# 15.2 The Equilibrium Constant, K

## Manipulating Equilibrium Constant Expressions

a) Multiply by a constant
b) Reverse the reaction.
c) Combining reactions.

### a) Multiple by a constant.

1. $SO_2(g) + \frac{1}{2} O_2(g) \Leftrightarrow SO_3(g)$
2. $2 SO_2(g) + O_2(g) \Leftrightarrow 2 SO_3(g)$

$$K_1 = \frac{[SO_3]}{[SO_2][O_2]^{1/2}} \qquad K_2 = \frac{[SO_3]^2}{[SO_2]^2 [O_2]}$$

Rxn 2. = 2 × Rxn 1.

$$K_2 = K_1^2$$

### b) Reverse the reaction.

1. $2 SO_3(g) \Leftrightarrow 2 SO_2(g) + O_2(g)$
2. $2 SO_2(g) + O_2(g) \Leftrightarrow 2 SO_3(g)$

$$K_1 = \frac{[SO_2]^2 [O_2]}{[SO_3]^2} \qquad K_2 = \frac{[SO_3]^2}{[SO_2]^2 [O_2]}$$

Rxn 2. = -1 × Rxn 1.

$$K_2 = K_1^{-1}$$

### c) Combining reactions.

1. $C(s) + \frac{1}{2} O_2(g) \Leftrightarrow CO(g)$
2. $C(s) + \frac{1}{2} O_2(g) \Leftrightarrow CO(g)$
3. $2 C(s) + O_2(g) \Leftrightarrow 2 CO(g)$

$$K_1 = \frac{[CO]}{[O_2]^{1/2}} \qquad K_2 = \frac{[CO]}{[O_2]^{1/2}} \qquad K_3 = \frac{[CO]^2}{[O_2]}$$

Rxn 3. = Rxn 1. + Rxn 2.

$$K_3 = K_1 \times K_2$$

## 15.2 The Equilibrium Constant, K

### Manipulating Equilibrium Constant Expressions

The equilibrium constant, **Kc**, for the following reaction is 0.25 at 500K

$$2\,PCl_5(g) \Leftrightarrow 2\,PCl_3(g) + 2\,Cl_2(g)$$

Calculate **Kc** at this temperature for:

$$PCl_3(g) + Cl_2(g) \Leftrightarrow PCl_5$$

**Kc = ?.0**

a) 1
b) 2 ✓
c) 3
d) 4
e) 3

Compare : $PCl_3(g) + Cl_2(g) \Leftrightarrow PCl_5(g)$

To : $2PCl_5(g) \Leftrightarrow 2PCl_3(g) + 2Cl_2(g)$

The reaction of interest is:-

a) Reversed
b) Multiplied by 1/2

$$K_c = (0.25)^{-1 \times 1/2}$$
$$= (0.25)^{-1/2}$$
$$= \frac{1}{\sqrt{0.25}}$$
$$= 2$$

# 15.3 Using Equilibrium Constants in Calculations

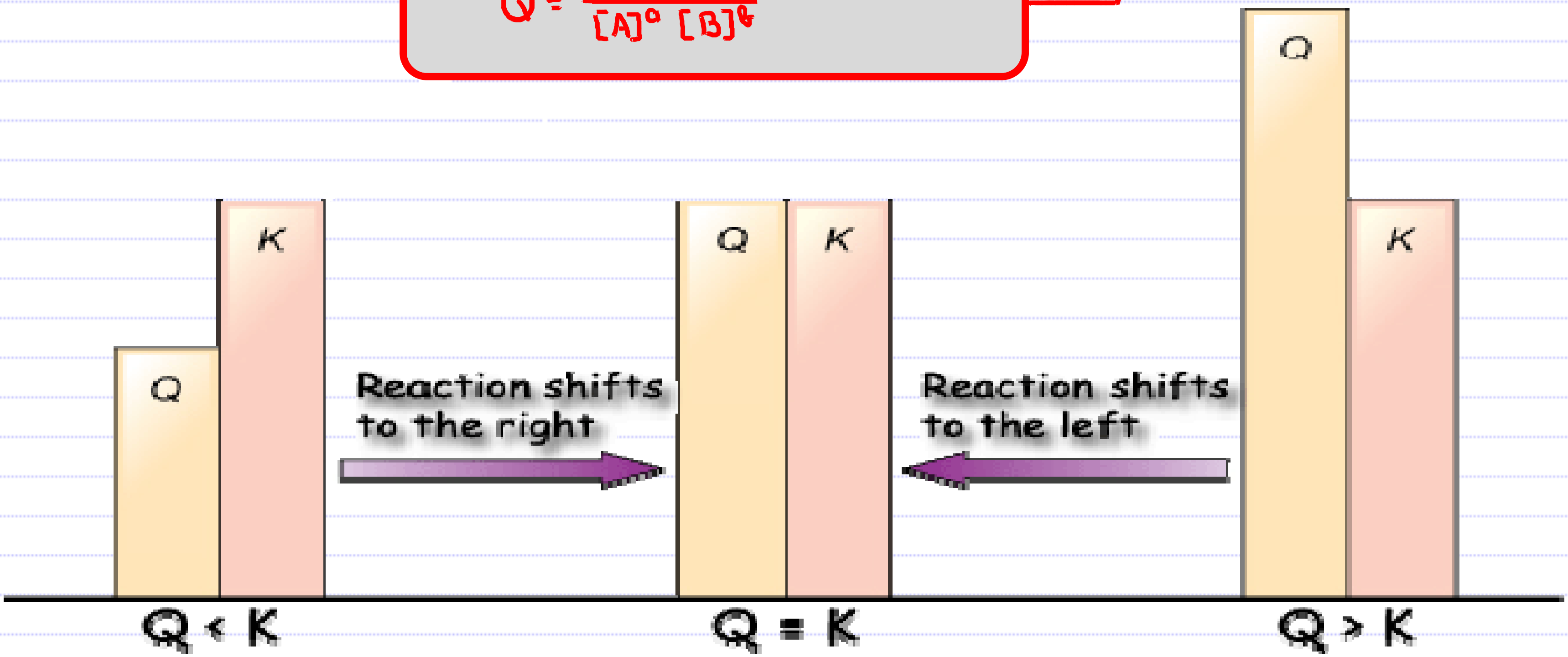
## Determining Whether a System Is at Equilibrium – Q

