Candidate 1 evidence

Increasing Particle Size

Aim:

To find out how increasing particle size affects the rate of reaction.

Underlying Chemistry:

The rate of reaction is how fast or slow a chemical reaction happens. If the reaction has a high rate, it is a fast reaction, and if it is a slow reaction it will have a low rate of reaction. There are four main factors which affect the rate of reaction:

- particle size
- concentration
- temperature
- presence of catalyst.

To work out the rate of reaction, use this formula:- rate = $\frac{\Delta \text{quantity}}{\text{time}}$

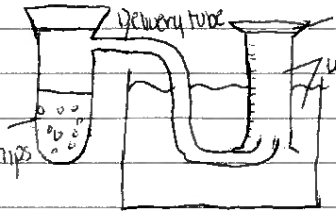
Substances are either acidic, alkaline or neutral. The pH of an acidic substance is less than 7, more than 7 for an alkaline substance, and equal to 7 for a neutral substance. Bases are used to neutralise an acid. The 3 main types of bases are:

- metal oxides
- metal hydroxides
- metal carbonates.

All 3 react to produce a salt and water, with an additional CO_2 being produced when a metal carbonate is used. A neutralisation reaction can be shown in an equation as:- acid + base → salt + water (CO_2)

$$2HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$$

As calcium carbonate was reacted with hydrochloric acid, a carbon dioxide is also produced. To catch the CO_2 produced, the following method can be used:



The CO_2 that is produced, travels through the delivery tube and into the measuring cylinder where when it rises, pushes the water out, allowing for the volume of gas produced to be measured.

Brief Description :-

Different sized particles were added to an acid, and the volume of gas produced was measured.

Raw Data :-

	Volume of Gas Produced (cm^3)	
particle size	Test 1	Test 2
Small	77	27
medium	16	10
large	0	0

Averages :-

Small = 77 + 27 = 104 ÷ 2 = 52

medium = 16 + 10 = 26 ÷ 2 = 13

large = 0 + 0 = 0 ÷ 2 = 0

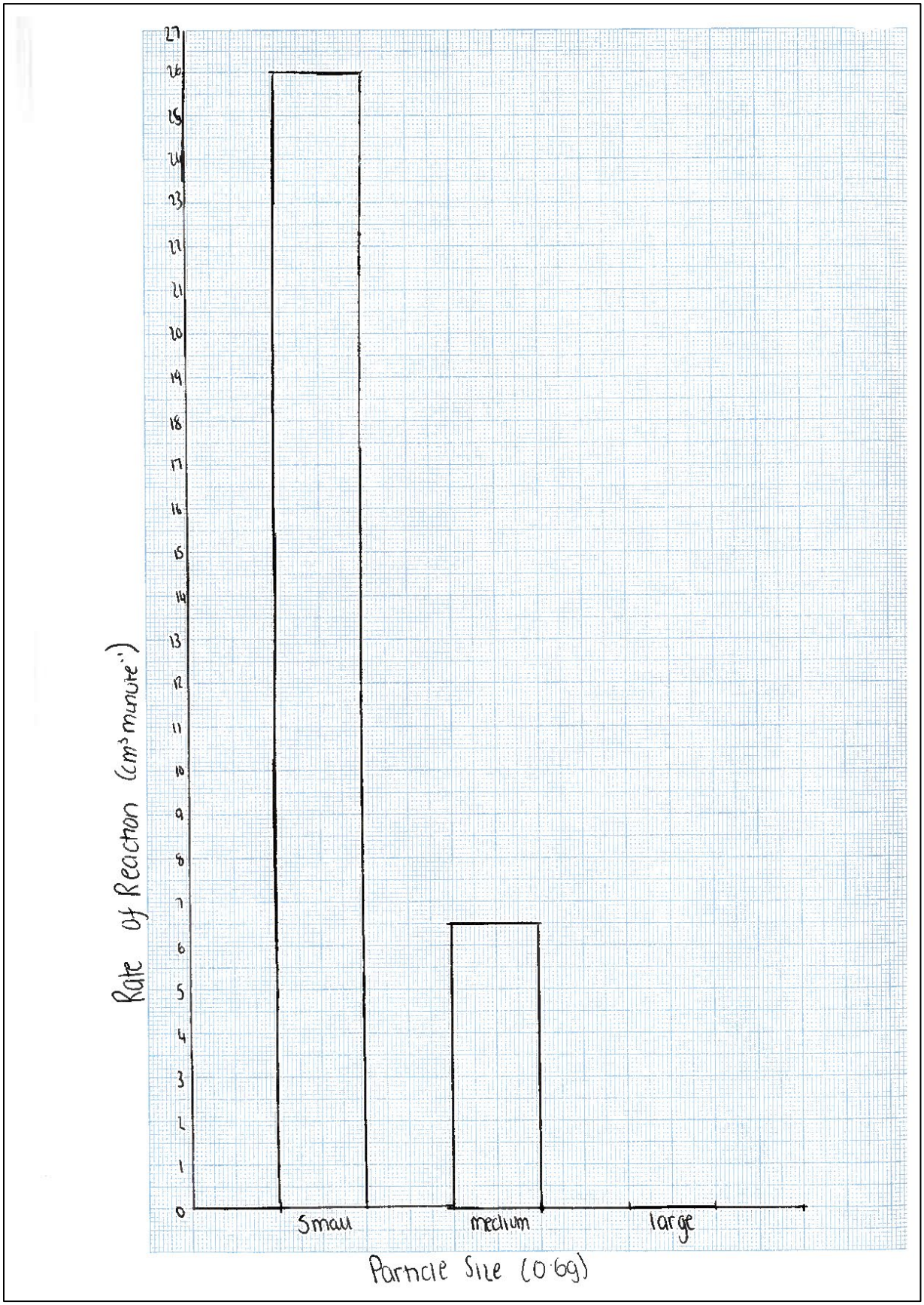
particle size	Average Volume of Gas Produced (cm^3)
Small	52
medium	13
large	0

