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EB Education Revision Guide

How to work with Rates of Reaction: Part 2

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Rates of Reaction

In a chemical reaction, the substances that react together are known as the **reactants**, while the substances that are formed are known as the **products**.

Reactants are found on the left of a chemical equation and products on the right

Reactants $\longrightarrow$ Products

The rate of reaction is how quickly the reaction takes place. It is a measure of how quickly a reactant is used up, or a product is formed.

$$\text{Rate of reaction} = \frac{\text{amount of reactant used or amount of product formed}}{\text{time}}$$

How to measure rates of reaction.

Precipitation

The rate of a chemical reaction can be measured in different ways.

- Precipitation is when two solutions are mixed together, and an insoluble solid is produced. This is a precipitate.
- The two clear reactants are mixed together, and as the solid is produced the mixture will go cloudy.
- You can measure how long this takes.

Practical 1:

Measure changes in colour. This can be done by reacting different concentrations of sodium thiosulphate with hydrochloric acid placed on a cross. The solution will change from clear to cloudy as solid sulphur is produced, and the time taken for the cross to disappear can be measured.

How to measure rates of reaction

Volume of gas produced

- A gas syringe can be used to measure the volume of gas which is produced during a chemical reaction.
- Once the reaction has completed, no more gas will be produced.
- The greater the volume of gas produced, in a given time, the faster the rate of reaction.

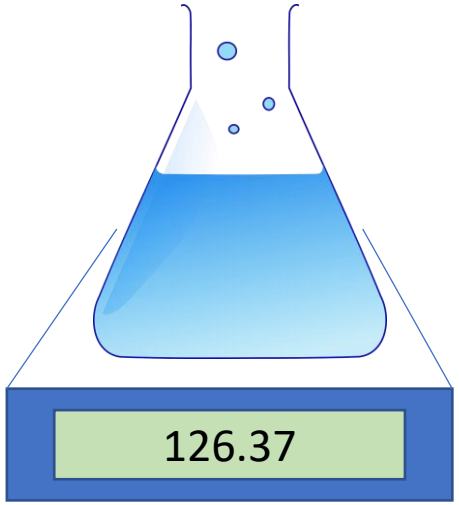
Practical 2:

Collect gas produced in a gas syringe. This method can be used in reactions which produce a gas.

How to measure rates of reaction

Change in mass

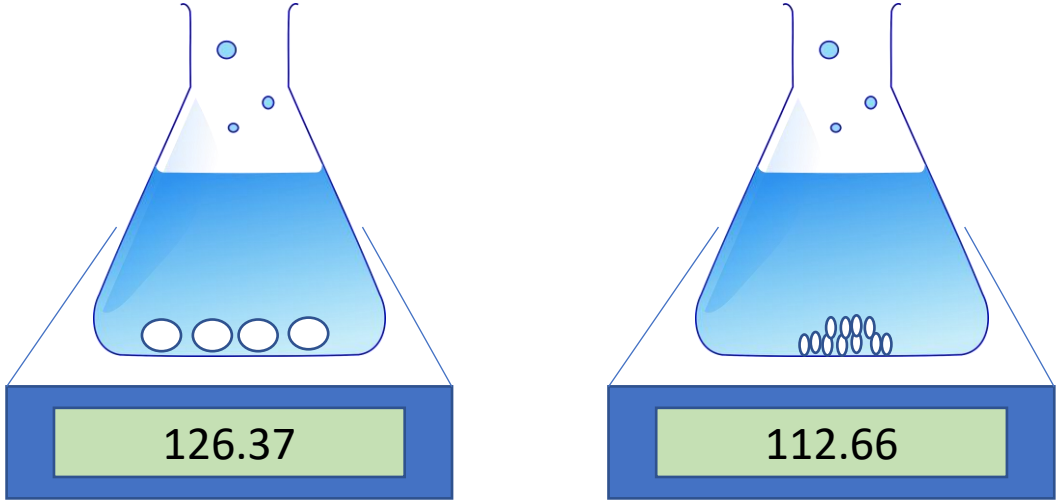
- If a gas is produced during a chemical reaction, the rate of reaction can be measured by using a top pan balance.
- The experiment is completed on the balance, and as gas is released, the mass will decrease – the faster the reading decreases, the faster the reaction.
- With this method you need to be careful that the gas being released is not harmful.



