

the reaction between calcium carbonate and hydrochloric acid

AIM- My task is to investigate the reaction between calcium carbonate and hydrochloric acid, which produces calcium chloride, carbon dioxide, and water. To do this I will conduct an experiment.

Word Equation:

Calcium + Hydrochloric \longrightarrow Calcium + Carbon Dioxide + Water

Carbonate Acid Chloride

Chemical Equation:



The key variables in this experiment that affect the rate of reaction is, surface area, temperature, mass of CaCO_3 and concentration of acid.

The surface area can be investigated by increasing or decreasing the surface area of the calcium carbonate (marble) chips (i.e. have them as chips or powdered). The temperature can be investigated by increasing the temperature of water in the water trough. Increasing or decreasing the mass of the calcium carbonate chips used in the experiment can investigate the mass. The concentration can be investigated by increasing or decreasing the concentration of acid put on the marble chips.

The variable I will be changing in order to conduct my experiment is the concentration of acid as this will have an effect on how much Carbon Dioxide is produced.

There are a number of ways in which this experiment can be conducted. Firstly, the volume of Carbon Dioxide produced can be measured at regular intervals- using a gas syringe or a measuring cylinder. The second way is to measure the loss in mass of the container, calcium carbonate, and hydrochloric acid at intervals.

I will be conducting this experiment, by using a measuring cylinder, to measure the volume of Carbon Dioxide produced at regular intervals of one minute until ten minutes have passed. I will be doing it this way, as this is the way I did it in my preliminary experiment and it produced accurate results.

This is how I will conduct the experiment. I will set up the apparatus as shown below. I will pour in the Hydrochloric acid and get someone else to start the stopwatch for me, next I will measure the volume of CO_2 produced at intervals of one minute until ten minutes have passed. I will do it for ten minutes as when I did my preliminary experiment, all the reaction had stopped completely within ten minutes.

Therefore, I think the initial rate will be ten minutes. I will do four different experiments, using four different concentrations of acid. I will be starting with 0.5 molar acid. This is because, I thought 0.5 molar would produce a sufficient enough reaction and the difference can be seen quite clearly. In the next experiment I will use 1 molar acid. As you can tell that is a difference of 0.5 molar. I will work up in a difference of 0.5 molar until 2 molar. I decided to stop at 2 molar, as I think I will be able to see quite clearly up to then whether the concentration of acid has an effect on the volume of Carbon Dioxide produced I will be using 30ml of Hydrochloric acid as when I did my preliminary experiment, it was enough to cover the marble chips. I will be doing each of the four experiments, three times. I will do them three times each as that will mean I can have an average, which will mean more accurate results and any minor problems won't be noticed as well.

DIAGRAM-

The apparatus I will be using to conduct this experiment are:

100ml measuring cylinder,
Water trough,
Hydrochloric acid, (0.5M, 1M, 1.5M, 2M)
Calcium Carbonate Chips,
Side-arm flask,
Thermometer,
Top-pan-balance,
Stop-watch &
Water.

I will make sure this experiment is fair, by always using the same amount/mass of marble chips, making sure the same volume of water is used every time in the water trough, and making sure the water in the water trough is at a constant temperature. I will also make sure the same volume of acid is used. The only factor, I will be changing is the concentration of hydrochloric acid.

I will make sure this experiment is safe, by always wearing goggles as acid is being used and there will be a chemical reaction. Also I will make sure, that if any acid is spilled, it should be cleared away quickly. If it gets on my hands or clothes, I will wash them thoroughly to avoid burning myself. If it spills on the desk, I will inform the teacher and clean it without getting it on my hands or clothes.

The measuring cylinder I will use to measure the volume of CO_2 produced will be 100ml because I will be able to measure quite accurately.

The mass of the calcium carbonate chips I will be using is 10g.

The volume of acid I will use is 30ml.

