CHEMWHIZ QUICK REFERENCE

TOPIC 21

Chemical Equilibrium

K expressions, Kp/Kc, the reaction quotient, ICE tables, and Le Chatelier's principle.

01 Equilibrium constant — CORE RULE

Kc = [products]^v / [reactants]^v (Kp uses partial pressures). EXCLUDE pure solids and liquids. $N_2 + 3H_2 \rightleftharpoons 2NH_3$: Kc = $[NH_3]^2/([N_2][H_2]^3)$. For $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$: Kp = $P(CO_2)$.

02 Kp and Kc — CORE RULE

Kp = Kc(RT)^Δn, R = 0.0821, T in K, Δn = (mol gas products) − (mol gas reactants), counting gases only. Δn = 0 → Kp = Kc.

03 Manipulating K — CORE RULE

Reverse a reaction → K_rev = 1/K. Add reactions → K_net = $K_1 \cdot K_2 \cdot \ldots$ Scale all coefficients by x → K_scaled = K^x. Convert moles to molarity (M = mol/V) before substituting.

04 Q vs K direction — CORE RULE

Q has K's form with current concentrations. Q < K → shifts right (toward products); Q > K → shifts left; Q = K → at equilibrium.

05 ICE table — METHOD

Initial / Change (±vx) / Equilibrium rows, then solve K for x. Three paths: perfect square (take √), x-small approximation (valid when K < 10^{-3} or [init] ≫ x; check x < 5%), or the quadratic formula (keep the positive root). Always back-substitute to confirm K.

06 Decomposition from total P — METHOD

Given only total pressure + product ratio (e.g. $NH_4HS(s) \rightleftharpoons NH_3 + H_2S$, 1:1): write each partial pressure in one unknown, sum to the total, solve, then substitute into Kp.

07 Le Chatelier's principle — REFERENCE

Stress	Shift
add reactant / remove product	right
remove reactant / add product	left
V↓ (P↑), Δn ≠ 0	toward fewer moles of gas
V↑ (P↓), Δn ≠ 0	toward more moles of gas
T↑, endothermic	right (K increases)
T↑, exothermic	left (K decreases)
catalyst / inert gas at const V	no shift

08 Temperature is special — CORE RULE

Only temperature changes the value of K. Every other stress leaves K fixed and the system shifts to restore Q = K.

09 K magnitude → extent — CORE RULE

K ≫ 1 (> 10^3): products dominate (essentially complete). K ≪ 1 (< 10^{-3}): reactants dominate. $10^{-3} \le K \le 10^3$: comparable amounts of both. Rule-of-thumb thresholds for extent prediction.