Practical 3:
If the reaction produces gas, a conical flask with the reactants added can be placed on a top pan balance, and the decrease in mass in a certain time recorded.

Investigating Surface Area

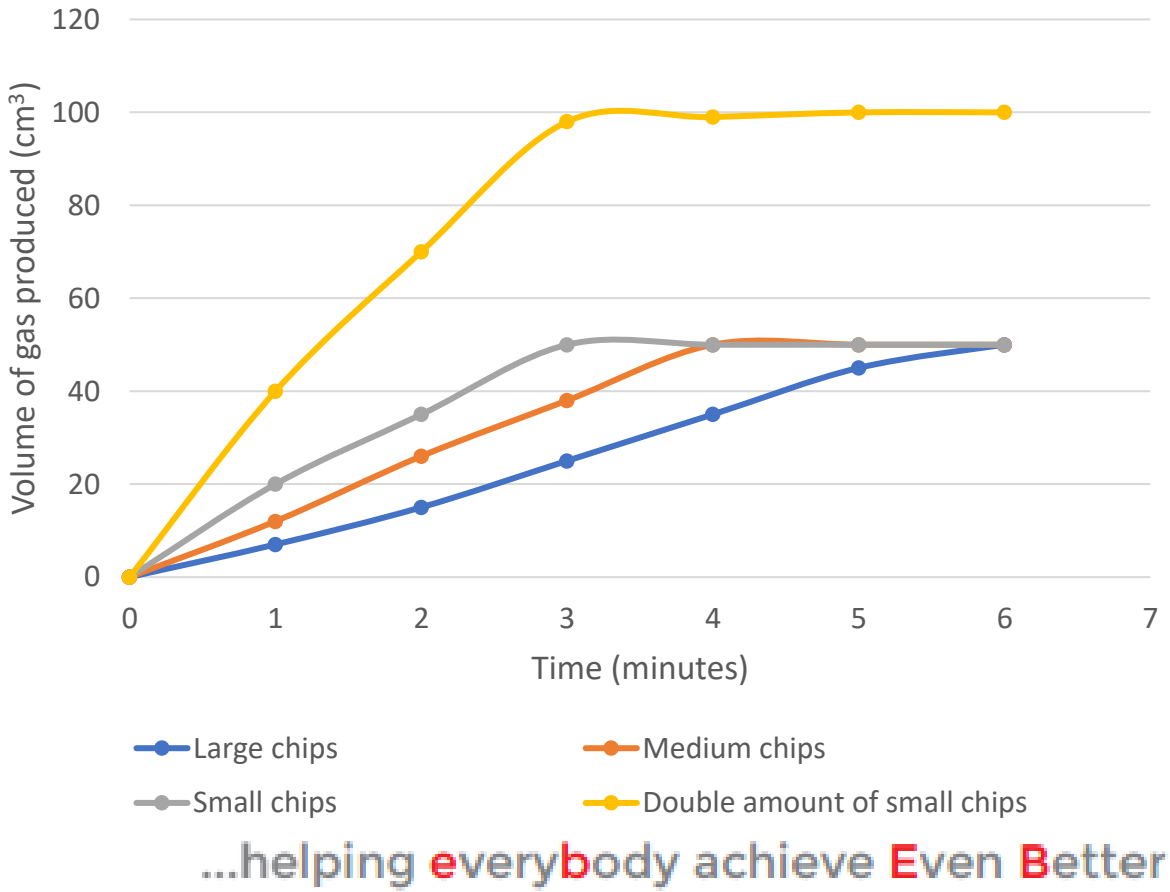
- How surface area affects rate of reaction can be investigated using marble chips and hydrochloric acid.
- The volume of gas produced when different sized marble chips are added to hydrochloric acid is measured.
- The same volume and concentration of acid must be used, and the same mass of marble chips.
- The greater the surface area, (the finer the powder), the faster the rate of reaction will be.



