***Developing a Problem Solving Strategy for Chemical Equilibrium Problems***

In making an ICE chart the following items should be noted:

* Express all quantities in terms of [**MOLARITY**](http://www.chem.purdue.edu/gchelp/howtosolveit/Solutions/concentrations.html#Molarity) (moles per liter)
* Use **initial quantities** when calculating the [reaction quotient, Q,](http://www.chem.purdue.edu/gchelp/howtosolveit/Equilibrium/Reaction_Quotient.htm) to determine the direction the reaction shifts to establish equilibrium.
* Use **equilibrium quantities**in calculations involving the [equilibrium constant](http://www.chem.purdue.edu/gchelp/howtosolveit/Equilibrium/Calculating_Equilibrium_Constants.htm), K.
* The **change in each quantity** must be in agreement with the **reaction stoichiometry.**
* Read each problem carefully to identify what quantities are given, including their unit of measure, and to identify what is unknown.
* Clearly define the change you choose to be represented by "x."  Define all other unknown changes in terms of this change.

Here is an example. A chemist has a container of A2 and B2 and they react as given below.

A2 (g) + B2 (g) ⇔ 2 AB (g) K = 9.0 at 100oC

If 1.0 mole A2 and 1.0 mole B2 are placed in a 2.0 L container, what are the equilibrium concentrations of A2, B2, and AB? First find initial concentrations!

A2 + B2 ⇔ 2 AB K = [AB]2/[A2][B2]

Initial: 0.50M 0.50M 0

Change: -x -x +2x (This MUST obey stoichiometry!)

Equilibrium: 0.50-x 0.50-x 2x

Place the equilibrium values into the equilibrium constant expression and solve for the value of x. Calculate the equilibrium concentrations of A2, B2, and AB. Try it!

x=0.30

Suppose you had a container that was 1.0 M in A (g) and it underwent the following reaction. Find the equilibrium concentrations of A2 and A. Follow the steps outlined above!!!!!

2 A (g) ⇔ A2 (g) K = 4.0 at 50oC

Initial:

Change: (This MUST obey stoichiometry!)

Equilibrium:

x=0.71 or x=0.35

General comments about solving quadratic equations in equilibrium problems:

rearrange to equal zero (standard form) ax2 + bx + c = 0

then substitute into the quadratic formula

**Keq Questions**

1. For the system:

CO2 (g)  + H2 (g) ↔ CO (g) + H2O (g)

Keq = 0.64 at 900K

If we start with 0.100mol/L of CO2 and H­2, what are the concentrations of the reactants and products at equilibrium?

 **Answer:** [CO] =[H2O] = 0.044M, [CO2] = [H2] = 0.056M

1. For the system:

2HI(g) ↔ H2 (g)  + I2 (g)

Keq = 0.016

If we start with 0.010 mol/L of H2 and I2 and 0.096 mol/L of HI, what are their concentrations at equilibrium?

 **Answer:** [H2] = [I2] = 0.012M, [HI] = 0.092M

1. At 650°C, the reaction below has a Keq value of 0.771. If 2.00 mol of both hydrogen and carbon dioxide are placed in a 4.00L container and allowed to react, what will be the equilibrium concentrations of all four gases?

H2 (g)  + CO2 (g) ↔ CO (g)  + H2O (g)

 **Answer:** [CO] = [H2O] = 0.234M, [CO2] = [H2] = 0.266M

1. Carbonyl bromide, COBr2, can be formed by reacting CO with Br2. The equation for the reaction is:

CO (g) + Br2 (g) ↔ COBr2 (g) Keq = 5.26

A mixture of 0.400 mol CO, 0.300 mol Br2, and 0.0200 mol COBr2 is sealed in a 5.00L flask. Calculate equilibrium concentrations for all gases.

 **Answer:** [COBr2] = 0.0167M, [CO] = 0.0673M, [Br2] = 0.0473M

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Use the formula: –b ± √­ b2 – 4ac

 2a