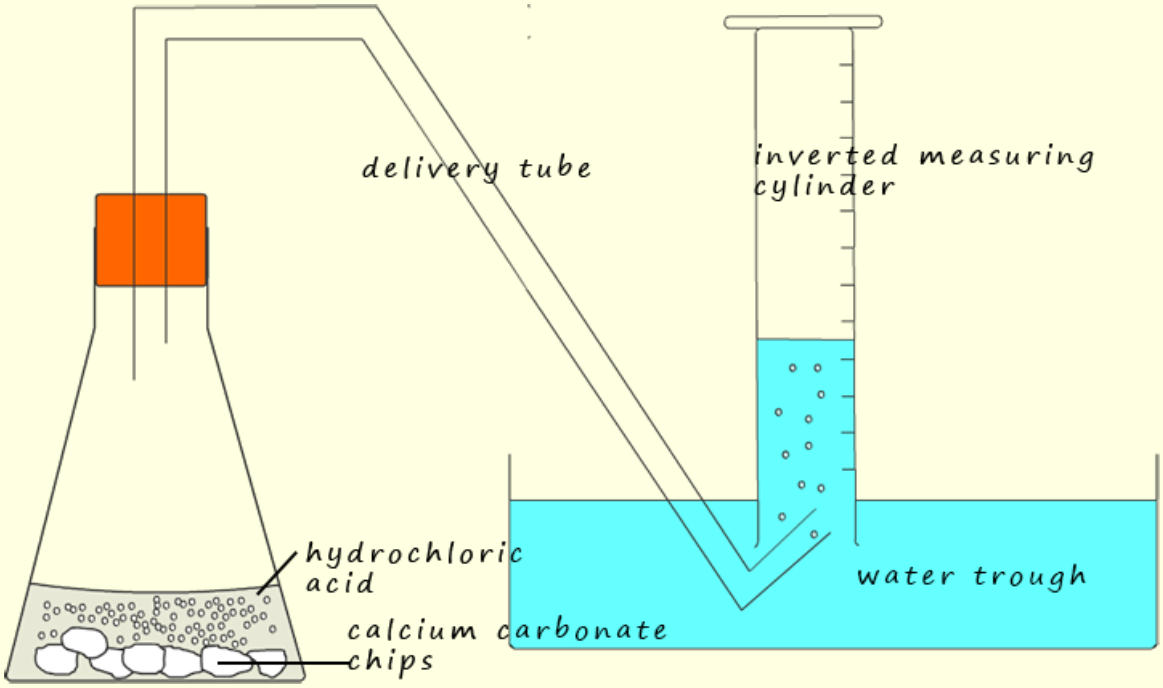
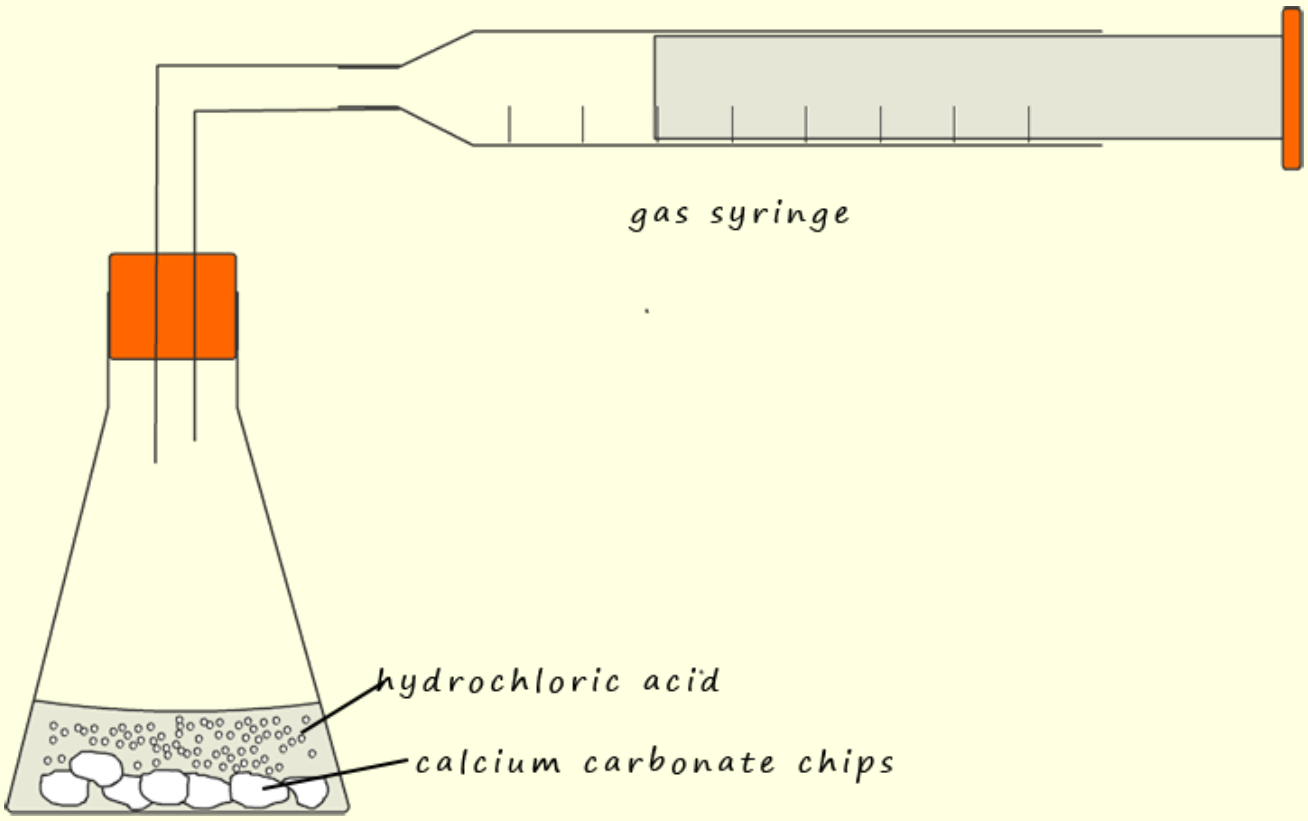
He decided to investigate the rate by measuring how quickly the carbon dioxide gas was released.