Investigating surface area

Analysing results:

- The faster the reaction takes place, the steeper the gradient of the graph. This graph shows that where small chips are used, the gradient is steeper as the reaction is faster.
- Once the reaction is complete, no more gas will be produced, and the line becomes flat.
- If a greater mass of chips is used, there will be increased surface area, therefore the reaction will be faster, and more gas will be produced.



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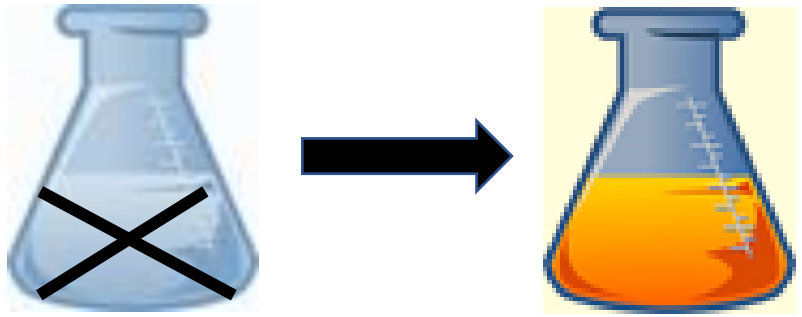
Investigating Concentration

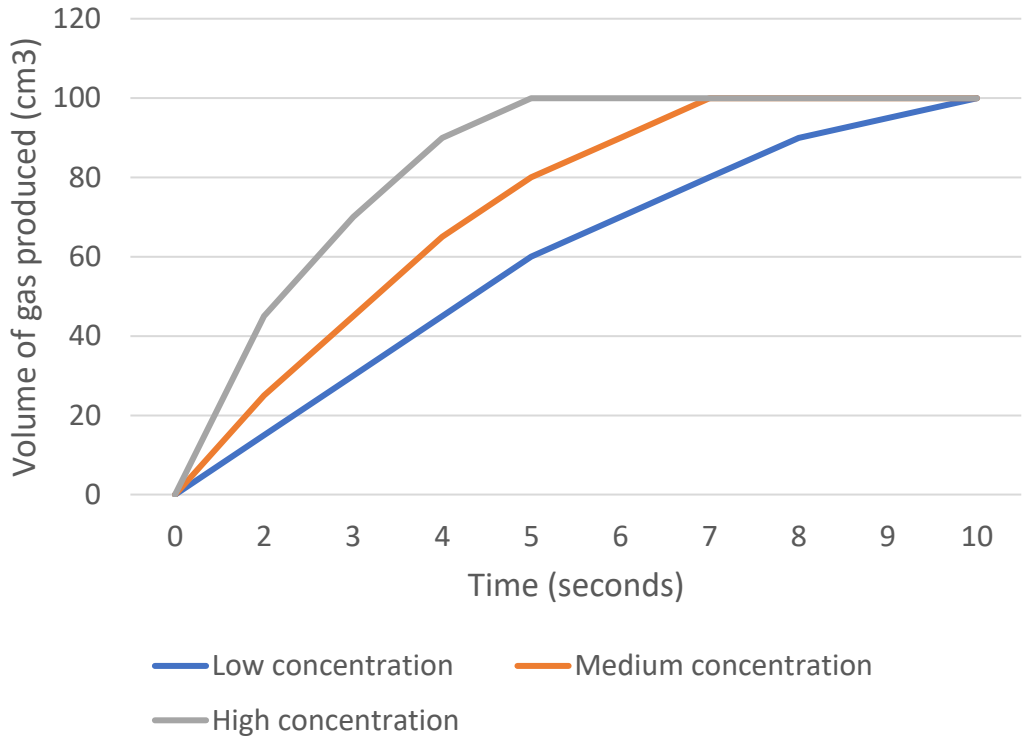
- Changing the concentration of reactants will affect the rate of reaction.
- To investigate you could react hydrochloric acid with marble chips, changing the concentration of hydrochloric acid, and either measure the volume of gas produced, or change in mass over time.
- You could also measure out fixed volumes of sodium thiosulphate and hydrochloric acid, place on a black cross and measure the time taken for the cross to disappear, as solid yellow sulphur precipitates out of the solution.



