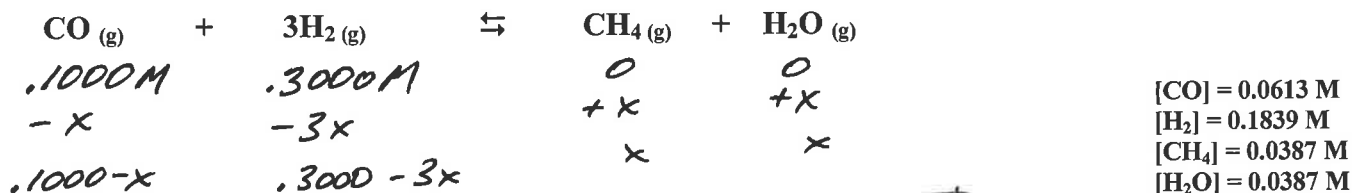


Equilibrium Worksheet #4
From the Internet October, 2003 (Revised 2011)

1. Suppose 1.000 mole CO and 3.000 moles H₂ are put into a 10.00 L vessel at 1200 Kelvin. If the equilibrium constant for the reaction shown below is 3.92, calculate the final composition of the mixture at equilibrium.



$$K = 3.92 = \frac{[x][x]}{[.1000-x][.3000-3x]^3}$$

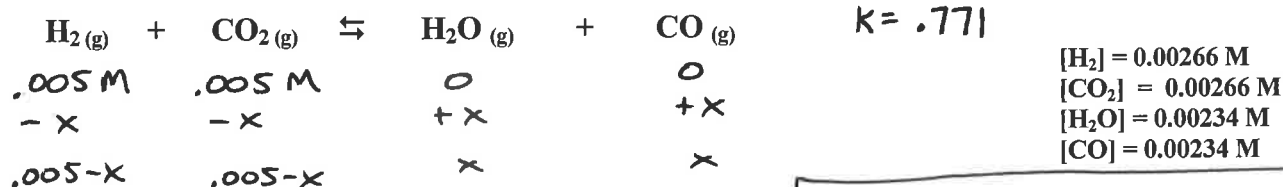
x = .0387

[CO] = .1000 - .0387 = .0613 M
[H₂] = .3000 - (3)(.0387) = .1839 M
[CH₄] = .0387 M
[H₂O] = .0387 M

2. For the reaction represented by the equation:



the value of K is 0.771 at 750°C. If 0.0100 mole of H₂(g) and 0.0100 mole of CO₂(g) are mixed inside a 2.00 L vessel at 750°C, what are the concentrations of all substances at equilibrium?

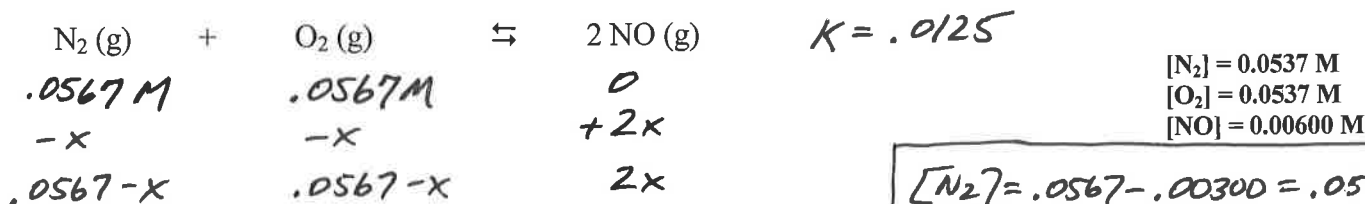


$$K = .771 = \frac{[x][x]}{[.005-x][.005-x]}$$

x = .00234

[H₂] = .005 - .00234 = .00266 M
[CO₂] = .005 - .00234 = .00266 M
[H₂O] = .00234 M
[CO] = .00234 M

3. Nitrogen monoxide is formed in automobile exhaust by the reaction of the N₂ and O₂ in the air. At 2127°C, K=0.0125. Initially, a mixture contains 0.850 moles of N₂ and 0.850 moles of O₂ in a 15.0-Liter vessel. Calculate the concentration of all species when equilibrium is established at 2127°C.

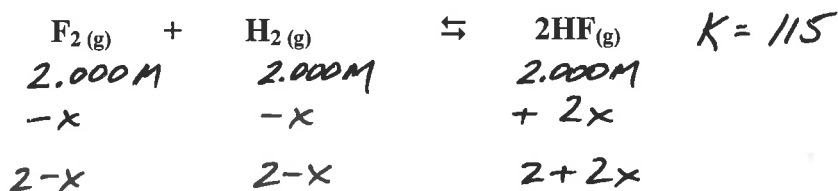


$$K = .0125 = \frac{[2x]^2}{[.0567-x][.0567-x]}$$

x = .00300

[N₂] = .0567 - .00300 = .0537 M
[O₂] = .0567 - .00300 = .0537 M
[NO] = (2)(.00300) = .00600 M

4. The equilibrium constant K is 115 at 60°C for the reaction shown below. A 1.500 L flask contains 3.000 mole of each substance.



- A. Is the system at equilibrium? (Show work here)

$$Q = \frac{[2]^2}{[2][2]} = 1 \quad K > Q \quad \text{System NOT @ equilibrium}$$

- B. If not, in which direction will the equilibrium shift? *To the right*

- C. What are the equilibrium concentrations for each substance?