a Draw a diagram of the apparatus he could have used to measure the volume of gas released.

Use any of the two methods below using either the inverted measuring cylinder or gas syringe to measure the volume of gas released. The stop clock needed is not shown in the diagrams.





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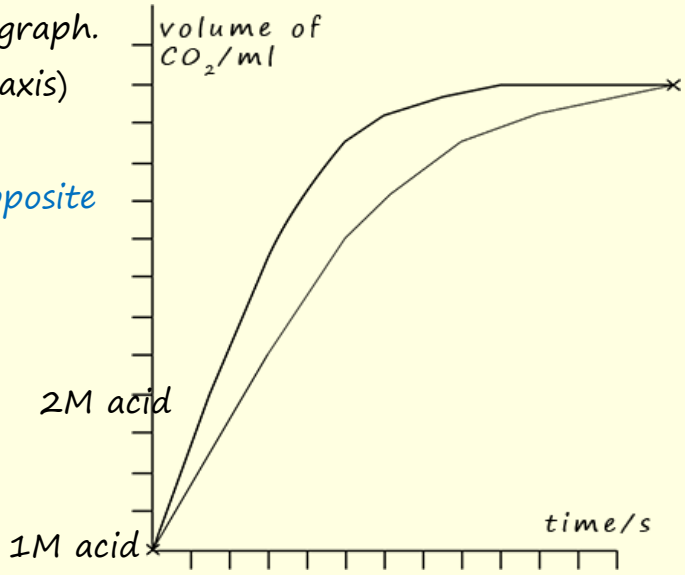
i Plot these ***two*** sets of results on ***one*** graph.
Plot a line graph of volume (vertical axis) against time (horizontal axis)

graphs should be similar shape to one opposite



ii What do the gradients of the two curves tell you?

The gradient will tell you rate of reaction, how quickly the gas is released.

iii Using the equation:

$$\text{rate of reaction} = \frac{\text{change in amount of carbon dioxide}}{\text{Time in seconds}}$$

Calculate the rate of reaction for the first 5 minutes of the reaction.

iv What is happening to the rate of reaction as the time gets higher? Explain your answer in terms of collisions.

For 1M acid.

First 60 seconds 15ml of gas released. So rate = 15/60= 025 ml/s

Next 60 seconds 7ml of gas released so rate = 7/60=0.1 ml/s

Next 60 seconds 8ml of gas released so rate = 8/60= 0.1 ml/s

Next 60 seconds 5ml of gas released so rate = 5/60=0.08 ml/s

Next 60 seconds 5ml of gas released so rate = 4/60=0.06 ml/s

v For each reaction give a time when each stops. Give reasons for your answer.

The reaction stops when the graph stops rising -at the flat portion of the graph. This tells us that no more gas is being given off. Read from your graph for value.

c Explain why both reaction produced the same amount of hydrogen.

Same mass of calcium carbonate used, acid is in excess to ensure all the calcium carbonate reacts.

2 Draw the line on your graph to represent the line obtained when 3M acid is used.

Line would be above the 2M line, should be steeper as reaction will be faster.