Cambridge Assessment International Education

The effect of changing the concentration of hydrochloric acid on the rate of reaction with calcium carbonate

Transcript

For many industrial processes, it is essential to know what the rate of reaction is between reactants. If the rate is too high, the system may overheat or release a gas too quickly and as a result an explosion could occur. If a reaction is too slow, it may not be economically viable.

Several factors affect the rate of a chemical reaction. These factors include concentration, surface area, catalysts including enzymes, temperature and pressure of gases.

In this experiment we will determine how the concentration of hydrochloric acid affects the rate of reaction with calcium carbonate. Various concentrations of hydrochloric acid will be used and calcium carbonate as marble chips. Calcium carbonate reacts with hydrochloric acid producing the salt calcium chloride, water and carbon dioxide gas. The rate of carbon dioxide released will be followed in this experiment.

For each concentration of hydrochloric acid, construct a table like this one to record your results.

The gas syringe is very delicate and is clamped gently. Check that the barrel of the syringe can move freely. A piece of string, attached to the body and barrel, prevents the barrel shooting out and breaking.

The conical flask in which the reaction occurs is also clamped gently, to stop it toppling over during the experiment. Make sure that the bung is a good fit for the conical flask. Also ensure that the rubber tubing is of a suitable diameter to attach firmly to the gas syringe and to the glass tube which fits into the rubber bung.

Using a measuring cylinder, measure out 50 centimetres cubed of the 2.0 moles per decimetre cubed hydrochloric acid. To ensure that you add exactly 50 centimetres cubed of acid, use a plastic pipette to fill to the 50 centimetres cubed mark. Do this at eye level to avoid parallax errors.

Pre-weigh 0.5 grams of marble chips into a weighing boat. To obtain the most accurate results in this experiment, roles should be assigned to each learner in the group before you start doing the experiment.

In your group, the following jobs should be performed simultaneously. Add the hydrochloric acid to the marble chips. Secure the bung, rotating it gently to ensure a firm fit. Start the stopwatch. Record the results in the results table.

Once you have obtained all the results, a graph of volume of carbon dioxide against time is plotted. The experiment is then repeated with different concentrations of hydrochloric acid.

From the graphs we can see that with lower concentrations of hydrochloric acid, the reaction is slower. This is clear from the gradients of the curves. For the higher concentrations of acid, the curve is steeper. We can also see that the 2.0 moles per decimetre cubed hydrochloric acid reaction finished in a shorter time.

This evidence shows that the reaction rate increases with increased concentration of hydrochloric acid. This conclusion is consistent with collision theory considerations. Using more concentrated hydrochloric acid causes there to be more hydrochloric acid particles per unit volume which leads to more frequent collisions between particles of hydrochloric acid and particles of calcium carbonate.

This leads to a faster reaction.