The Rate Of Reaction

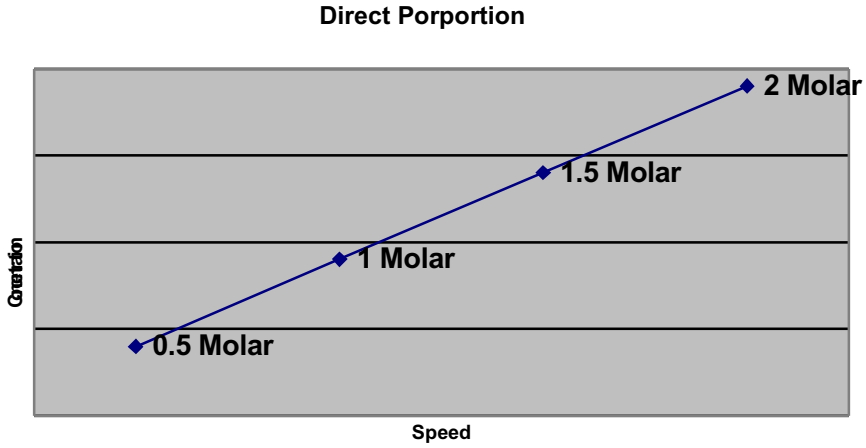
Aim: I am trying to find out if the concentration oh hydrochloric acid will increase the rate of reaction between calcium carbonate and hydrochloric acid.

Prediction: I suspect that the stronger the hydrochloric acid I use, the faster the reaction will be, more gas will be given off and more collision between particles will take place.

I also think that as I dilute the acid the rate of reaction will decrease, less collision between particles will take place and as a result, less gas will be given off.

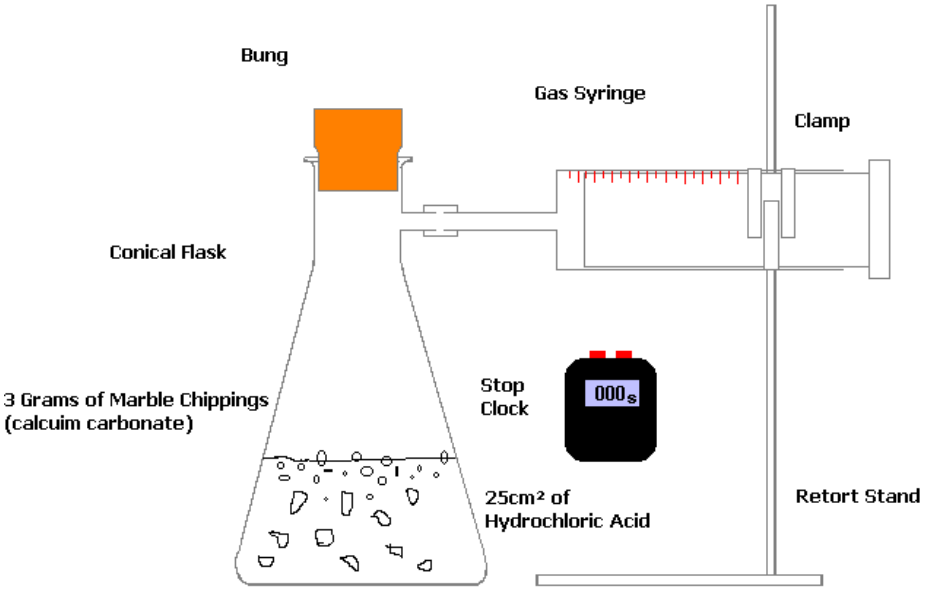
I believe this because the higher the concentration of the acid, the more ions there will be. Therefore more collision between the calcium carbonate (marble chips) and the hydrochloric acid will take place. The acid particles will collide with the marble chippings causing the reaction to take place faster.

If you further double the strength of the acid you will double the amount of ions. This will then double the speed of the reaction.



Each time you increase the concentration of the hydrochloric acid the speed increases in direct proportions.

Plan: I intend to carry out the experiment using the apparatus illustrated below:



I chose this apparatus as I found it gave the most accurate reading as opposed to the gas collection kit.