Investigating Concentration

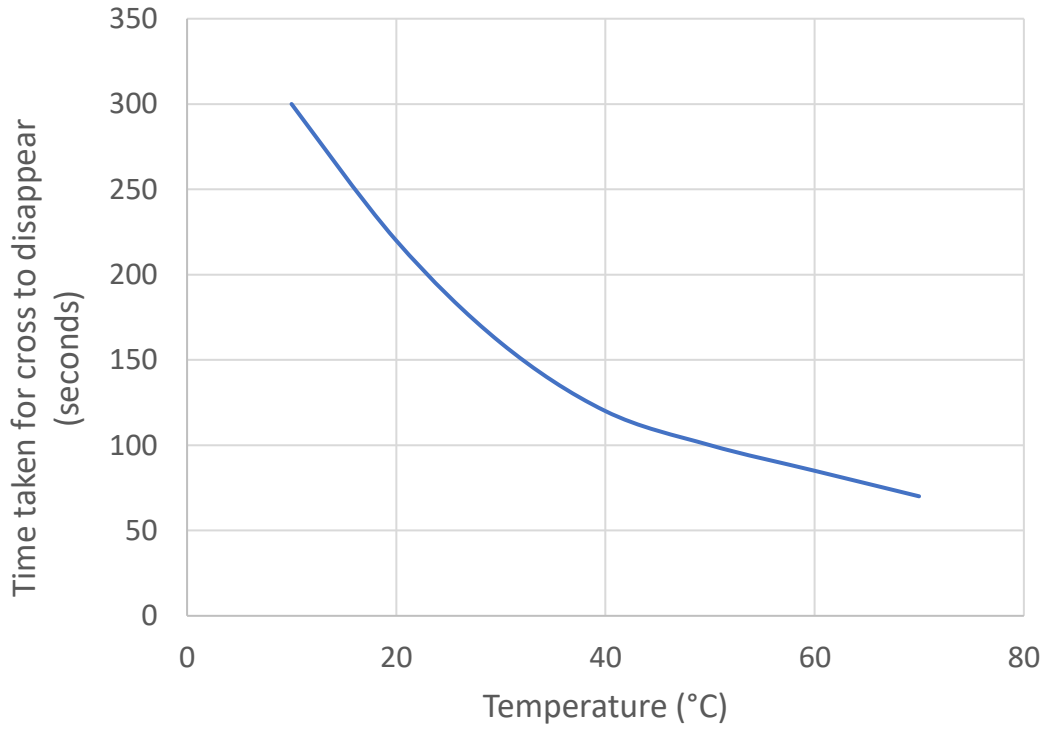
Analysing results

- This graph shows that when the concentration of acid is increased, the rate of reaction also increases.



Investigating Temperature

- How temperature affects reaction rate can also be investigated using sodium thiosulphate and hydrochloric acid, using a water bath to heat the solutions to different temperatures.
- The graph shows that as temperature increases the rate of reaction also increases, as it takes less time for the cross to disappear.



