

Exercise walk-through

7.4

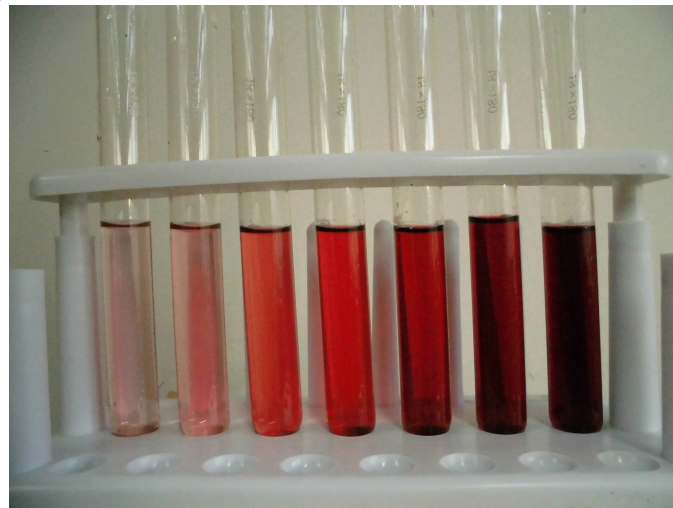
Calculating the Equilibrium Constant

AP Chemistry

Dynamic equilibrium

Chemical equilibrium is **dynamic** : the forward and reverse reactions run at the **same rate**, so concentrations stay constant (not zero).

Reached from **either side** – all reactant or all product gives the same mixture.



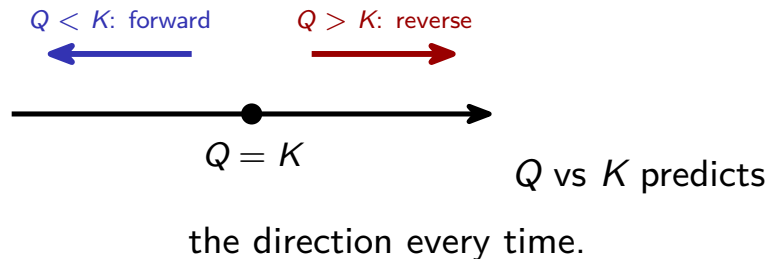
*Dynamic equilibrium: forward and reverse
still run*

The reaction quotient and K

Equilibrium constant

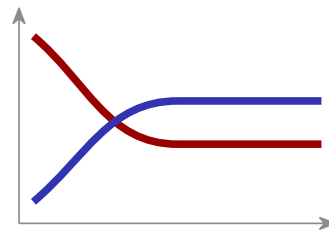
$$K = \frac{[C]^c[D]^d}{[A]^a[B]^b}$$

Reaction quotient Q has the same form at any moment. Leave out pure solids and liquids.



Check yourself

- 1 At equilibrium, how do the forward and reverse rates compare?
- 2 If $Q < K$, which way does the reaction run?
- 3 Which stress actually changes the value of K ?
- 4 Does adding a common ion raise or lower solubility?



Answers 1. they are equal 2. forward 3. temperature 4. lower

Exercises 2.1-2.3

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]

Exercises 2.1-2.3

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]

2.1

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

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

2.2

- Initial, Change, Equilibrium

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]

2.3

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

Exercise 3.1

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

☐

A initial

B equilibrium

C standard

D average

Exercise 3.1

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

☐

A initial

B equilibrium

C standard

D average

3.1 B

- the equilibrium concentrations

Exercise 3.2 (a)

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]

Exercise 3.2 (a)

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]

(a)

- A fell by 0.4, so $x = 0.4$; B rose by $2x = 0.8$, so $[B] = 0.8 \text{ M}$

Exercise 3.2 (b)

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

(b) Calculate K .

[2]

Exercise 3.2 (b)

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

(b) Calculate K .

[2]

(b)

- $$K = \frac{(0.8)^2}{0.6} = \frac{0.64}{0.6} = 1.07$$

Exercise 3.3

3.3 For $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$, the equilibrium concentrations are $[\text{N}_2] = 0.20$, $[\text{H}_2] = 0.20$, $[\text{NH}_3] = 0.40$. Calculate K . [3]

Exercise 3.3

3.3 For $\text{N}_2 + 3\text{H}_2 \rightleftharpoons 2\text{NH}_3$, the equilibrium concentrations are $[\text{N}_2] = 0.20$, $[\text{H}_2] = 0.20$, $[\text{NH}_3] = 0.40$. Calculate K . [3]

3.3

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