Notes #49 Equilibrium III (Ice Tables/Le Chatelier's Principal)

Ap Chemistry

E. Calculating equilibrium concentrations.

** If you know K, you can calculate exactly what the equilibrium concentrations will be from the initial concentrations. This process is a lot like stoichiometry....very systematic.

EX: The K_c value for the reaction, $H_2 + I_2$ ------> 2 HI, is 54.3 at 430°C. Calculate the concentrations of H_2, I_2 and HI at equilibrium if the initial concentrations of H_2 and I_2 are both 0.100 M.

1. *Consider the information given and decide which way the reaction will go to reach equilibrium. Calculate Q, if necessary.*

   * If only initial concentrations of reactants are given, the reaction obviously has to proceed _____.

2. *Construct an ICE table.*

3. *Write an equilibrium expression and solve for x.*

4. *Substitute in your value for x and determine the equilibrium concentrations.*

5. *Check your answer by recalculating K_c using the equilibrium concentrations that you determined.*

EX1: Consider the same reaction from up above. Calculate the concentrations of HI, H_2 and I_2 at equilibrium if you start off with 0.040 M of HI. (*do problem on a separate sheet.)*

EX2: *Sometimes, you are going to have to use the quadratic equation to solve an equilibrium problem. This one is as tricky as it gets!* The equilibrium mixture, $SO_2 + NO_2 \Leftrightarrow NO + SO_3$, was found to contain 0.60 mole SO_3, 0.4 mole NO, 0.800 mol SO_2, 0.10 mol NO_2 per liter. One more mole of NO was forced into the vessel, V& T constant, calculate the new moles of each gas in the new equilibrium mixture.

EX3: *Sometimes you might THINK you want to use the quadratic equation but you don't have to because K is SMALL, 10^{-5} in magnitude or smaller.* Gaseous NOCl decomposes to form the gases NO and Cl_2. At 35°C the equilibrium constant is 1.6×10^{-5}. In an experiment in which 1.0 mol NOCl is placed in a 2.0-L flask, what are the equilibrium concentrations? The balanced equation is: $2NOCl\,(g) \Leftrightarrow 2\,NO(g) + Cl_2\,(g)$

F. FACTORS THAT AFFECT CHEMICAL EQUILIBRIUM (Section 14.5)

* Equilibrium is a very delicate state. It's easily affected by environmental changes. Once equilibrium is disturbed, the system does what it needs to do to return to equilibrium. This idea is represented by Le Chatelier's Principle.

* **Le Chatelier's Principle** - if an external stress is applied to a system at equilibrium, the system adjusts in such a way that the stress is partially offset. Stresses included changes in: _____.

1. CHANGES IN CONCENTRATION.

Consider the following reaction:

$$\text{heat} + \underset{\text{pink}}{Co(H_2O)_6^{2+}} + 4Cl^- \Leftrightarrow \underset{\text{blue}}{CoCl_4^{2-}} + 6\,H_2O$$

a. What happens when more Cl^- is added to the system?

b. What happens when more water is added to the system?

c. What happens when $AgNO_3$ is added?

** Think of it like a teeter-totter.....Express this idea in your own words.

d. Does changing concentration change K???

2. CHANGES IN VOLUME AND PRESSURE. These changes apply primarily to GASES only. Liquids and solids will not be affected too much by such changes.

** In general, if a pressure is applied, the system will shift towards what ever way has LESS gas particles. Likewise, if the pressure is lessened, the system will shift towards what ever way has MORE gas particles.

Consider the following reaction: $\underset{\text{clear}}{N_2O_4\,(g)} \Leftrightarrow \underset{\text{brown}}{2\,NO_2\,(g)}$

a. What will happen if the pressure of the system is INCREASED, volume decreases???

b. What will happen if the pressure of the system is DECREASES, volume increases???

c. Why does this happen? Think about the K expression for this reaction.....

**d. Can you change the pressure without changing the volume??? Sure. So, what would happen if you increased the pressure by adding an INERT GAS???

e. Does changing pressure (or volume) change K???

3. CHANGES IN TEMPERATURE.

** A CHANGE IN TEMPERATURE IS THE ONLY VARIABLE THAT ACTUALLY CHANGES K.

Consider the following reaction: $\underset{\text{clear}}{N_2O_4\,(g)} \Leftrightarrow \underset{\text{brown}}{2\,NO_2\,(g)}$ $\Delta H° = 58.0$ kJ

a. Judging from the ΔH value, making NO_2 is an _____ process. Think of ΔH just like another reactant or product. Rewrite the equation:

** At equilibrium, the net heat effect is zero because there is no net reaction.

b. What happens if the system is HEATED???

c. What happens if the system is COOLED???

**d. When heat is added an ENDOTHERMIC rxn shifts to the _____;
an EXOTHERMIC rxn shifts to the _____.

e. How and why does changing the temp actually change K?