Lecture 9.1 Determining Equilibrium Levels

Note Title 9/27/2011

Example: 0.50 moles of N_2, O_2 & NO are placed in a 500.0mL (0.5000L) container. The mixture reaches equilibrium via the equilibrium reaction below. What are the equilibrium concentrations for all species?

$$N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO \qquad K_c = 0.499 \text{ @ } 25^\circ C$$

ice	$N_{2(g)}$	$O_{2(g)}$	$2NO$
initial	$\frac{0.50mol}{0.5000L} = 1.0M$	$\frac{0.50mol}{0.5000L} = 1.0M$	1.0M
change	+x	+x	−2x
✓ equil.	(1.0M + x)	(1.0M + x)	(1.0 − 2x)

$Q = \frac{[NO]^2}{[N_2][O_2]} = \frac{(1.0)^2}{(1.0)(1.0)} = 1 > K_c$ (0.499) → rxn shifts left

Know "x", calc equil. conc

Law of mass action:

$$K_c = \frac{[NO]_e^2}{[N_2]_e[O_2]_e}$$

$$0.499 = \frac{(1.0-2x)^2}{(1.0+x)(1.0+x)}$$

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$$\sqrt{0.499} = \sqrt{\left(\frac{1.0-2x}{1.0+x}\right)^2}$$

$$0.706399 = \frac{1.0-2x}{1.0+x} \Rightarrow (0.706399)(1.0+x) = 1.0-2x$$

$$0.2936 = 2.706399x$$

$$0.10848 = x \quad ☺$$

Equilibrium conc (2 SF)

$[N_2]_e = 1.0 + x = 1.0 + x = 1.10848 = 1.1M$

$[O_2]_e = 1.0 + x = 1.0 + x = 1.10848 = 1.1M$

$[NO]_e = 1.0 - 2x = 1.0 - 2(0.10848) = 0.783 = 0.8M$

Check work

$$Q = \frac{[NO]^2}{[N_2][O_2]} = \frac{(0.783)^2}{(1.10848)(1.10848)} = 0.499 \; ☺ = K_c = 0.499$$

yes! equil conc