

## Objectives

- C7.1** Investigate the effects of changing the conditions of a reaction on the rates of chemical reactions by:
- a** measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)
  - b** observing a colour change (in the reaction between sodium thiosulfate and hydrochloric acid).
- C7.3** Explain how reactions occur when particles collide and that rates of reaction are increased when the frequency and/or energy of collisions is increased.
- C7.4** Explain the effects on rates of reaction of changes in temperature, concentration, surface area to volume ratio of a solid and pressure (on reactions involving gases) in terms of frequency and/or energy of collisions between particles.

## 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

-  **SC7.3** Explain what has to happen for reactions to take place.
-  **SC7.3** Explain why changes in the energy of particles affect rates of reaction.
-  **SC7.3** Explain why changes in the frequency of collisions between particles affect the rate of reaction.
-  **SC7.4** Explain why changes in temperature, concentration, surface area and pressure affect the rate of reaction (surface area for solids, pressure for gases only).
-  **SC7.4** Describe ways of speeding up or slowing down chemical reactions.

## Exploring

### 1. Core practical – Investigating reaction rates

This practical forms part of the core practical requirement of the specification. It is supported by the information on *Students' sheet CP6b(Rates of reaction-colour change)* and in the Student Book.

This core practical investigates the effects of changing the conditions of a reaction on the rate of a chemical reaction, by observing a colour change. This is part b of the core practical; part a, 'by measuring the production of a gas (in the reaction between hydrochloric acid and marble chips)' is covered in *SC18a Rates of reaction*. Both sections of this practical are covered in the unit *SC18 Rates of Reaction* in the Student Book.

Students should work in groups, following the instructions in *Students' sheet CP6b(Rates of reaction-colour change)*, to investigate the effect of temperature on the rate of the reaction between sodium thiosulfate and hydrochloric acid. To save time, students could share results.

#### Safety

Wear eye protection at all times.

**Support:** Some students may need to be observed when making their first measurements and given advice about how to ensure they are measuring the temperature and time correctly.

**Stretch:** Ask students to consider the relationship between the time taken for the cross to disappear and the rate of the reaction. The rate increases as the time decreases, and so the rate is proportional to  $1/\text{time}$ . Students could create a graph with  $1/\text{time}$  ( $\text{min}^{-1}$ ) on the vertical axis and temperature ( $^{\circ}\text{C}$ ) on the horizontal axis. This will show the direct relationship between temperature and rate in this reaction.

#### Expected results

The results should show that for every  $10^{\circ}\text{C}$  rise in temperature, the time for the cross to disappear halves and so the rate of the reaction doubles.

#### Equipment

For each group: eye protection,  $250\text{ cm}^3$  conical flask,  $10\text{ cm}^3$  measuring cylinder,  $50\text{ cm}^3$  measuring cylinder, stop clock, test tube, test-tube rack, water bath, white paper with cross, sodium thiosulfate solution ( $40\text{ g dm}^{-3}$ ), dilute hydrochloric acid ( $2\text{ mol dm}^{-3}$ ), graph paper

#### Course resources:

Chem Students' worksheet CP6b