

# AP CHEMISTRY CHEAT SHEET

## Unit 7: EQUILIBRIUM

### Quick Overview

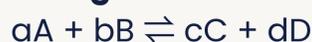
- **Focus:** dynamic equilibrium, equilibrium constants, reaction quotient, ICE tables, and Le Chatelier's Principle.
- **Exam Lens:** compare Q vs K → predict direction → calculate equilibrium concentrations → justify shifts.

### What Equilibrium Really Means

- Chemical equilibrium occurs when forward and reverse reaction rates are equal.
- Concentrations stay constant, but particles continue reacting.
- Equilibrium does not mean equal amounts of reactants and products.

### Equilibrium Constant (K)

For a general reaction:



#### Mini formula box

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

Rules:

- Only include gases and aqueous species.
- Omit solids and pure liquids.
- Exponents come from balanced equation coefficients.

Types of K:

- K<sub>c</sub> uses molar concentrations.
- K<sub>p</sub> uses partial pressures.

### K<sub>c</sub> and K<sub>p</sub> Relationship

#### Mini formula box

$$K_p = K_c(RT)^{\Delta n}$$

Where:

- $\Delta n$  = moles gas products - moles gas reactants
- R = 0.0821 L·atm·mol<sup>-1</sup>·K<sup>-1</sup>
- T in Kelvin

### Reaction Quotient (Q)

Q has the same form as K but uses current concentrations.

- Q < K → reaction shifts forward
- Q > K → reaction shifts backward
- Q = K → system at equilibrium

**Mnemonic:** "Q chases K."

### Magnitude of K

- K ≫ 1 → product-favored
- K ≈ 1 → comparable amounts
- K ≪ 1 → reactant-favored

Large K does **not** mean fast reaction.

### ICE Tables

Used to calculate equilibrium concentrations.

Steps:

- **I:** initial concentrations
- **C:** change based on reaction direction
- **E:** equilibrium concentrations

Assume small x when K is very large or very small.

### Le Chatelier's Principle

When a system at equilibrium is disturbed, it shifts to counteract the change.

#### Concentration Changes

- Add reactant → shift right
- Add product → shift left

#### Pressure and Volume (gases)

- Decrease volume → shift toward fewer gas moles
- Increase volume → shift toward more gas moles

#### Temperature

- Treat heat as a reactant or product.
- Exothermic: heat is product
- Endothermic: heat is reactant

#### Catalysts

- Do not shift equilibrium.
- Only speed up reaching equilibrium.

### Equilibrium Manipulations

- Multiply reaction → K raised to that power.
- Reverse reaction → K becomes 1/K.
- Add reactions → multiply K values.

### Equilibrium and Thermodynamics

#### Mini formula box

$$\Delta G^\circ = -RT \ln K$$

- Large K → negative  $\Delta G^\circ$
- Small K → positive  $\Delta G^\circ$

At equilibrium:  $\Delta G = 0$ .

### Solubility Equilibria (Intro)

- K<sub>sp</sub> describes dissolution of sparingly soluble salts.
- Larger K<sub>sp</sub> → greater solubility.
- ICE tables often used with K<sub>sp</sub> problems.

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