Rate of Reaction :-

Small = rate = $\frac{\Delta quantity}{\Delta time} = \frac{52}{2} = 26\ cm^3\ minute^{-1}$

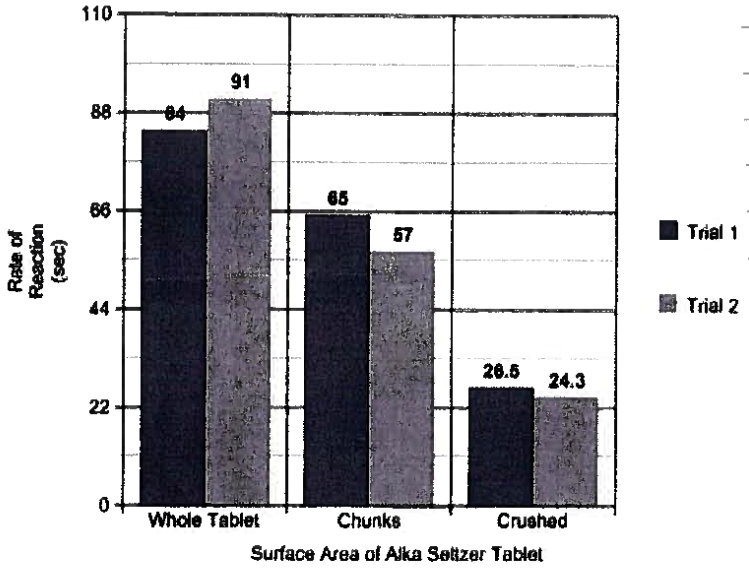
medium = rate = $\frac{\Delta quantity}{\Delta time} = \frac{13}{2} = 6.5\ cm^3\ minute^{-1}$

large = rate = $\frac{\Delta quantity}{\Delta time} = \frac{0}{2} = 0\ cm^3\ minute^{-1}$


Rate of Reaction (cm³ minute⁻¹)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
small
medium
large
Particle Size (0·6g)

particle size (big)	Rate of Reaction
small	26 cm^3 $minute^{-1}$
medium	6·5 cm^3 $minute^{-1}$
large	0 cm^3 $minute^{-1}$

Internet Source:-



https://jessiezsci.weebly.com/data-observation-results.html

Analysis:-

In my experiment, the bar for the smallest particle was the longest as it produced the most within 2 minutes. In the second source, the bar for the smallest particle was the smallest, meaning it took the least time to react. Both of these prove that the smallest particle is the fastest. For the largest particle, in my experiment it had the shortest bar as it produced the least within 2 minutes, whereas in the second source it had the longest bar as it took the most time to react, which proves that the largest particle is the slowest. In both sets of results,

the medium-sized particle had a medium-sized bar showing that it isn't as slow as the largest particle nor as ~~the~~ fast as the smallest. In my experiment, and the second source, the jump from small to medium is fairly big, whereas the jump from medium to large is a lot smaller.

Conclusion:-

From my investigation, I have found out that as the particle size increases, the rate of reaction decreases.

Evaluation:-

If any gas is lost after the particle is added to the acid, it can have an affect on the results. To ensure that all gas produced is accounted for and the results are more accurate, a stopper is placed on top of the test tube as soon as the chips are added to the acid.