How the concentration of hydrochloric acid affects the dissolution of calcium carbonate

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Abstract

An experiment was planned and conducted to determine whether a positive correlation between concentration and rate of reaction exist. The experiment focused on hydrochloric acid and calcium carbonate; however, the results and conclusion may be relevant to alternative reactions.

Contents

1 Factors that affect the rate of reaction

There are various factors that affect rate of reaction. For this experiment, only one is changed—the rest controlled. This is to ensure the results of the experiment are repeatable.

The factors that affect rate of reaction include

- Temperature
- Presence of a catalyst
- Surface area (only applies to solids)
- Concentration

The factor that will be variable in this experiment is concentration.

2 Hypothesis

A positive correlation between the concentration of a reactant and the rate of reaction is expected.

If the amount of a particular reactant increases without a proportional increase in volume, there is an increase in concentration. An increase in concentration will result in a greater probability that any two reactants collide and react. Additionally, the involved reactants must posses a minimum of activation energy to perform a reaction.

3 Experiment

3.1 Method

3.1.1 Chosen method

- Set up equipment
  - Grind marble chips with a mortar and pestle
  - Fill a trough with water—half way between the base and the rim
  - Insert one end of the delivery tube in the rubber bung
- Begin the experiment
  - Using a small measuring cylinder measure out 5 ml of hydrochloric acid (with a variable concentration between repeats).
  - Fill the large measuring cylinder with water.
  - invert the cylinder into the water trough. Then, secure it with a retort stand and clamp.
  - Place the bungless end of the delivery tube through the measuring cylinder.
  - Place 1 g of calcium carbonate in the conical flask.

  - From the small measuring cylinder: pour in all of the hydrochloric acid.
  - Undubiously place the rubber bung through the mouth of the conical flak and start a stop watch.
    * The large measuring cylinder should fill with carbon dioxide.
    * Record the time upon every moment the carbon dioxide reaches multiples of 10 ml.
    * Upon the completion of the reaction: stop the stopwatch.
  - Repeat the experiment several times using the same concentration of hydrochloric acid.
- Repeat the experiment several times using a different concentration of hydrochloric acid.

3.2 Equipment

The following table describes the equipment, its purpose and the reasons for using it.

Equipment	Purpose	Justification
Conical flask	A container for the reaction.	Allows for the use of a rubber bung and delivery tube.
Retort stand and clamp	Keeps the measuring cylinder in an vertical orientation.	Allows one to conveniently read measurements from the large measuring cylinder.
Water trough	Contain the water that is ejected from the large measuring cylinder.	It is reasonably big—allowing for flexible the flexible placement of the large measuring cylinder.
Delivery tube	Allows the carbon dioxide to move from the conical flask to the measuring cylinder.	It is unlikely to leak significantly.
Rubber bung	Secures the delivery tube in place.	It is unlikely to leak significantly. Allows for the use of a delivery tube.
Mortar and pestle	Utilised to grind the calcium carbonate.	Crushing the calcium carbonate may contribute to more reliable results
large measuring cylinder 100 ml	Contains water (inverted over the water trough)	Sufficiently large for the experiment. Not cumbersome.
Small measuring cylinder 20 ml	Used to measuring the hydrochloric acid.	Sufficiently large for the small measurements. Nor cumbersome.
Stopwatch	Assists in measuring the rate of the reaction.	Sufficiently accurate.

4 Risk assessment

Risk	Precaution	Plausibility
Hydrochloric acid	Wear safety goggles. Attempt not to ingest.	If the concentration is $n < 2\,\text{mol}$ then there is a low hazard.
Calcium carbonate	Wear safety goggles. Attempt not to ingest.	There is a low hazard
Carbon dioxide	Consider performing in a well ventilated environment.	If a preexisting breathing problem is present, there may be a hazard.
Spillages	Dry all equipment regularly and perform experiment. on non-slip surface	Reasonably plausible.
Ingestion (of any substance involved) as a result of contamination	Wash all equipment, surfaces and hands	Likely to occur in insignificant quantities.