

Edexcel Chemistry IGCSE

Practical 3.15: Investigate the effect of changing the surface area of marble chips and of changing the concentration of hydrochloric acid on the rate of reaction between marble chips and dilute hydrochloric acid

Notes

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Rate of reaction between marble chips and dilute hydrochloric acid

Aim

To investigate what effect the concentration of hydrochloric acid and the surface area of marble chips have on the rate of reaction when marble chips react with hydrochloric acid.

Equipment list

- 250 cm³ conical flask
- Cotton wool
- Digital mass balance
- Measuring cylinder
- Timer

Chemicals required

- Hydrochloric acid, various concentrations (e.g. 0.25 mol/dm³, 0.5 mol/dm³, 0.75 mol/dm³)
- Marble chips, various sizes (e.g. large chips, small chips, powder)

Method

Investigating the effect of changing concentration:

- Begin with the lowest concentration of hydrochloric acid. Using a measuring cylinder, add 100 cm³ of hydrochloric acid to the conical flask.
- 2. Place the conical flask on the balance and push the cotton wool into the opening. Record the mass.
- 3. Leave the conical flask on the balance to allow the mass can be measured throughout the experiment.
- 4. Add the marble chips to the flask, replacing the cotton wool as soon as it is added. Start the timer immediately.
- 5. After 30 seconds record the new mass of the conical flask.
- 6. Repeat steps 1-6 with the increasing concentrations of hydrochloric acid, ensuring the size of marble chips remains constant. Record all results in a table.
- 7. Calculate the rate of reaction for each of the experiments. Compare the results for the different concentrations of acid.

Investigating the effect of changing surface area:

- 1. Take the sample of marble chips with the smallest surface area. Measure the mass of the chips.
- 2. Place 100 cm³ of hydrochloric acid in the conical flask. Make a note of the concentration of acid as this must be kept the same for each test.
- 3. Place the conical flask on the balance and push the cotton wool into the opening. Measure the mass of the conical flask containing the acid.
- 4. Carry out the experiment on the digital mass balance so that the mass can be measured throughout the experiment.
- 5. Add the marble chips to the flask, replacing the cotton wool as soon as it is added. Start the timer immediately.

6. After 30 seconds record the new mass of the conical flask.



- 7. Repeat steps 2-6, increasing the surface area of the marble chips. Make sure the mass of each sample is the same. Record all results in a table.
- 8. Calculate the rate of reaction for each of the experiments. Compare the results for marble chips with different surface areas.

Key points

• The equation for this reaction is:

 $CaCO_3(s) + 2HCI(aq) \rightarrow CaCI_2(aq) + H_2O(I) + CO_2(g)$

- The change in mass can be used to calculate the rate because the carbon dioxide gas produced during the reaction escapes through the cotton wool, causing the mass of the mixture to decrease.
- The cotton wool allows the gas to escape while preventing any acid splashing out of the flask during the reaction.
- Increasing the concentration of the acid should increase the rate of reaction. This is because there are more particles in the same volume so more frequent successful collisions.
- Increasing the surface area of the marble chips should increase the rate of reaction. This is because there are more exposed particles so more frequent successful collisions between reactants.
- The concentration of acid can be changed by mixing known quantities of water with hydrochloric acid to dilute it.

Diagram





Safety precautions

- Hydrochloric acid is corrosive when concentrated. Use dilute solutions to prevent harm. Wash hands after contact with any acid.
- Place the cotton wool on the conical flask immediately, to prevent any acid splashing onto skin.

• Be careful when handling glassware. Clear up any broken glass immediately.



Analysis of results

The results from the reactions can be recorded in a table similar to the one below:

| | Mass of flask with acid at 0 seconds | Mass of flask after 30 seconds | Rate of reaction |
|------------------------------|---|--------------------------------|------------------|
| 0.25 mol/dm ³ HCl | | | |
| 0.50 mol/dm ³ HCl | | | |
| 0.75 mol/dm ³ HCl | | | |
| Large marble chips | | | |
| Small marble chips | | | |
| Powdered marble | | | |

The rate should increase as the concentration of acid increases. This means the rate for 0.25mol/dm³ HCl will be slower than the rate for 0.5mol/dm³ and 0.75 mol/dm³. Equally, the rate for the large marble chips should be slower than the rate for the small chips and powdered marble because the large marble chips have the smallest surface area.

The results from the table can be plotted on two different graphs, one for investigating the effect of changing concentration and one for investigating the effect of changing surface area.

▶ Image: PMTEducation