Exercise walk-through

Introduction to Equilibrium ▪ 7.1

eXercise

You must be able to

- describe **dynamic equilibrium** 动态平衡 (forward rate = reverse rate)
- explain that concentrations stay **constant**, not equal
- recognise the $\rightleftharpoons$ symbol

Method — Dynamic equilibrium

In a closed system a reversible reaction reaches **equilibrium** when the **forward and reverse rates are equal**. Both reactions still happen — it is **dynamic**, not stopped.

Method — Concentrations are constant, not equal

At equilibrium the concentrations of reactants and products stay **constant** over time, but they are usually **not equal** to each other.

Method — The reversible arrow

The $\rightleftharpoons$ symbol means the reaction goes **both** ways at once. A reaction that goes essentially to completion uses a single arrow.

Method — Reaching equilibrium

Starting from reactants, the forward rate is high and falls as reactants deplete; the reverse rate starts at zero and rises. They meet — that is equilibrium.

Practice 2.1 ▪ 1 mark

At equilibrium, how do the forward and reverse rates compare?

Solution 2.1

Method: Dynamic equilibrium

Worked steps

They are equal B1.

Practice 2.2 ▪ 1 mark

Are reactant and product concentrations equal at equilibrium?

Solution 2.2

Method: Concentrations are constant, not equal

Worked steps

Not necessarily — they are constant, but usually not equal B1.

Practice 2.3 ▪ 1 mark

What does “dynamic” mean in dynamic equilibrium?

Solution 2.3

Method: Dynamic equilibrium

Worked steps

Both the forward and reverse reactions continue at the molecular level B1.

Exam-style 3.1 ▪ 1 mark

At equilibrium, the concentrations of reactants and products are

A equal to each other

B constant over time

C zero

D always increasing

Solution 3.1

Method: Concentrations are constant, not equal

A equal to each other

B constant over time ✓

C zero

D always increasing

Worked steps

B — constant over time.

Exam-style 3.2 ▪ 2 marks

A reversible reaction is placed in a closed flask starting with only reactants.
(a) Describe how the forward and reverse rates change until equilibrium.
(b) State what is true of the rates at equilibrium.

Solution 3.2

Method: Dynamic equilibrium

Worked steps

(a) The forward rate starts high and falls as reactants deplete; the reverse rate starts at zero and rises as products build, until they meet M1 A1. (b) They are equal B1.

Exam-style 3.3 ▪ 2 marks

Explain why equilibrium is called “dynamic” even though concentrations do not change.

Solution 3.3

Worked steps

The forward and reverse reactions continue at equal rates, so molecules keep converting both ways; the concentrations stay constant only because the two rates cancel M1 A1.