Lecture 9.2 Solving Equilibrium Problems using the Quadratic Equation!

Note Title 10/3/2011

Example. 0.20 mole A and 0.15 mole of B are placed in a 1.00L reaction flask. If they react to produce C via the following reaction:

$$A + B \rightleftharpoons 2C \qquad K_c = 4.25 \times 10^{-5}$$

... what are the molar concentrations of A, B & C at equilibrium?

$$[A]_i = \frac{\text{mole A}}{\text{Vol}} = \frac{0.20\,\text{mol}}{1.00\,\text{L}} = 0.20\,M_A \qquad [B]_i = \frac{0.15\,\text{mol}}{1.00\,\text{L}} = 0.15\,M$$

	A	+	B	⇌	2C	$K_c = 4.25\times10^{-5}$
i	0.20M		0.15M		0 M	conc.
c	−x		−x	→	+2x	Q = 0 ... rxn shifts right.
e	0.20M − x		0.15M − x		2x	

L.M.A. $K_c = \dfrac{[C]_e^2}{[A]_e[B]_e}$ $\Rightarrow$ $4.25\times10^{-5} = \dfrac{(2x)^2}{(0.20M-x)(0.15M-x)}$ ← perfect square

... algebra

.... $(4.25\times10^{-5})\underbrace{(0.20-x)(0.15M-x)}_{\text{FOIL}} = \underbrace{(2x)^2}_{4x^2}$ ... solve for x

... $\underbrace{3.999975}_{a}x^2 + \underbrace{1.4857\times10^{-3}}_{b}x \underbrace{- 1.275\times10^{-6}}_{c} = 0$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$ ... solve a, b, c

$$x = \underbrace{5.627\times10^{-4}}_{\text{☺}} \quad \text{or} \quad \underbrace{-5.66\times10^{-4}}_{\text{neg. impossible}}$$

$[A]_e = 0.20 - x = 0.20 - 5.627\times10^{-4} = 0.1994373M = 0.20M$?

$[B]_e = 0.15 - x = 0.15 - 5.627\times10^{-4} = 0.1494373\,M = 0.15\,M$

$[C]_e = 2x = 2(5.627\times10^{-4}) = 1.1254\times10^{-3}M = 1.13\times10^{-3}M$

Checking Work: $Q = \dfrac{[C]^2}{[A][B]} = \dfrac{(1.1254\times10^{-3})^2}{(0.20M)(0.15)} = 4.25\times10^{-5} = K_c$ ☺