Exercise walk-through

Rate of reaction ▪ 8.1

eXercise

You must be able to

- explain rate, collision frequency, and effective vs non-effective collisions
- explain the effect of concentration and pressure on rate
- calculate a rate from experimental data

Method — Collisions and rate

The **rate** is the change in concentration (or amount) per unit time. It depends on the **frequency of effective collisions**.

effective collision

reactive ends line up

$\Rightarrow$ **reaction**

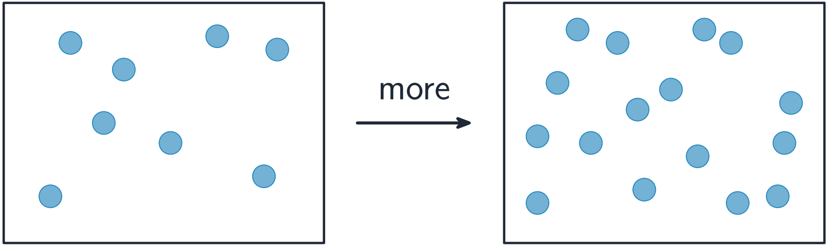
ineffective collision

wrong orientation

$\Rightarrow$ **no reaction**

Method — Concentration and pressure

Increasing concentration (or gas pressure) packs particles closer $\rightarrow$ more effective collisions per second $\rightarrow$ faster rate.



lower concentration
fewer collisions

higher concentration
more collisions

Two boxes of the same size, the second holding more particles, which collide more often

Practice 2.1 ▪ 2 marks

State the **two** things a collision needs to be effective.

Solution 2.1

Method: Collisions and rate

Worked steps

enough energy (at least the activation energy); the correct orientation/direction **B1** *each*.

Practice 2.2 ▪ 2 marks

Explain why increasing the concentration of a reactant speeds up a reaction.

Solution 2.2

Worked steps

there are more particles in the same volume **M1**, so they collide more often — more effective collisions per second **A1**.

Exam-style 3.1 ▪ 1 mark

Increasing the pressure of a gas reaction increases the rate because:

A the particles gain activation energy

B the particles are closer, so collide more often

C the activation energy falls

D the catalyst works better

Solution 3.1

Method: Concentration and pressure

A the particles gain activation energy

B the particles are closer, so collide more often ✓

C the activation energy falls

D the catalyst works better

Worked steps

B. Higher pressure brings particles closer, so they collide more often.

Exam-style 3.2 ▪ 1 mark

A reaction produces 48 cm^3 of gas in 20 s. The mean rate of reaction is:

A 0.42 cm^3 s^{-1}

B 2.4 cm^3 s^{-1}

C 24 cm^3 s^{-1}

D 960 cm^3 s^{-1}

Solution 3.2

Method: Collisions and rate

A $0.42\ \mathrm{cm^3\,s^{-1}}$

B $2.4\ \mathrm{cm^3\,s^{-1}}$ ✓

C $24\ \mathrm{cm^3\,s^{-1}}$

D $960\ \mathrm{cm^3\,s^{-1}}$

Worked steps

B. $48/20 = 2.4\ \mathrm{cm^3\,s^{-1}}$.

Exam-style 3.3 ▪ 2 marks

A reaction makes carbon dioxide. The volume collected is 30 cm^3 at 15 s and 54 cm^3 at 45 s.

(a) Calculate the mean rate of reaction between 15 s and 45 s.

(b) Explain why the rate is faster at the start of the reaction than near the end.

Solution 3.3

Method: Concentration and pressure

Worked steps

(a) $\dfrac{54-30}{45-15} = \dfrac{24}{30} = 0.80\ \mathrm{cm^3\,s^{-1}}$ **M1** **A1**.

(b) at the start the reactant concentration is highest **M1**, so collisions are more frequent and the rate is faster; as reactant is used up the rate falls **A1**.