The 3'rd Kind - Keq Calculations involving ICE tables

Remember:
A chemical system can be thought of as being either:
1. At Equilibrium
or
2. Not At Equilibrium
A system which is ***not at equilibrium*** *will move spontaneously to a position of* ***being at equilibrium.***

In this type of problem, there will be one species which we will know the concentration of **initially and at equilibrium**. We can find the **change in the concentration** (which we abbreviate as **"[C]"** where the "C" stands for the words "Change in" and [ ]'s stand for Concentration) of this species and by using **mole ratios in the balanced equation**, find the changes in concentration **"[C]"** of the other species. From this we can calculate the **equilibrium concentration** (which we abbreviate as **"[E]"**) of all the species.

3rd type of Keq

ICE Examples # 1

Given the reaction: $N_{2(g)} + 3H_{2(g)}$ <-- --> $2NH_{3(g)}$

Some H_2 and N_2 are added to a container so that initially, the $[N_2]$ = 0.32 M and $[H_2]$ = 0.66 M. At a certain temperature and pressure, the equilibrium [H2] is found to be 0.30 M.

a) Find the equilibrium $[N_2]$ and $[NH_3]$.
b) Calculate Keq at this temperature and pressure.

Set up ICE table under the reaction

	1 $N_2(g)$	+ 3 $H_2(g)$ <-- -->	$2NH_3(g)$
Initial Conc. (I)	0.32 M	0.66 M	0
Change Conc. (C)	−0.12 M	- 0.36 M	+ 0.24 M
Equilibrium Conc (E)	0.20 M	0.30 M	0.24 M

$$Keq = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(0.24)^2}{(0.2)(0.3)^3} = 10.7$$

$$\boxed{Keq = 11}$$

Add in the info from problem

Find the change from initial to equilibrium

Combine (I and C) to find Equilibrium concentrations

First we write the expression for Keq : $N_{2(g)} + 3\,H_{2(g)} \rightleftarrows 2NH_{3(g)}$

$$Keq = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

To calculate Keq , we plug in the values for the ***equilibrium concentrations*** of all the species.

Example 2

Consider the following equilibrium system:
$2NO\ (g) + Cl_2\ (g) \longleftrightarrow 2NOCl\ (g)$

0.80 moles of NO and 0.60 moles of Cl_2 are placed into a 1.0 L container and allowed to establish equilibrium. At equilibrium [NOCl] = 0.56 M.
a) Calculate the equilibrium [NO] 0.24 M
b) Calculate the equilibrium [Cl_2] 0.32 M
c) Determine the value of Keq at this temperature.

NOTE: In a 1.0 Litre container!!! so what is the [conc]??

	2NO(g) +	1 Cl2(g) <---->	2NOCl(g)
[I]	0.80M	0.60M	0
[C]	−0.56M	−0.28 M	+0.56 M
[E]	0.24M	0.32 M	0.56 M

$$K_{eq} = \frac{[NOCl]^2}{[NO]^2[Cl_2]} = \frac{(0.56)^2}{(0.24)^2(0.32)} = 17$$

Example 3:

In another variation of ICE Problems, we are sometimes given the initial moles when we have something *other than a 1.0 L container*. In this case, you must find initial concentrations [I]. by using the familiar formula:

$$Molarity(M) = \frac{mol}{L}$$

Let's do an example:
Consider the equilibrium system: A + 3B <-- --> 2 C
0.20 moles of A and 0.60 moles of B are placed in a 2.0 L container. When equilibrium is reached, the [A] is found to be 0.08 M. Calculate the ***equilibrium [B]*** and the ***equilibrium [C]***

Initial [A] = 0.10 M
Initial [B] = 0.30M

Notice that in this case the equilibrium concentration (**not moles**!) of A is given. This can go right in the table under ***equilibrium concentration [E]*** of A.

	A +	3B <-- -->	2C
[I]	0.10M	0.30m	0
[C]	-0.02M	-0.06 M	+0.04 M
[E]	0.08M	0.24M	0.04M

$$K_{eq} = \frac{[C]^2}{[A][B]^3} = 1.4$$