

## Objectives

- C7.1** Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:
- measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)
  - observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid).
- C7.2** Suggest practical methods for determining the rate of a given reaction.
- C7.5** Interpret graphs of mass, volume or concentration of reactant or product against time.

## Maths requirements

- 1a** Recognise and use expressions in decimal form.
- 1c** Use ratios, fractions and percentages.
- 4a** Translate information between graphical and numeric form.
- 4d** Determine the slope and intercept of a linear graph.
- 4e** Draw and use the slope of a tangent to a curve as a measure of rate of change.

## Learning outcomes

-  **SC7.2** Describe different changes that can occur as a reaction proceeds.
-  **SC7.2** Suggest different experimental methods to investigate rates of reaction (e.g. measurements of mass of reactants against time, volume of gas released against time, concentration of reactant or product against time).
-  **SC7.5** Use graphs of changes (in mass, volume or concentration of reactant or product) against time, to interpret what is happening during reactions.

## Exploring

### 1. Core practical – Investigating rates of reaction

This practical forms part of the core practical requirement of the specification. It is supported by the information on Students' sheet CP6a (Rates of reaction-Vol of gas) and in the Student Book.

Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by measuring the production of a gas (in the reaction between hydrochloric acid and marble chips). This is part a of the core practical; part b, 'by observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid)', is covered in the next topic, *SC18b Factors affecting reaction rates*.

Students should work in groups and follow the instructions on Students' sheet CP6a (Rates of reaction-Vol of gas) to investigate the effect of changing variables on the rate of a chemical reaction. In task 1, students investigate the effect of changing the surface area of solids (the size of solid lumps) in the reaction between marble chips and hydrochloric acid. In task 2, students investigate the effect of changing the concentration of acid in the same reaction. Most students will use the method on the first page of Worksheet SC18a.1. If time allows, students can carry out both investigative tasks. Alternatively, half the groups can carry out task 1, the others doing task 2, with the groups then sharing their results.

Note that the concentrations of hydrochloric acid to be used in task 2 are given in  $\text{mol dm}^{-3}$ . They are 1.0, 0.8, 0.6, 0.4 and 0.2  $\text{mol dm}^{-3}$ . However, these units and the concept of moles will only be covered by students studying higher tier. For teachers who would prefer to use concentrations in  $\text{g dm}^{-3}$ , the equivalent concentrations are 36.5, 29.2, 21.9, 14.6 and 7.3  $\text{g dm}^{-3}$ .

After the activity, ask groups picked at random to explain what the tasks tell us about the effects of surface area and concentration on reaction rates.

If necessary, students can stick the method from the first page of Worksheet SC18a.1 into their books and then answer the directed questions at the bottom of the page.

**Support:** Some students will need help to set up experiments, may need to be told how to make measurements, and may need help to ensure that they measure the changes as soon as the reactions start. These students should record their results and draw conclusions using the second page of Worksheet SC18a.1.

**Stretch:** Students follow the instructions above the cutting line on page 1 of Worksheet SC18a.1. They then write up the experiment in their own words, design their own results tables, and write a conclusion and an evaluation (with help from Skills Sheets as needed). The directed questions on the worksheet should be covered or removed before photocopying/printing.

### Expected results

The results will depend on the conditions used.

In task 1 for both experiments, the volume of gas produced in each 30 second interval will be greatest at the start of the experiment and decrease until the reaction is finished and no more gas is formed. The reaction using the small chips will produce the gas more quickly at first and be finished in a shorter time than the reaction using the large chips.

In task 2, the volume of gas produced should be directly proportional to the concentration of acid used. (For example, the 0.8  $\text{mol dm}^{-3}$  hydrochloric acid should produce twice the volume of gas in one minute as produced by the 0.4  $\text{mol dm}^{-3}$  hydrochloric acid.)

### Safety

Wear eye protection at all times. Wash off all spills immediately.

### Equipment

For each group:

Task 1 – eye protection, balance, 100  $\text{cm}^3$  measuring cylinder, stop clock, water trough, 250  $\text{cm}^3$  conical flask, bung with delivery tube, stand and clamp, dilute hydrochloric acid (1.0  $\text{mol dm}^{-3}$ ), large marble chips, small marble chips, graph paper

Task 2 – as above plus 0.8, 0.6, 0.4 and 0.2  $\text{mol dm}^{-3}$  hydrochloric acid solutions

### Course resources

Chem Students' sheet CP6a