Chemistry 102 Winter 2010

Announcements

1. Key for Exam 2 posted outside of PS 158.
2. Final exam on Mar. 15, Monday.

Today

1. Chemical equilibrium calculations.

Chemical equilibrium

Chemical equilibrium is a dynamic equilibrium between reactants and products in which their concentrations remain constant.

K_c, the equilibrium constant, is the ratio of the concentrations of products to reactants *at equilibrium*, and K_c has a constant value at a given temperature.

K_c can answer three important questions (p.466).

1. Are products or reactants favored?

2. Given initial concentrations of reactants and products, which direction of the reaction (forward or reverse) will be favored to reach equilibrium? (*remember, the opposite rates are only equal at equilibrium. To reach equilibrium, one of the rates has to start out faster, and then slow down, as the other rate starts out slower and speeds up)*

3. What are the equilibrium concentrations of reactants and products?

Calculating the Equilibrium Constant

For a reaction, if we can determine the concentrations of reactants and products at equilibrium, then we can calculate the equilibrium constant for that reaction at that temperature.

	(colorless)	(brown)
Example: p.472	$N_2O_4(g)$	$2NO_2(g)$
Initial conc. (M)		
Change in conc. (M)		
Equilibrium conc. (M)		

(Why use fractions?)

The set-up to track Initial, Change, and Equilibrium concentrations is a <u>reaction table</u> (or I-C-E table).

Example: p.474	$H_2(g)$	+	$I_2(g)$	$2HI(g)$
Initial conc. (M)				
Change in conc. (M)				
Equilibrium conc. (M)				

(Why use fractions?)

Practice: p.474, P-S Practice 13.3

$CH_3COOH(aq) + H_2O(l) \quad CH_3COO^-(aq) + H_3O^+(aq)$

Calculating Equilibrium Concentrations

For a reaction, if we know the equilibrium constant, then we can determine the concentrations of reactants and products at equilibrium.

Example: p.481	$2HI(g)$	$H_2(g) + I_2(g)$
Initial conc. (M)		
Change conc. (M)		
Equil. conc. (M)		

(no fractions!)

<u>Example</u>: 0.15 mol SO_3, 0.015 mol SO_2, 0.0075 mol O_2 in 10.0-L flask at 25°C ($K_c = 3.58 \times 10^{-3}$). What are equilibrium concentrations?

	$2SO_3(g)$	$2SO_2(g)$	+	$O_2(g)$
Initial conc. (M)				
Change conc. (M)				
Equil. conc. (M)				

(need to calculate Q and compare to K)

<u>Practice</u>: p.482, P-S Practice 13.6.

<u>Practice</u>: Consider $N_2(g) + O_2(g) \qquad 2NO(g)$ at 2300 K with $K_c = 1.7 \times 10^{-3}$. If 0.15 mol NO is placed into 10.0-L flask and heated to 2300 K, what are the equilibrium concentrations?

Equilibrium Constants in Terms of Pressure

$aA(g) + bB(g) \rightleftharpoons cC(g) + dD(g)$

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

K_p = equilibrium constant expressed in terms of partial pressure (Ch. 10). Gas equilibria only.

$$K_p = \frac{P_C\ P_D}{P_A\ P_B}$$

How are K_p and K_c related?

$PV = nRT \qquad P_A = \dfrac{n_A RT}{V} \qquad n_A/V = \text{mol/L} = M$

So $P_A = [A]RT$

Substitute $[X]RT$ into K_p and do algebra …

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

Δn = final moles of gas – initial moles of gas

<u>Example</u>: $N_2(g)$ + $3H_2(g)$ $2NH_3(g)$

$K_c = 3.5 \times 10^8$ at 25 °C. What is K_p at 25 °C.

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OWL HW deadlines

Due Date	Assignment
3/15/10	Chapters 9-13

Before next class,

1. Study Chapter 13, p.471, and Sec. 13.3.-13.5.
2. Read Sec. 13.6-13.7.
3. Work on OWL HW.