Properties of the Equilibrium Constant

Essential Question

How does K change when we change the equation?

Properties of the Equilibrium Constant

Rule 1: Reverse the Reaction

- Products and reactants switch places
- K flips upside down

$$K_{new} = 1/K$$

$A \rightleftharpoons B$ **K = 4.0**



$B \rightleftharpoons A$ **K = 0.25**

Rule 2: Multiply the Coefficients

- Multiply every coefficient by n
- Raise K to the power n

$$K_{new} = K^n$$

$A \rightleftharpoons B$ **K = 4.0**

↓

$2A \rightleftharpoons 2B$ **K = 16**

Rule 3: Add Reactions

- Add the equations, cancel what repeats
- Multiply the K values

$A \rightleftharpoons B$ $\quad K_1 = 2.0$

$B \rightleftharpoons C$ $\quad K_2 = 3.0$

$A \rightleftharpoons C$ $\quad K = 6.0$

$$K_{overall} = K_1 \times K_2$$

Summary of the Rules

Change to the equation	New K
Reverse it	$1/K$
Multiply coefficients by n	K^n
Add two reactions	$K_1 \times K_2$

These rules work for Q too.

Example: Reversing a Reaction

The K for this reaction is 6.00×10^{-2}. Find K for the reverse reaction, $2NH_3(g) \rightleftharpoons N_2(g) + 3H_2(g)$.

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

Example: Changing Coefficients

For $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$, $K = 2.50 \times 10^2$. Find K for:

$$SO_2(g) + \tfrac{1}{2}O_2(g) \rightleftharpoons SO_3(g)$$

Example: Adding Reactions

Use the two reactions below to find K for: $N_2(g) + 2O_2(g) \rightleftharpoons 2NO_2(g)$

$N_2(g) + O_2(g) \rightleftharpoons 2NO(g)$ $\quad K_1 = 2.0 \times 10^{-25}$

$2NO(g) + O_2(g) \rightleftharpoons 2NO_2(g)$ $\quad K_2 = 6.4 \times 10^{9}$

Example: Using Two Rules

Use the reactions below to find K for: $2HF + C_2O_4^{2-} \rightleftharpoons 2F^- + H_2C_2O_4$

$HF \rightleftharpoons H^+ + F^-$ $\quad K_1 = 6.8 \times 10^{-4}$

$H_2C_2O_4 \rightleftharpoons 2H^+ + C_2O_4^{2-}$ $\quad K_2 = 3.8 \times 10^{-6}$

All species are (aq).

Properties of the Equilibrium Constant

Big Ideas

- Reverse → 1/K
- Multiply by n → K^n
- Add reactions → multiply K values
- Same rules apply to Q

$1/K$

K^n

$K_1 \times K_2$