Exercise walk-through

Calculating the Equilibrium Constant ▪ 7.4

eXercise

You must be able to

- substitute equilibrium concentrations into the K expression
- use an **ICE table** 初始-变化-平衡 (Initial, Change, Equilibrium)
- solve for K

Method — Straight substitution

Given the equilibrium concentrations, put them into the K expression. For $H_2 + I_2 \rightleftharpoons 2HI$ with $[H_2] = 0.1$, $[I_2] = 0.1$, $[HI] = 0.8$:

$$K = \frac{(0.8)^2}{(0.1)(0.1)} = 64.$$

Method — The ICE table

When only starting amounts and one change are given, use an **ICE** table: write **I**nitial, the **C**hange ($\pm x$ scaled by coefficients), and the **E**quilibrium row. Then substitute.

Method — A worked ICE

A $\rightleftharpoons$ B, start $[\mathrm{A}] = 1.0$, $[\mathrm{B}] = 0$. At equilibrium $[\mathrm{B}] = 0.6$, so $x = 0.6$ and $[\mathrm{A}] = 1.0 - 0.6 = 0.4$. Then $K = \dfrac{0.6}{0.4} = 1.5$.

Method — Watch the coefficients

The change x is multiplied by each species' coefficient (e.g. a "2" species changes by $2x$).

Practice 2.1 ▪ 2 marks

For $H_2 + I_2 \rightleftharpoons 2HI$ with $[H_2] = [I_2] = 0.2$, $[HI] = 0.8$, find K.

Solution 2.1

Worked steps

$$K = \frac{(0.8)^2}{(0.2)(0.2)} = \frac{0.64}{0.04} = 16 \quad \text{M1} \; \text{A1}.$$

Practice 2.2 ▪ 1 mark

In an ICE table, what do I, C, and E stand for?

Solution 2.2

Worked steps

Initial, Change, Equilibrium B1.

Practice 2.3 ▪ 1 mark

A $\rightleftharpoons$ B starts at $[\mathrm{A}] = 2.0$, $[\mathrm{B}] = 0$; at equilibrium $[\mathrm{B}] = 0.5$. Find $[\mathrm{A}]$ at equilibrium.

Solution 2.3

Worked steps

$[\mathrm{A}] = 2.0 - 0.5 = 1.5$ M **B1**.

Exam-style 3.1 ▪ 1 mark

To find K, you substitute the ____ concentrations into the expression.

A initial

B equilibrium

C standard

D average

Solution 3.1

Method: Straight substitution

A initial

B equilibrium ✓

C standard

D average

Worked steps

B — the equilibrium concentrations.

Exam-style 3.2 ▪ 2 marks

For $\mathrm{A} \rightleftharpoons 2\mathrm{B}$, start $[\mathrm{A}] = 1.0$ M, $[\mathrm{B}] = 0$. At equilibrium $[\mathrm{A}] = 0.6$ M.
(a) Find $[\mathrm{B}]$ at equilibrium (note the coefficient 2).
(b) Calculate K.

Solution 3.2

Method: A worked ICE

Worked steps

(a) A fell by 0.4, so $x = 0.4$; B rose by $2x = 0.8$, so $[\mathrm{B}] = 0.8$ M M1 A1. (b) $K = \dfrac{(0.8)^2}{0.6} = \dfrac{0.64}{0.6} = 1.07$ M1 A1.

Exam-style 3.3 ▪ 3 marks

For $N_2 + 3H_2 \rightleftharpoons 2NH_3$, the equilibrium concentrations are $[N_2] = 0.20$, $[H_2] = 0.20$, $[NH_3] = 0.40$. Calculate K.

Solution 3.3

Method: Straight substitution

Worked steps

$$K = \frac{(0.40)^2}{(0.20)(0.20)^3} = \frac{0.16}{(0.20)(0.008)} = \frac{0.16}{0.0016} = 100$$ M1 M1 A1.