Q = Reaction Quotient

$aA + bB \rightleftharpoons cC + dD$

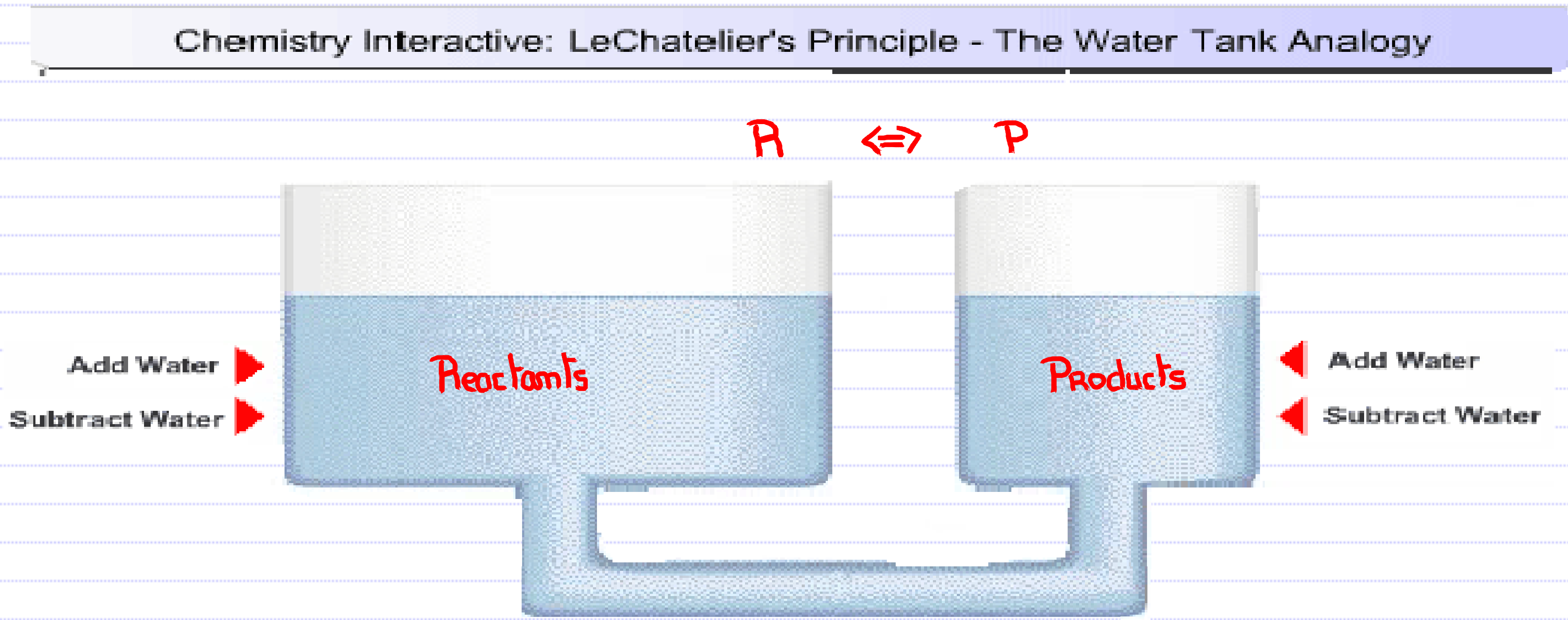
$$Q = \frac{[C]^c [D]^d}{[A]^a [B]^b}$$

- $Q < K$
- $Q > K$
- $Q = K$



## 15.4 Disturbing a Chemical Equilibrium: Le Chatelier's Principle

### Addition or Removal of a Reactant or Product

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