This is the table I propose to record my results in:

Volume of Acid	Concentration Of Acid	Time/ Minutes	Mass of Marble chips	Volume of CO_2 produced	Temp of H_2O

HYPOTHESIS- I think that as the concentration of acid increases the volume of CO_2 produced will also increase. I think this is because as the acid becomes more concentrated it will be easier for the calcium carbonate (marble) chips to react (come into contact) with the acid particles and therefore will produce more Carbon Dioxide. For example, what it says in this book I used as a secondary source, 'If the acid is at low concentrations, the acid particles, will be widely spread in the water, and the number of collisions between them and the marble chips will be limited. At higher concentrations, however, the chances of a collisions between the acid particles and the marble chips are greatly increased.' (Heinemann, Higher Chemistry) That is why I feel, that as the concentration of acid increases, the volume of Carbon Dioxide produced will also increase.

RESULTS-

Concentration Of acid	Time/ Minutes	First Results	Second Results	Third Results	Average (3sf)
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0.5 Molar	1	65.0 ml	50.0 ml	60.0 ml	58.3 ml
0.5 Molar	2	120 ml	80.0 ml	90.0 ml	96.7 ml
0.5 Molar	3	130 ml	100 ml	110 ml	113.3 ml
0.5 Molar	4	135 ml	120 ml	120 ml	125 ml
0.5 Molar	5	140 ml	130 ml	130 ml	133 ml
0.5 Molar	6	142 ml	135 ml	135 ml	137 ml
0.5 Molar	7	143 ml	140 ml	138 ml	140 ml
0.5 Molar	8	145 ml	142 ml	140 ml	142 ml
0.5 Molar	9	145 ml	145 ml	141 ml	144 ml
0.5 Molar	10	145 ml	145 ml	141 ml	144 ml

Concentration Of acid	Time/ Minutes	First Results	Second Results	Third Results	Average (3sf)
1 Molar	1	165 ml	165 ml	160 ml	163 ml
1 Molar	2	200 ml	220 ml	220 ml	213 ml
1 Molar	3	220 ml	248 ml	245 ml	238 ml
1 Molar	4	228 ml	255 ml	255 ml	246 ml
1 Molar	5	229 ml	258 ml	259 ml	249 ml
1 Molar	6	230 ml	258 ml	260 ml	249 ml
1 Molar	7	230 ml	258 ml	260 ml	249 ml
1 Molar	8	230 ml	258 ml	260 ml	249 ml
1 Molar	9	230 ml	258 ml	260 ml	249 ml
1 Molar	10	230 ml	258 ml	260 ml	249 ml

Concentration Of acid	Time/ Minutes	First Results	Second Results	Third Results	Average (3sf)
1.5 Molar	1	210 ml	150 ml	200 ml	187 ml
1.5 Molar	2	295 ml	200ml	280 ml	258 ml
1.5 Molar	3	330 ml	210 ml	305 ml	282 ml
1.5 Molar	4	342 ml	215 ml	312 ml	290 ml
1.5 Molar	5	350 ml	216 ml	315 ml	294 ml
1.5 Molar	6	351 ml	217 ml	317 ml	295 ml
1.5 Molar	7	352 ml	217 ml	317 ml	295 ml
1.5 Molar	8	352 ml	217 ml	317 ml	295 ml
1.5 Molar	9	352 ml	217 ml	317 ml	295 ml
1.5 Molar	10	352 ml	217 ml	317 ml	295 ml

Concentration Of acid	Time/ Minutes	First Results	Second Results	Third Results	Average (3sf)
2 Molar	1	300 ml	335 ml	300 ml	312 ml
2 Molar	2	335 ml	365 ml	325 ml	342 ml
2 Molar	3	395 ml	400 ml	375 ml	390 ml

2 Molar	4	415 ml	419 ml	395 ml	410 ml
2 Molar	5	426 ml	429 ml	400 ml	418 ml
2 Molar	6	432 ml	435 ml	405 ml	424 ml
2 Molar	7	434 ml	439 ml	406 ml	426 ml
2 Molar	8	435 ml	439 ml	406 ml	427 ml
2 Molar	9	436 ml	439 ml	406 ml	427 ml
2 Molar	10	436 ml	439 ml	406 ml	427 ml