Solutions

Marking: **M1** a correct method, **A1** the correct answer, **B1** an independent mark.

Each answer shows the steps, then the **result**.

2.1

Any two (1 mark each):

- use more concentrated acid
- heat the acid
- use zinc powder instead of lumps
- add a catalyst (copper(II) sulfate)

2.2

- $48 \div 30$
- **1.6** cm^3/s

2.3

- it gives a different reaction pathway with a lower activation energy
- so more collisions have enough energy to react

3.1

- particles have more kinetic energy and move faster
- so they collide more often
- and a larger fraction of collisions have at least the activation energy, so more collisions are successful

3.2

- forward (heating): blue to white
- backward (adding water): white to blue
- the backward reaction is exothermic

3.3

(a) $42 \div 40 =$ **1.05** cm^3/s; the acid is used up, so there are fewer acid particles and fewer collisions per second

(b) the initial rate is faster, because powder has a larger surface area, so more frequent collisions; the final volume is the same (64 cm^3), because the same amount of acid reacts

(c) points to include:

- use several concentrations of acid, e.g. 0.5, 1.0, 1.5, 2.0 mol/dm^3 (App)
- add the marble chips, put the bung in straight away and start the timer (K)
- record the volume of gas every 20 s (or the time to collect a fixed volume) (K)
- keep the same mass and size of marble chips and the same volume of acid (App)
- keep the temperature the same (App)
- plot volume against time; compare the initial gradients, or the mean rates, for each concentration (An)

Levels: **5–6** a full, logical answer with correct chemistry and correct terms; **3–4** several correct points, partly linked; **1–2** one or two relevant points.