CHM 111 – In-Class Practice Problems

1) Hydrogen bromide (HBr) dissociates on heating to 200 °C:

$$2HBr(g) \leftrightarrow H_2(g) + Br_2(g) \; ; \; Kc = \; 1.6\times10^{-2}$$

If we load a 1.00 L reaction vessel with 0.010 moles of HBr, how many moles of HBr will be in the vessel at equilibrium?

0.0080 moles HBr

$K_c = \frac{[Br_2][H_2]}{[HBr]^2} = 0.016$

Assign 'x' to be the change in bromine concentration

species	[init]	Δ	[Equil]
Br_2	0	+x	x
H_2	0	+x	x
HBr	$\frac{0.010}{1.00} = 0.010$	-2x	0.010-2x

$\frac{(x)(x)}{(0.010-2x)^2} = 0.016 \rightarrow \frac{x^2}{(0.010-2x)^2} = 0.016$

Take square root of both sides (or use quadratic eqn)

$\frac{x}{0.010-2x} = \sqrt{0.016}$

$\frac{1}{\sqrt{0.016}}x = 0.010-2x$ – Rearrange to isolate 'x'

$\left(\frac{1}{\sqrt{0.016}}+2\right)x = 0.010$

$x = 1.0095\times10^{-3}$

mol = M times L

$m\,HBr = 0.010-2(1.0095\times10^{-3}) = 0.00798\,M \times 1.00L$

$= 0.0080$ mol HBr

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2) Dinitrogen tetroxide dissociates to give nitrogen dioxide at 25 °C.

$$N_2O_4(g) \leftrightarrow 2NO_2(g) \; ; \; Kc = 0.125$$

If a 1.00 L flask is loaded with 0.0500 mol N_2O_4, what is the concentration of NO_2 in the flask when equilibrium is reached?

0.0536 M NO_2

Assign 'x' to change in dinitrogen pentoxide conc

Species	[Init]	Δ	[Equil]
NO_2	0	+2x	2x
N_2O_4	$\frac{0.0500}{1.00} = 0.0500$	−x	0.0500 − x

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = 0.125$$

$$\frac{(2x)^2}{0.0500 - x} = 0.125 \rightarrow \frac{4x^2}{0.0500 - x} = 0.125$$

Quadratic Rearrange for quadratic formula

$$32x^2 = 0.0500 - x$$

$$\underset{a}{32}x^2 + \underset{b}{1}x \underbrace{- 0.0500}_{c} = 0$$

$$x = \frac{-1 \pm \sqrt{(1)^2 - 4(32)(-0.0500)}}{2(32)} = \frac{-1 \pm \sqrt{7.4}}{64}$$

$x = 0.0268746$; $2x = \boxed{0.0536 \text{ M } NO_2}$

$= -0.0581296$

Discard this root, since it would result in a negative concentration.