

## Exercise walk-through

### Representations of Equilibrium ■ 7.8

eXercise

## You must be able to

- read a **particle diagram** showing an equilibrium mixture
- connect the diagram's ratio to the size of  $K$
- recognise that amounts stay constant at equilibrium

## Method — Particle diagrams of equilibrium

An equilibrium particle diagram shows a **mixture** of reactant and product particles whose numbers stay **constant** over time (equal forward and reverse rates).

## Method — Reading $K$ from the ratio

The ratio of product to reactant particles reflects the size of  $K$ : mostly products  $\rightarrow$  large  $K$ ; mostly reactants  $\rightarrow$  small  $K$ ; roughly equal  $\rightarrow K \approx 1$ .

## Method — A worked reading

A box with 8 product particles and 2 reactant particles suggests products are favored, so  $K > 1$ . The exact value uses the equilibrium expression.

## Method — Constant over time

Two diagrams at different times, both at equilibrium, should show the **same** numbers of each particle — individual molecules interconvert, but the totals hold.

## Practice 2.1 ■ 1 mark

At equilibrium, do the numbers of each particle change over time?

## Solution 2.1

### Worked steps

No — they stay constant **B1**.

## Practice 2.2 ■ 1 mark

A diagram shows mostly product particles. Is  $K$  large or small?

## Solution 2.2

Method: Reading K from the ratio

### Worked steps

Large **B1**.

## Practice 2.3 ■ 1 mark

A diagram shows roughly equal reactant and product particles. Estimate  $K$ .

## Solution 2.3

Method: Particle diagrams of equilibrium

### Worked steps

About 1 **B1**.

## Exam-style 3.1 ■ 1 mark

An equilibrium particle diagram with mostly reactant particles indicates

**A**  $K > 1$

**B**  $K < 1$

**C**  $K = 0$

**D** no reaction

## Solution 3.1

Method: Particle diagrams of equilibrium

**A**  $K > 1$

**B**  $K < 1$



**C**  $K = 0$

**D** no reaction

### Worked steps

**B** — mostly reactants means  $K < 1$ .

## Exam-style 3.2 ■ 2 marks

For  $A \rightleftharpoons B$ , a box at equilibrium shows 3 A and 9 B particles (in a fixed volume).

- (a) Estimate  $K$  (treat particle counts as concentrations).
- (b) State whether products or reactants are favored.

## Solution 3.2

## Worked steps

(a)  $K = \frac{[B]}{[A]} = \frac{9}{3} = 3$  **M1** **A1**. (b) Products favored ( $K > 1$ ) **B1**.

## Exam-style 3.3 ■ 2 marks

Explain why two particle diagrams of the same equilibrium, taken 1 minute apart, should show the same numbers of each species.

## Solution 3.3

Method: Constant over time

### Worked steps

At equilibrium the forward and reverse rates are equal, so although individual molecules keep converting, the total number of each species does not change

**M1** **A1**.