AP CHEMISTRY • EXERCISE SHEET

7.4 Calculating the Equilibrium Constant

Name: _____ Class: _____ Date: _____ **Total: 12 marks**

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 $H_2 + I_2 \rightleftharpoons 2HI$ with $[H_2] = 0.1$, $[I_2] = 0.1$, $[HI] = 0.8$:

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

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

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

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

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

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

3.2 For $A \rightleftharpoons 2B$, start $[A] = 1.0$ M, $[B] = 0$. At equilibrium $[A] = 0.6$ 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]

4 Go further

You are now ready for the real exam questions on this subtopic:

- work through the **7.4 Calculating the Equilibrium Constant** lesson on the **Learn** page;
- read the **Calculating the Equilibrium Constant** section of the AP Chemistry handout on the **Know** page.

Solutions

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

2.2 Initial, Change, Equilibrium.

2.3 $[\text{A}] = 2.0 - 0.5 = 1.5$ 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 $[\text{B}] = 0.8$ M. (b) $K = \dfrac{(0.8)^2}{0.6} = \dfrac{0.64}{0.6} = 1.07.$

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