

Exercise walk-through

Direction of Reversible Reactions ■ 7.2

eXercise

You must be able to

- write the **equilibrium expression** $K = \frac{[\text{products}]}{[\text{reactants}]}$ with coefficients as powers
- exclude pure solids and liquids
- write K for a given equation

Method — The equilibrium expression

For $aA + bB \rightleftharpoons cC + dD$,

$$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}.$$

Products over reactants, each raised to its coefficient.

Method — A worked expression

For $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$:

$$K = \frac{[\text{NH}_3]^2}{[\text{N}_2][\text{H}_2]^3}.$$

Method — Leave out solids and pure liquids

Pure **solids** and pure **liquids** have constant “concentration” and are **omitted** from K . Only gases and dissolved species appear.

Method — Gases can use pressures

For gas equilibria, K_p uses partial pressures in place of concentrations, with the same product-over-reactant form.

Practice 2.1 ■ 2 marks

Write K for $2\text{SO}_2 + \text{O}_2 \rightleftharpoons 2\text{SO}_3$.

Solution 2.1

Worked steps

$$K = \frac{[\text{SO}_3]^2}{[\text{SO}_2]^2[\text{O}_2]} \quad \text{M1} \quad \text{A1} .$$

Practice 2.2 ■ 1 mark

Which states are left out of an equilibrium expression?

Solution 2.2

Method: The equilibrium expression

Worked steps

Pure solids and pure liquids **B1**.

Practice 2.3 ■ 1 mark

Write K for $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$.

Solution 2.3

Worked steps

$$K = \frac{[\text{HI}]^2}{[\text{H}_2][\text{I}_2]} \quad \text{B1}.$$

Exam-style 3.1 ■ 1 mark

In the equilibrium expression, each concentration is raised to the power of its

- A** molar mass
- B** coefficient in the balanced equation
- C** oxidation number
- D** charge

Solution 3.1

Method: The equilibrium expression

- A molar mass
- B coefficient in the balanced equation 
- C oxidation number
- D charge

Worked steps

B — its coefficient in the balanced equation.

Exam-style 3.2 ■ 2 marks

For $\text{CaCO}_3(s) \rightleftharpoons \text{CaO}(s) + \text{CO}_2(g)$:

- (a) Write the equilibrium expression.
- (b) Explain why the solids do not appear.

Solution 3.2

Method: The equilibrium expression

Worked steps

(a) $K = [\text{CO}_2]$ **M1** **A1**. (b) The solids (CaCO_3 , CaO) have constant activity and are omitted **B1**.

Exam-style 3.3 ■ 2 marks

Write the equilibrium expression for $\text{Fe}^{3+}(\text{aq}) + \text{SCN}^{-}(\text{aq}) \rightleftharpoons \text{FeSCN}^{2+}(\text{aq})$.

Solution 3.3

Method: The equilibrium expression

Worked steps

$$K = \frac{[\text{FeSCN}^{2+}]}{[\text{Fe}^{3+}][\text{SCN}^{-}]} \quad \text{M1} \quad \text{A1}.$$