

Equilibrium and kinetics notesheet

$K_p > K_c$: at Equilibrium, $[P] > [R]$. Lies to the right, or favors products.
 $K_p = K_c$: at Equilibrium, $[P] = [R]$. Lies to the left, or favors reactants.
 $K_p < K_c$: at Equilibrium, $[R] > [P]$. Lies to the left or favors reactants.

$$K_c = \frac{[C]^c \cdot [D]^d}{[A]^a \cdot [B]^b} \quad [K_c = K_{eq}]$$

$$K_p = \frac{[P]^p \cdot [Q]^q}{[R]^r \cdot [S]^s} \quad [K_p = K_{eq}]$$

$K_p = K_c (RT)^{\Delta n}$ (Δn = moles of gas, P - moles of gas, R)
 $K_p = K_c$ if $\Delta n = 0$

	Stress	Change in K or Q	Result
Equilibrium Res ⁿ	Add more reac.	decrease Q	Reaction to the right
	Remove reac.	increase Q	Reaction to the left
	Add more prod.	increase Q	Reaction to the left
	Remove prod.	decrease Q	Reaction to the right
Substantial Res ⁿ	Increase Temp.	decrease K	Reaction to the left
	Decrease Temp.	increase K	Reaction to the right
	Increase Temp.	increase K	Reaction to the right
	Decrease Temp.	decrease K	Reaction to the left
	Inc. partial p.	shift K	Reaction to fewer gas mole.
	Dec. partial p.	shift K	Reaction to more gas mole.
	Inc. volume	shift K	Reaction to more gas mole.
	Dec. volume	shift K	Reaction to fewer gas mole.
	Addine Catalyst	No change to K or Q	Reach equilibrium sooner

Relating Q , K and ΔG	ΔG	K/Q	Forward Res ⁿ	Reverse Res ⁿ	Characteristics
$\Delta G < 0$	$(-)$	$Q < K$	Spontaneous, towards products (right)		Spontaneous, towards products (right)
$\Delta G > 0$	$(+)$	$Q > K$		Spontaneous, towards reactants (left)	Spontaneous, towards reactants (left)
$\Delta G = 0$		$Q = K$			Reaction at Equilibrium

Identifying acids and bases
 A strong acid completely dissociates in water. Weak acids only partially dissociates.
 A strong base ionizes completely in water, a weak base only partially ionize.

Bronsted Lowry Definition: Acids \rightarrow donate protons, Bases \rightarrow accept protons
 Compounds who act as an acid/base depending on what else is present: amphoteric compounds. Eg. water

K_a [acid ionization constant]: $\frac{[A^-][H^+]}{[HA]}$
 $pK_a = -\log(K_a)$

$K_a \uparrow$ Acid Strength \uparrow	$K_b \uparrow$ pH \downarrow	$K_a = \frac{[H^+][A^-]}{[HA]}$	$K_b = \frac{[OH^-][BH^+]}{[B]}$
$pK_a \downarrow$ Acid Strength \uparrow	$pK_b \downarrow$ pH \downarrow	$\uparrow K_a$ Base strength \uparrow	$\uparrow pK_b$ Base strength \uparrow

Homogenous vs Heterogenous Equilibria
 Homogenous: same phases. Usually gas or aqueous sol.
 Heterogenous: different phases.
 K_c consists of only gaseous or aqueous phases of products and reactants.

$K < Q$
 Q is Reaction Quotient = current conc. of reactants and products.
 If $Q > K$ then: proceeds towards the reactants.
 If $Q < K$ then: proceeds towards products.

Thermodynamics and Equilibrium
 At Eq $\Delta G = 0, Q = K$
 $\therefore \Delta G = \Delta G^\circ + RT \ln Q$
 $0 = \Delta G^\circ + RT \ln K$
 $-RT \ln K = \Delta G^\circ$
 OR $K = e^{\frac{-\Delta G^\circ}{RT}}$ **Notesheet**

Van't Hoff Equation
 $\ln K = \frac{-\Delta H^\circ}{RT} = \ln K = \frac{-\Delta H^\circ + T\Delta S}{RT}$
 $\ln K = \frac{-\Delta H^\circ}{R} \left[\frac{1}{T} \right] + \frac{\Delta S}{R}$ slope = $-\frac{\Delta H^\circ}{R}$
 $\ln \left[\frac{K_2}{K_1} \right] = -\frac{\Delta H^\circ}{R} \left[\frac{1}{T_1} - \frac{1}{T_2} \right]$ **Notesheet**

Conjugate acid/base pair
 Strong acids have weaker affinity for protons, and have weak conjugate bases.
 Weak acids have stronger affinity for protons and have strong conjugate base.

pH and acidity: $-\log [H^+] = pH$
 $\downarrow pH = \uparrow$ Acidity
 pOH and basicity: $-\log [OH^-] = pOH$
 $\uparrow pOH = \uparrow$ Basicity

$pH + pOH = 14$
 $K_w = [H^+][OH^-]$
 \downarrow ion product constant.
 At 25°C (298K), $K_w = [H^+][OH^-] = 1.0 \times 10^{-14}$
 $K_a K_b = K_w$

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N Colangelo



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