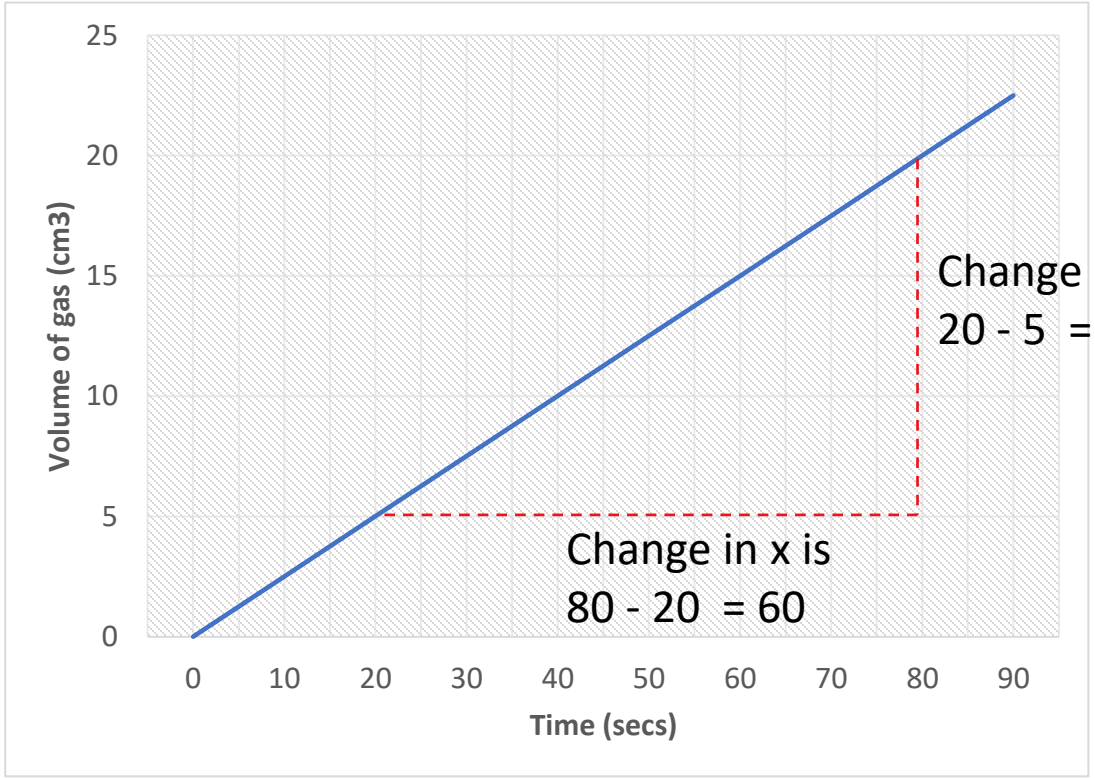
Calculating rate of reaction

To calculate the rate of reaction from a graph, you need to work out the gradient of the graph.

- Find 2 points on the line that you can read easily (2 co-ordinates).
- Draw a straight vertical line down from the higher point, and across to form a triangle.
- The change in y is the height of your triangle.
- The change in x is the base of your triangle.
- Work out the gradient from the formula

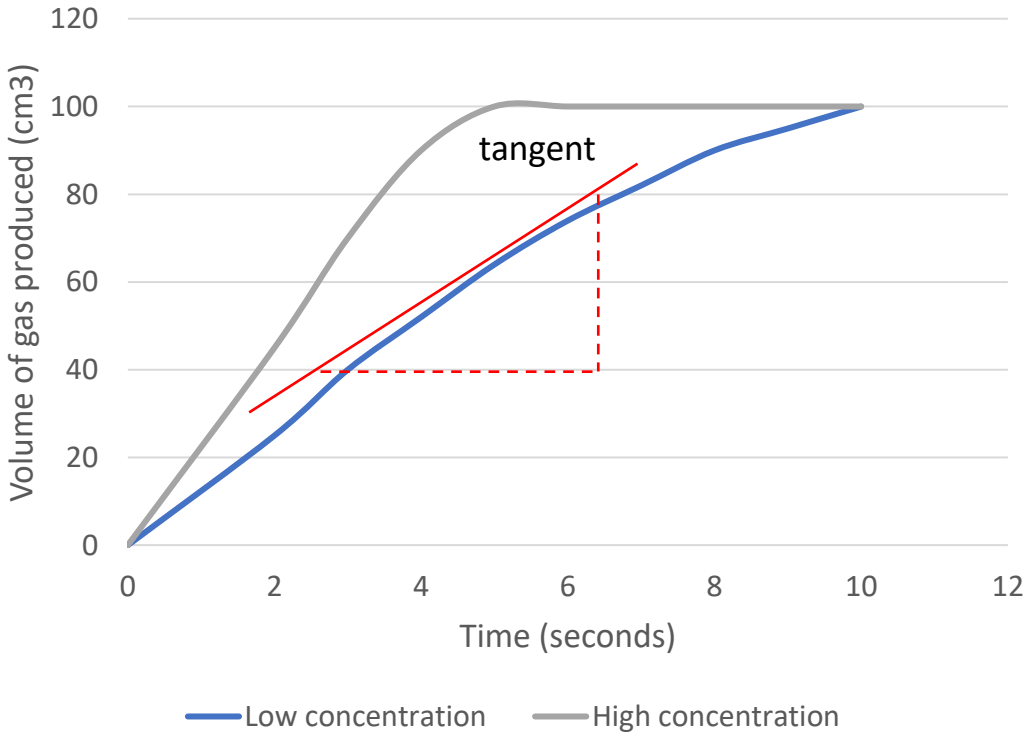
$$\frac{\text{change in y}}{\text{change in x}}$$

