# Equilibrium II  Ch. A # 13-27 (odd)

13. The equilibrium constant for a reaction represents the relative amounts of products and reactants in a system at chemical equilibrium. The algebraic form of the equilibrium constant for a typical rxn $aA + bB \leftrightharpoons cC + dD$ is

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

where the square brackets indicate the concentration of the bracketed compound.

5. a) $4NH_3(g) + 5O_2(g) \leftrightharpoons 4NO(g) + 6H_2O(g)$ ; $K_c = \dfrac{[NO]_{eq}^{4}[H_2O]_{eq}^{6}}{[NH_3]_{eq}^{4}[O_2]_{eq}^{5}}$

b) $2NO(g) + O_2(g) \leftrightharpoons 2NO_2(g)$ ; $K_c = \dfrac{[NO_2]_{eq}^{2}}{[NO]_{eq}^{2}[O_2]_{eq}}$

c) $CH_3OH(g) \leftrightharpoons CH_2O(g) + H_2(g)$ ; $K_c = \dfrac{[H_2]_{eq}[CH_2O]_{eq}}{[CH_3OH]_{eq}}$

7. a) $K_c = \dfrac{[NO]_{eq}[ClNO_2]_{eq}}{[NO_2]_{eq}[ClNO]_{eq}^{2}}$

b) $K_c = \dfrac{[BrF_5]_{eq}}{[Br_2]_{eq}[F_2]_{eq}^{5}}$

c) $K_c = \dfrac{[N_2]_{eq}^{5}[H_2O]_{eq}^{6}}{[NH_3]_{eq}^{4}[NO]_{eq}^{6}}$

19. $CH_3OH(g) \leftrightharpoons CH_2O(g) + H_2(g)$ ; $[CH_3OH]_{eq} = 0.00215\ M$, $[CH_2O]_{eq} = 0.441\ M$, $[H_2] = 0.0331\ M$

$$K_c = \frac{[CH_2O]_{eq}[H_2]_{eq}}{[CH_3OH]_{eq}} = \frac{(0.441)(0.0331)}{(0.00215)} = 6.789$$

21. $N_{2(g)} + O_{2(g)} \leftrightharpoons 2NO_{(g)}$ ; $[N_2]_{eq} = 0.041\ M$, $[O_2]_{eq} = 0.0078\ M$, $[NO]_{eq} = 4.7 \times 10^{-4}\ M$

$$K_c = \frac{[NO]_{eq}^2}{[N_2]_{eq}[O_2]_{eq}} = \frac{(4.7 \times 10^{-4})^2}{(0.041)(0.0078)} = 6.907 \times 10^{-4}$$

23. In a homogeneous equilibrium system, all reactants and products are in the same phase. For example, $N_{2(g)} + O_{2(g)} \leftrightharpoons 2NO_{(g)}$.

In a heterogeneous equilibrium system, not all reactants and products are in the same phase. Two examples are:

$$2H_2O_{(l)} \leftrightharpoons H_3O^+_{(aq)} + OH^-_{(aq)}$$

$$CaCO_{3(s)} \leftrightharpoons Ca^{2+}_{(aq)} + CO_3^{2-}_{(aq)}$$

25. a) $SO_{3(g)} + H_2O_{(l)} \leftrightharpoons H_2SO_{4(l)}$ ; $K_c = \frac{1}{[SO_3]}$

b) $2NH_{3(g)} + CO_{2(g)} \leftrightharpoons N_2CH_4O_{(s)} + H_2O_{(g)}$ ; $K_c = \frac{[H_2O]}{[NH_3]^2[CO_2]}$

c) $ZrI_{4(s)} \leftrightharpoons Zr_{(s)} + 2I_{2(g)}$ ; $K_c = [I_2]^2$

27. a) $K_c = [O_2]$

b) $K_c = [O_2]^3$

c) $K_c = \frac{[CO]^2}{[CO_2]}$