A.P. CHEMISTRY

TYPES OF EQUILIBRIUM PROBLEMS/STRATEGIES FOR SOLVING THEM

1. Determine Keq or Kp given equilibrium [ ]'s or P's
   a. Balanced equation/Equilibrium expression
   b. Plug-in problem

2. Determine Keq given equilibrium P's
   a. Balanced equation/Equilibrium expression for Kp
   b. Solve for Kp
   c. Solve for Keq using $Keq = Kp(RT)^{-\Delta n}$

$Kp = Kc(RT)^{\Delta n_{gas}}$

3. Determine Keq or Kp given initial P/[ ] of one species and the equilibrium P/[ ] of another
   a. Balanced equation/Equilibrium expression
   b. Construct table: initial, change, and equilibrium P's/[ ]'s; fill in information given
   c. Use stoichiometry to determine change and then other equilibrium P's/[ ]'s
   d. Use equilibrium P's/[ ]'s in equilibrium expression to determine Keq/Kp

4. Determine Keq or Kp given the initial P/[ ] of one species and how much of that species is used up
   a. Same strategies as in 3a-c except how much of species used up determines change for that species – use stoichiometry to determine change for others
   b. Use equilibrium P's/[ ]'s in equilibrium expression to determine Keq/Kp

5. Calculating equilibrium P's/[ ]'s
   a. Given Kp/Keq and equilibrium P's/[ ]'s for all species but one
      - Balanced equation/Equilibrium expression
      - Plug- in problem

   b. Given only the initial P's/[ ]'s of all or some of the species and Kp/Keq
      - Same as 3a-c
      - Solve for x using equilibrium P's/[ ]'s and K values
      - Substitute value of x back into equilibrium P's/[ ]'s
      - In some cases, use Q and size of K to determine which direction reaction will go – use stoichiometry to determine how to write the change
        * Large K, mostly products
        * Small K, mostly reactants
        * Q > K, system will shift to the left to reach equilibrium
        * Q < K, system will shift to the right to reach equilibrium
        * Q = K, system at equilibrium, no shift will occur
      - Use 5% rule for small K values

   c. Given equilibrium P's/[ ]'s, Kp/Keq, and new conditions (addition/removal of reactant/product)
      - Same as 3a-c, but use given equilibrium P's/[ ]'s as the initial P's/[ ]'s
      - Solve for x using the new equilibrium P's/[ ]'s and K values
      - Substitute value of x back into equilibrium P's/[ ]'s

b. Rewrite equilibrium expression in terms of x
c. Solubility = x, therefore, substitute correct values into your expression
d. Solve for Ksp

7. Calculating solubility, given Ksp
   a. Same as 6a,b
   b. Solve for x
   c. x = solubility; convert mole to grams in appropriate volume

8. Calculate solulbility with common ion effect, given Ksp
   a. Same as 6a,b
   b. Add common ion amount to [x] of appropriate ion
   c. Same as 7b,c

9. Calculate the equilibrium [ ] of one ion, given Ksp and equilibrium [ ] of the other ion
   a. Same as 6a,b
   b. Substitute given [ ] and solve for x

10. Knowing whether a PPT will form
    a. When the concentration of the ions are given
       - Same as 6a
       - Determine Q with initial concentrations
       - Compare Q with Ksp
         * Q > Ksp PPT (supersaturated solution)
         * Q < Ksp No PPT (unsaturated solution)
         * Q = Ksp Equilibrium established (saturated solution)

    b. When the volume and concentrations of two solutions that are mixed are given
       - Determine what will be the PPT and write the appropriate equation/equilibrium expression
       - Determine final concentration of ions in solution
       - Determine Q with the final concentrations
       - Compare Q with Ksp (see 9)