Rate of reaction = $\frac{15}{60}$ = 0.25 $cm^3\ s^{-1}$



Calculating rate of reaction

- To calculate the rate of reaction from a curved graph you need to draw a tangent to the curve.
- A tangent is a line that touches the curve. You need to place a ruler on the line of best fit where you would like to calculate the rate of reaction. You must be able to see the whole curve. Draw a line along the ruler.
- The rate of reaction at this point is the gradient of the tangent.



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Your turn:

1. Dilute hydrochloric acid is reacted with a solution of sodium thiosulphate. A cloudy solution is produced during the reaction.

The equation for the reaction is:

$Na_2S_2O_{3\ (aq)} + 2HCL_{\ (aq)}$ $NaCl_{\ (aq)} + SO_{2\ (g)} + H_2O_{\ (l)} + S_{\ (s)}$

a) Explain why the solution turns cloudy.

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b) The concentration of the sodium thiosulphate affects the rate of reaction.

Plan an investigation to investigate how the rate of reaction is affected by the concentration of sodium thiosulphate.

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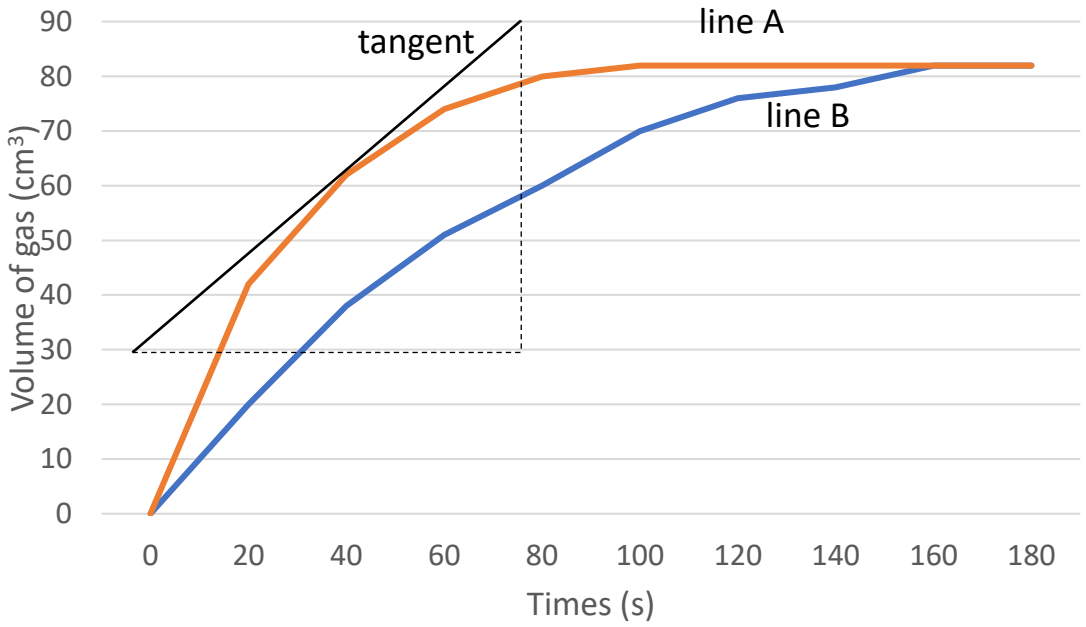
Your turn:

2. Ben investigated how different sized marble chips affect the rate of reaction. The same mass of marble chips was used in each experiment.

He measured the volume of gas given off and plotted his results on a graph.



a) How does the graph show that line B gives the results for the larger chips?

