CHEMICAL EQUILIBRIUM B PROBLEMS

Name KEY

Period ______________

1) A mixture of 0.10 moles of NO, 0.050 moles of H_2, and 0.10 moles of H_2O is placed in a 1.0-liter vessel at 300 K. The following equilibrium is established:

$$2\,NO_{(g)} + 2\,H_{2(g)} \longleftrightarrow N_{2(g)} + 2\,H_2O_{(g)}$$

At equilibrium, [NO] = 0.062 *M*.

a. Calculate the equilibrium concentrations of H_2, N_2, and H_2O.

b. Calculate K_c.

	NO	H_2	N_2	H_2O
I	.1M	.05M	ØM	.1M
C	.1-.062 = .038 (2x)	-.038 (2x)	+.019 (x)	+.038 (2x)
E	.062M	.05-.038 = .012M	0+.019 = .019M	.1+.038 = .138M

$$K_c = \frac{[N_2]^1 \cdot [H_2O]^2}{[NO]^2 \cdot [H_2]^2}$$

$$K_c = \frac{(.019)^1 \cdot (.138)^2}{(.062)^2 \cdot (.012)^2} = 653.7$$

2) From the following equation:

$$2\,CO_{(g)} + O_{2(g)} \longleftrightarrow 2\,CO_{2(g)} \qquad K_c = 1.2 \times 10^{-4}$$

Calculate the concentrations of all the species if 0.30 moles of CO and 0.30 moles of O_2 are reacted in a 1.0-liter container.

	CO	O_2	CO_2
I	.30M	.30M	ØM
C	-2x	-x	+2x
E	.3-2x	.3-x	2x

$$K_c = 1.2\times10^{-4} = \frac{(2x)^2}{(.3-2x)^2 \cdot (.3-x)}$$

Small K, disregard x change

$$\rightarrow 1.2\times10^{-4} = \frac{4x^2}{(.3)^2\cdot(.3)^1} \rightarrow 1.2\times10^{-4} = \frac{4x^2}{.027}$$

$3.24\times10^{-6} = 4x^2$

$x^2 = 8.1\times10^{-7}$

$x = 9\times10^{-4}$

CO → .3-2x = .298M

O_2 → .3-x = .299M

CO_2 → 2x = 1.8×10^{-3}M

3) A flask is charged with 1.50 atm of N_2O_4 and 1.00 atm NO_2 at 25°C, and the following equilibrium is achieved:

$$N_2O_{4(g)} \longleftrightarrow 2\,NO_{2(g)}$$

After equilibrium is reached, the partial pressure of NO_2 is 0.512 atm.

a. What is the equilibrium partial pressure of N_2O_4?

b. Calculate the value of K_p for the reaction.

	N_2O_4	NO_2
I	1.5	1.00
C	2)‾.488 = .244 (x)	1-.512 = -.488 (2x)
E	1.5+.244 = 1.744 Atm	.512 Atm (provided in problem)

$$K_p = \frac{[NO_2]^2}{[N_2O_4]^1} = \frac{(.512)^2}{1.744} = .150$$

4) At 2000°C, the equilibrium constant for the reaction

$$2\,NO_{(g)} \longleftrightarrow N_{2(g)} + O_{2(g)} \qquad K_c = 2.4 \times 10^3$$

If the initial concentration of NO is 0.200 *M*, what are the equilibrium concentrations on NO, N_2 and O_2?

	NO	N_2	O_2
I	.200	∅	∅
C	−2X	+X	+X
E	.2−2X	X	X

K_c IS LARGE, SO CANNOT DISREGARD VALUE OF X!

$2.4\times10^3 = \frac{(x)^1\cdot(x)^1}{(.2-2x)^2}$

$2.4\times10^3 = \frac{x^2}{(.2-2x)^2}$

$\sqrt{2.4\times10^3} = \frac{x}{.2-2x} \rightarrow 9.8 - 98X = X \rightarrow 9.8 = 99X$

$X = .099$

[NO] → 2X = .198M
[N_2] → X = .099M
[O_2] → X = .099M

5) For the equilibrium:

$$Br_{2(g)} + Cl_{2(g)} \longleftrightarrow 2\,BrCl_{(g)}$$

At 400 K, K_c = 7.0. If 0.30 mol of Br_2 and 0.30 mol Cl_2 are introduced into a 1.0 L container at 400 K, what will be the equilibrium concentrations of Br_2, Cl_2, and BrCl?

	Br_2	Cl_2	$BrCl_2$
I	.3M	.3M	∅
C	−X	−X	+2X
E	.3−X	.3−X	2X

$K_c = 7 = \frac{(2x)^2}{(.3-x)\cdot(.3-x)}$

$\sqrt{7} = \frac{2X}{(.3-X)} \rightarrow .795 - 2.65X = 2X \rightarrow .795 = 4.65X$

$X = .17$

[Br_2] = .3−X = .13M
[Cl_2] → .3−X = .13M
[BrCl] → 2X = .34M

6) At 218°C, $K_c = 1.2 \times 10^{-4}$ for the equilibrium:

$$NH_4HS_{(s)} \longleftrightarrow NH_{3(g)} + H_2S_{(g)}$$

Calculate the equilibrium concentrations of NH_3 and H_2S if a sample of solid NH_4HS is placed in a closed vessel and decomposes until equilibrium is reached.

$NH_4HS_{(s)}$	NH_3	H_2S
↑ NON-FACTOR SINCE IT IS SOLID!	∅	∅
	X	X
	X	X

$K_c = [NH_3]^1\cdot[H_2S]^1$

$1.2\times10^{-4} = [x]^1\cdot[x]^1$

X = .011M