In preparation, I carried my experiment out a few times to help me decide what strengths of acid, time intervals to record data and the amount of chippings I would use in my experiment.

On my first attempt I used 25cm² of 2 molar, hydrochloric acid and 4 grams of marble chippings. I found that this produced carbon dioxide gas at too quick a rate. I then decided to reduce the amount of marble chippings to 3 grams and keep the volume of acid at 25cm². This produced carbon dioxide at a steady rate. I decided to use 2 molar, 1.5 molar, 1 molar and 0.5 molar acid strengths. Now that I had found the amount and strength of hydrochloric acid and the amount of marble chippings, I set out to find a practical time interval to record the amount of gas given off by the reaction.

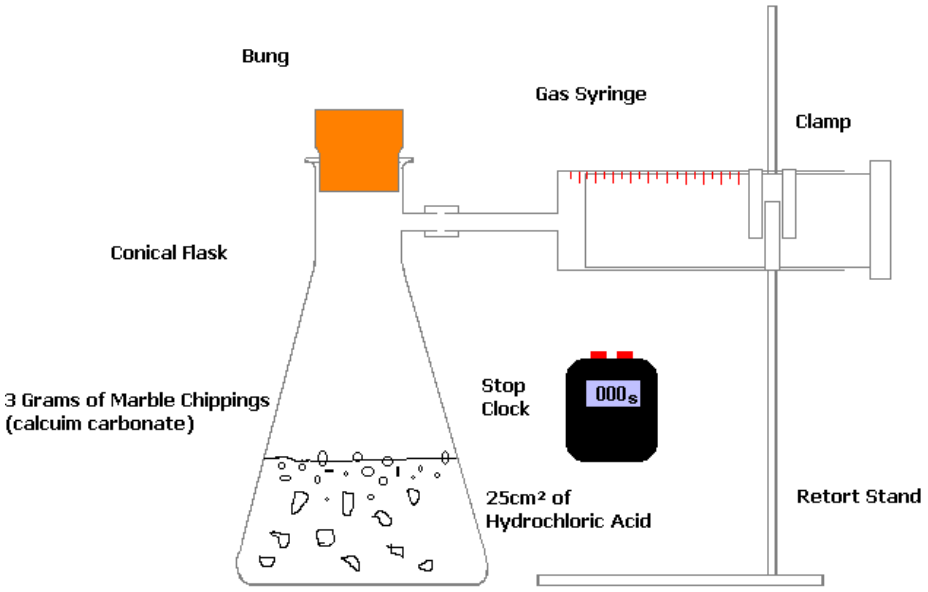
I tried recording the data every 5 second but I found that it was very difficult to look at the syringe, record the volume and look back up to see the next reading. I then tried measuring the volume of gas every 30 seconds, this worked okay but it wasn't producing enough readings. For my last attempt I wrote down the volume of gas every 10 seconds. This was perfect, I could read the data, record, and look up in perfect time for the next reading and it also produced a lot of results, benefiting the appearance of my graph.

I decided I would use 25cm² of hydrochloric acid, 3 grams of marble chips and would record the volume of carbon dioxide gas given off every 10 seconds.

I will carry out my experiment 3 times as this is more reliable as the experiment could produce extreme results one time but the next could be different, I will average off my results and use these for my final graph.

Apparatus:

- Bung
- Conical flask
- Retort stand
- Clamp
- Gas syringe
- Calcium carbonate (marble chips)
- Hydrochloric acid
- Stop Clock



Results:

- First Experiment

	Gas given off by ($25cm^2$)			
	2 molar acid	1.5 molar acid	1 molar acid	0.5 molar acid
0 seconds	0	0	0	0
10 seconds	65	63	18	17
20 seconds	84	95	35	25
30 seconds	94	115	50	29
40 seconds	114	135	64	32
50 seconds	133	142	75	39
60 seconds	152	165	85	40
70 seconds	171	190	95	42
80 seconds	190	200	105	49
90 seconds	209	210	113	-