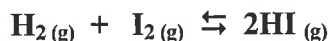
$$K = 115 = \frac{[2+2x]^2}{[2-x][2-x]}$$

$$x = 1.528$$

$$\begin{array}{l}
 [\text{F}_2] = 2 - 1.528 = .472\text{M} \\
 [\text{H}_2] = 2 - 1.528 = .472\text{M} \\
 [\text{HF}] = 2 + (2)(1.528) = 5.056\text{M}
 \end{array}$$

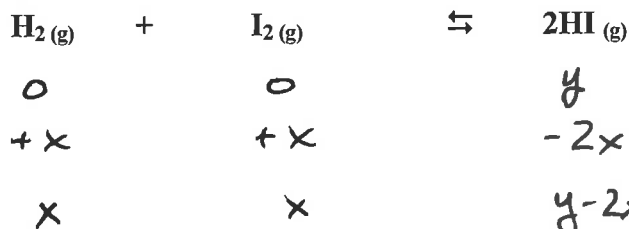
$[\text{H}_2] = 0.472\text{M}$
 $[\text{F}_2] = 0.472\text{M}$
 $[\text{HF}] = 5.056\text{M}$

5. The value of K for the HI equilibrium at 425°C is 54.8.



A quantity of $\text{HI}(\text{g})$ is placed in a 1.00 L container and allowed to come to equilibrium at 425°C . At equilibrium, the concentration of $\text{HI}(\text{g})$ is found to be 0.50 M.

- (a) What are the concentrations of $\text{H}_2(\text{g})$ and $\text{I}_2(\text{g})$ at equilibrium?
 (b) What was the initial concentration of $\text{HI}(\text{g})$?



$$\begin{array}{l}
 [\text{H}_2] = 0.068\text{M} \\
 [\text{I}_2] = 0.068\text{M} \\
 [\text{HI}] = 0.64\text{M}
 \end{array}$$

$$K = 54.8 = \frac{[.50]^2}{[x][x]}$$

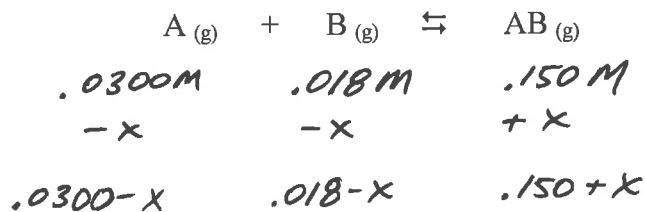
$$x = .068$$

$$\begin{array}{l}
 \text{AT EQUILIBRIUM} \\
 [\text{H}_2] = .068\text{M} \\
 [\text{I}_2] = .068\text{M}
 \end{array}$$

$$\begin{array}{l}
 y - 2(.068) = .50 \\
 y - .136 = .50 \\
 y = .636 \\
 y = .64\text{M}
 \end{array}$$

6. Consider the system $A_{(g)} + B_{(g)} \rightleftharpoons AB_{(g)}$ at equilibrium where $K_c = 500$.

At equilibrium, the concentrations of A, B, and AB are found to be 0.0300 M, 0.0100 M, and 0.150 M, respectively, in a 5.00 L container. An additional 0.0400 moles of B are added. What are the final equilibrium concentrations of A, B, and AB?



$$\frac{.0400}{5.00} = .008M \text{ B added}$$

$$Q = \frac{[.150]}{[.0300][.018]}$$

$Q = 278$

 $K > Q$

$$\begin{aligned} [A] &= 0.0246M \\ [B] &= 0.0126M \\ [AB] &= 0.1554M \end{aligned}$$

$$K = 500 = \frac{[.150+x]}{[.0300-x][.018-x]}$$

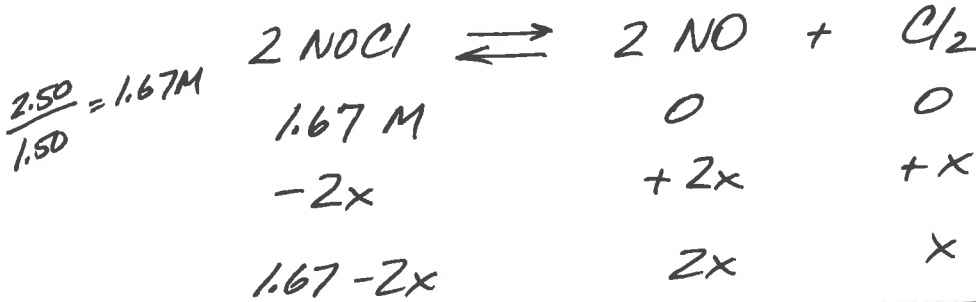
$X = .00538$

$$\begin{aligned} [A] &= .0300 - .00538 = .0246M \\ [B] &= .018 - .00538 = .0126M \\ [AB] &= .150 + .00538 = .1554M \end{aligned}$$

7. A 2.50-mole quantity of NOCl was initially in a 1.50-L reaction chamber at 400°C where the following chemical reaction occurred.



After equilibrium was established, it was found that 28.0% of the NOCl had decomposed. Calculate the equilibrium constant K_c for this reaction.



$$\frac{2.50}{1.50} = 1.67M$$

$$K = 0.0353$$

$$(1.67)(.28) = .468M$$

has decomposed

Since 28.0% of NOCl has decomposed, then we calculate the molarity change for NOCl is .468M. This number represents 2x in the RICE chart. $2x = .468$

$x = .234$

$$K = \frac{[2x]^2[x]}{[1.67-2x]^2} = \frac{[(2)(.234)]^2[.234]}{[1.67-2(.234)]^2} = \frac{.0513}{1.44} = .0356$$