

7.4 Calculating the Equilibrium Constant

Name: _____ Class: _____ Date: _____

Total: 12 marks

KEY WORDS ice table 初始 • equilibrium constant 平衡常数

Objective

Build the skills to answer exam questions on **calculating the equilibrium constant** from equilibrium concentrations.

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

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Straight substitution

Given the equilibrium concentrations, put them into the K expression. For $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ with $[\text{H}_2] = 0.1$, $[\text{I}_2] = 0.1$, $[\text{HI}] = 0.8$:

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

■ 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.

■ A worked ICE

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

■ **Watch the coefficients**

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

2 Practice

Now apply the methods above.

2.1 For $\text{H}_2 + \text{I}_2 \rightleftharpoons 2\text{HI}$ with $[\text{H}_2] = [\text{I}_2] = 0.2$, $[\text{HI}] = 0.8$, find K . [2]

2.2 In an ICE table, what do I, C, and E stand for? [1]

2.3 $\text{A} \rightleftharpoons \text{B}$ starts at $[\text{A}] = 2.0$, $[\text{B}] = 0$; at equilibrium $[\text{B}] = 0.5$. Find $[\text{A}]$ at equilibrium. [1]

3 Exam-style questions

3.1 To find K , you substitute the _____ concentrations into the expression. [1]

- **A** initial
 - **B** equilibrium
 - **C** standard
 - **D** average
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3.2 For $A \rightleftharpoons 2B$, start $[A] = 1.0 \text{ M}$, $[B] = 0$. At equilibrium $[A] = 0.6 \text{ M}$.

(a) Find $[B]$ at equilibrium (note the coefficient 2). [2]

(b) Calculate K . [2]

3.3 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 . [3]

Solutions

2.1 $K = \frac{(0.8)^2}{(0.2)(0.2)} = \frac{0.64}{0.04} = 16.$

2.2 Initial, Change, Equilibrium.

2.3 $[A] = 2.0 - 0.5 = 1.5 \text{ M}.$

3.1 B — the equilibrium concentrations.

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

3.3 $K = \frac{(0.40)^2}{(0.20)(0.20)^3} = \frac{0.16}{(0.20)(0.008)} = \frac{0.16}{0.0016} = 100.$