- Second Experiment

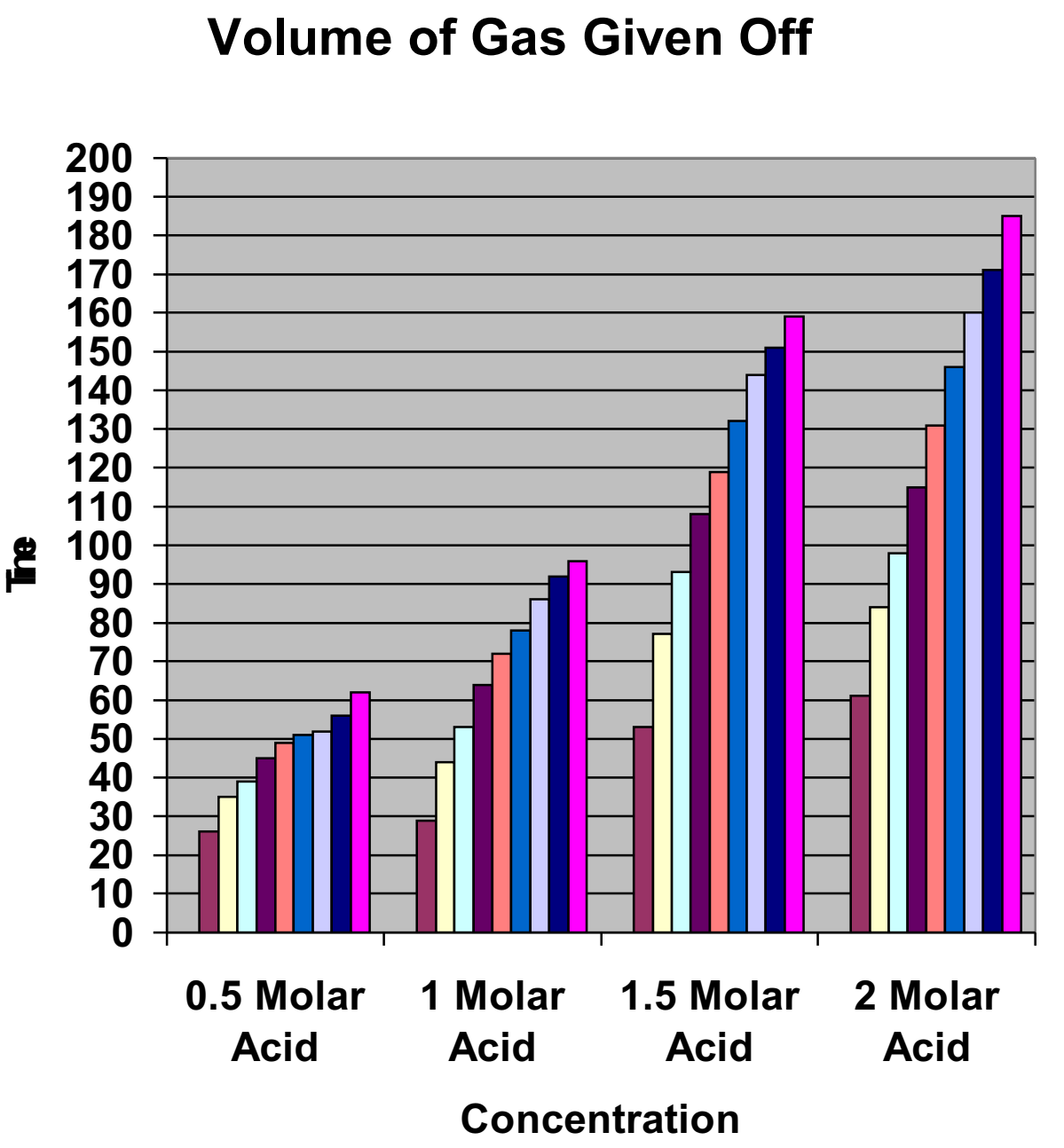
	Gas given off by ($25cm^2$)			
	2 molar acid	1.5 molar acid	1 molar acid	0.5 molar acid
0 seconds	0	0	0	0.
10 seconds	63	45	33	32
20 seconds	87	65	47	46
30 seconds	100	80	50	50
40 seconds	117	93	63	60
50 seconds	130	105	70	63
60 seconds	142	111	75	65
70 seconds	154	118	79	66
80 seconds	460	124	82	69
90 seconds	175	127	85	72