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b) Calculate the rate of reaction from the tangent drawn on line A.

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Answers:

1. Dilute hydrochloric acid is reacted with a solution of sodium thiosulphate. A cloudy solution is produced during the reaction.

The equation for the reaction is:

$Na_2S_2O_{3\ (aq)} + 2HCL_{\ (aq)}$ $NaCl_{\ (aq)} + SO_{2\ (g)} + H_2O_{\ (l)} + S_{\ (s)}$

a) Explain why the solution turns cloudy.

Sulphur is formed during the reaction. It is an insoluble solid so precipitates out of the solution.

b) The concentration of the sodium thiosulphate affects the rate of reaction.

Plan an investigation to investigate how the rate of reaction is affected by the concentration of sodium thiosulphate.

Measure (a stated) volume of sodium thiosulphate, and a volume of hydrochloric acid:.
Place the sodium thiosulphate into a conical flask and place the flask on a cross.
Add the hydrochloric acid to the flask, swirl it and start the timer.
Measure the time taken for the cross to no longer be visible.
Repeat at least 3 times and find the mean.
Repeat for different concentrations of sodium thiosulphate

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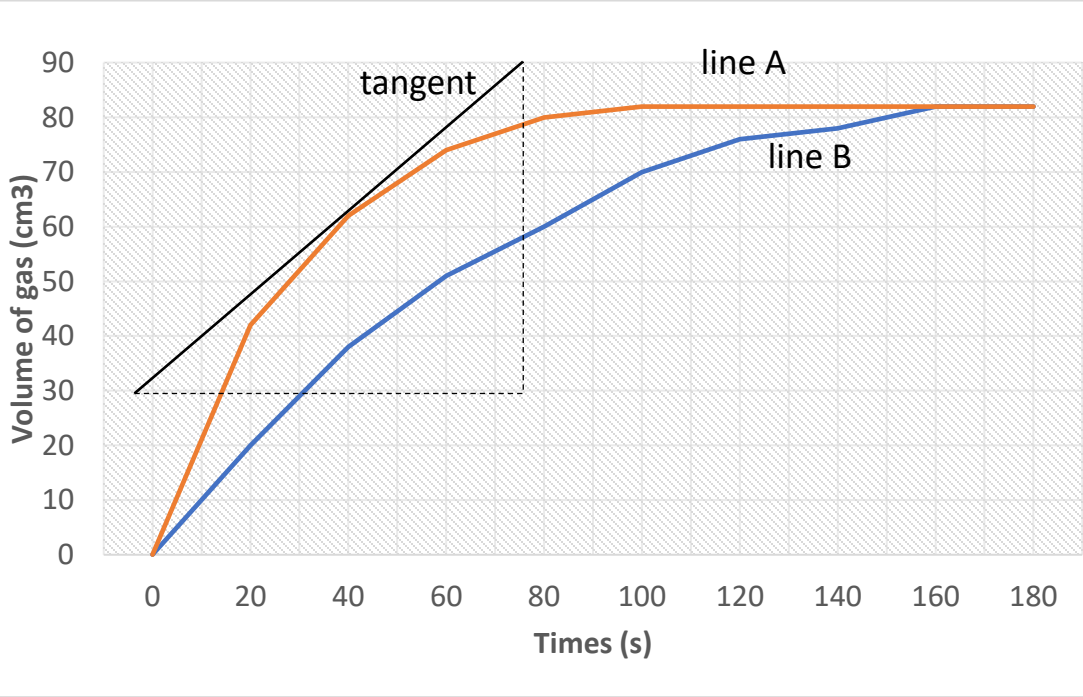
Answers:

2. Ben investigated how different sized marble chips affect the rate of reaction. The same mass of marble chips was used in each experiment.

He measured the volume of gas given off and plotted his results on a graph.



a) How does the graph show that line B gives the results for the larger chips?

Line B is less steep, and flattens out later.

b) Calculate the rate of reaction from the tangent drawn on line A.

Gradient = 60 ÷ 75 = 0.8 cm^3 s^{-1}

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For more help and resources, or to work with us as a tutor, please contact us

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