- Third Experiment

	Gas given off by ($25cm^2$)			
	2 molar acid	1.5 molar acid	1 molar acid	0.5 molar acid
0 seconds	0	0	0	0
10 seconds	55	50	36	29
20 seconds	80	70	49	34
30 seconds	100	85	60	38
40 seconds	115	97	66	42
50 seconds	130	110	70	45
60 seconds	145	120	75	47
70 seconds	155	123	85	48
80 seconds	163	130	88	49
90 seconds	171	140	90	51

- Average Results

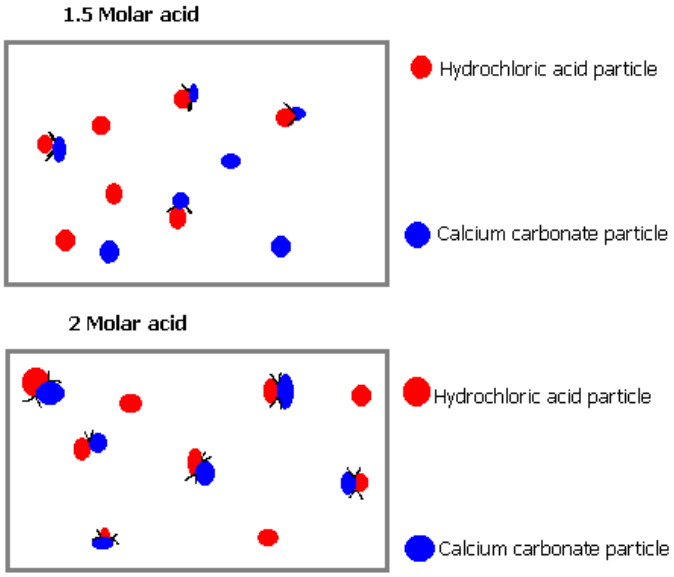
	Gas given off by ($25cm^2$)			
	2 molar acid	1.5 molar acid	1 molar acid	0.5 molar acid
0 seconds	0	0	0	0
10 seconds	61	53	29	26
20 seconds	84	77	44	35
30 seconds	98	93	53	39
40 seconds	115	108	64	45
50 seconds	131	119	72	49
60 seconds	146	132	78	51
70 seconds	160	144	86	52
80 seconds	171	151	92	56
90 seconds	185	159	96	62


Volume of Gas Given Off
200
190
180
170
160
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
Time
0.5 Molar Acid
1 Molar Acid
1.5 Molar Acid
2 Molar Acid
Concentration

Conclusion: This experiment shows that as I decreased the concentration of the hydrochloric acid, the volume of carbon dioxide gas given off also decreases. The table shows that the 2 molar acid gave off more gas than the 1.5 molar acid, this gave off more than the one molar and so on.

I also discovered that the stronger the acid the quicker the rate of reaction between the calcium carbonate and the hydrochloric was. The graph shows that the more concentrated the acid is, the faster the reaction occurs, this is shown in the graph by the steepness of the line, the 2 molar line is steeper than the 1.5 molar line and so on.

My results agree with the collision theory. There are more ions in the 2 molar acid than the 1.5 molar acid, this means there are more particles for the calcium carbonate to collide with, therefore a quicker reaction and more gas will be given off.



When the concentration of acid was doubled, as was the acid particles, this meant that there were more acid particles and that meant more collision took place

Error and improvement: My results were inconsistent throughout all three experiments. One result could be 100 cm^2 And the next one could be 150cm^2.

E.g.

		Volume of gas given off (cm^2)			
		2 molar	**1.5 molar**	**1 molar**	**0.5 molar**
Experiment 1	**After 50 seconds**	133	142	75	39
Experiment 2	**After 50 seconds**	130	105	70	63
Experiment 3	**After 50 seconds**	130	110	70	45

In some cases in my investigation my results were very inconsistent. One way that I could improve my results would be to use a better gas syringe; I think that after many uses they would begin to stick, which could manipulate the results.

Another improvement I would make would be to carry out all three experiments in the same day using the very same bottle of acid. I think that using different bottles of acid, although they are marked as the same strength, could be slightly more concentrated than other ones as they are mixed in school, this would affect the results.

Craig Lamont