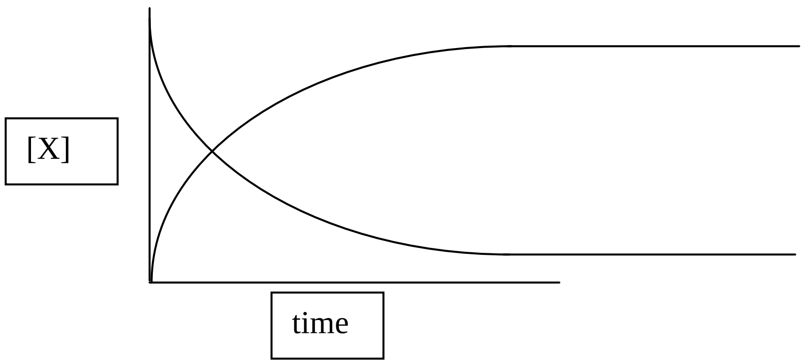
AP Chemistry
Unit 7- Homework Problems
Equilibrium and K_{sp}

Nature of the Equilibrium State

1. Draw on this graph where equilibrium has been reached.



2. What are three qualities of any equilibrium equation?
   a.
   b.
   c.

3. For a general equation: $aA + bB \leftrightarrow cC + dD$, write the equation for K_c.

Developing K_{eq}

1. For each of the equations below, write the expression for K_c:
   a. $2\ H_2S\ (g) \leftrightarrow 2\ H_2\ (g) + S_2\ (g)$
   b. $HCN\ (aq) + H_2O\ (l) \leftrightarrow H_3O^+\ (aq) + CN^{-1}\ (aq)$
   c. $PbCl_2\ (s) \leftrightarrow Pb^{+2}\ (aq) + 2\ Cl^{-1}\ (aq)$

2. For each of the equations below, write the expression for K_p:
   a. $SO_2Cl_2\ (g) \leftrightarrow SO_2\ (g) + Cl_2\ (g)$
   b. $CO\ (g) + H_2O\ (g) \leftrightarrow CO_2\ (g) + H_2\ (g)$
   c. $C_6H_{12}O_6\ (s) + 6\ O_2\ (g) \leftrightarrow 6\ CO_2\ (g) + 6\ H_2O\ (g)$

3. Put the following K values in order of increasing product-favored ability.
   a. $K = 4x10^{-5}$
   b. $K = 2x10^{-9}$
   c. $K = 7x10^{-5}$
   d. $K = 3x10^{-3}$

Equilibrium Mathematics

1. The equation: $C (s) + 2 H_2O (g) \leftrightarrow CO (g) + H_2 (g)$ has a value of $K_c = 2.5 \times 10^{-6}$
   What is the value of K_c for: $CO (g) + H_2 (g) \leftrightarrow C (s) + 2 H_2O (g)$?
   What is the value of K_c for: $2 C (s) + 4 H_2O (g) \leftrightarrow 2 CO (g) + 2 H_2 (g)$

2. The equation: $H_2O (g) \leftrightarrow H_2 (g) + ½ O_2 (g)$ has a value of $K_p = 4.9 \times 10^{-3}$
   What is the value of K_p for: $2 H_2O (g) \leftrightarrow 2 H_2 (g) + O_2 (g)$?
   What is the value of K_p for: $H_2 (g) + ½ O_2 (g) \leftrightarrow H_2O (g)$?

3. The equation: $2 NH_3 (g) \leftrightarrow N_2 (g) + 3 H_2 (g)$ has a value of $K_c = 2.7 \times 10^{-4}$
   What is the value for K_p?
   What is the value of K_c for: $½ N_2 (g) + 3/2 H_2 (g) \leftrightarrow NH_3 (g)$?

4. The equation: $N_2O_4 (g) \leftrightarrow 2 NO_2 (g)$ has a value of $K_p = 3.2 \times 10^{-4}$
   What is the value for K_c at 300 K?
   What is the value for K_c for: $NO_2 (g) \leftrightarrow ½ N_2O_4 (g)$

5. Given the following equations:
   $H_2O (g) + CO (g) \leftrightarrow H_2 (g) + CO_2 (g)$ Kc = 4.8
   $FeO (s) + CO (g) \leftrightarrow Fe (s) + CO_2 (g)$ $K_c = 0.48$

   Calculate the K_c value for:
   $Fe (s) + H_2O (g) \leftrightarrow FeO (s) + H_2 (g)$ K_c = ???

6. Given the following equations:
   $S (s) + O_2 (g) \leftrightarrow SO_2 (g)$ $K_p = 48.2$
   $2 SO_3 (g) \leftrightarrow 2 SO_2 (g) + O_2 (g)$ $K_p = 0.075$

   Calculate the K_p value for:
   $S (s) + 3/2 O_2 (g) \leftrightarrow SO_3 (g)$ K_p = ???

7. Which of the following equations has $K_c = K_p$
   a. $PCl_5 (g) \leftrightarrow PCl_3 (g) + Cl_2 (g)$
   b. $2 NOCl (g) \leftrightarrow 2 NO (g) + Cl_2 (g)$
   c. $CaCO_3 (s) \leftrightarrow CaO (s) + CO_2 (g)$
   d. $H_2O (g) + CO (g) \leftrightarrow H_2 (g) + CO_2 (g)$
   e. $2 NO (g) \leftrightarrow N_2 (g) + O_2 (g)$

K_c and K_p Calculations

At Equilibrium

1. For the reaction: $2\ NO_2\ (g) \leftrightarrow N_2O_4\ (g)$
   At equilibrium $[N_2O_4] = 0.25$ M & $[NO_2] = 0.175$ M. Calculate K_c
2. For the reaction: $2\ NH_3\ (g) \leftrightarrow N_2\ (g) + 3\ H_2\ (g)$ $K_p = 32$
   At equilibrium $P_{NH3} = 0.64$ atm & $P_{N2} = 1.18$ atm. Calculate P_{H2}

Dissociation

3. For the reaction: $PCl_5\ (g) \leftrightarrow PCl_3\ (g) + Cl_2\ (g)$
   If the initial pressure of PCl_5 is 2 atm and at equilibrium it is 15% dissociated, what is K_p?

4. For the reaction: $2\ NO\ (g) \leftrightarrow N_2\ (g) + O_2\ (g)$
   If the initial [NO] = 0.50 M and at equilibrium it is 5% dissociated, what is K_c?

5. For the equation: $NH_4I\ (s) \leftrightarrow NH_3\ (g) + HI\ (g)$
   The total pressure at equilibrium is 4.2 atm. What is K_p?

6. For the equation: $(NH_4)(H_2NCO_2)\ (s) \leftrightarrow 2\ NH_3\ (g) + CO_2\ (g)$
   The total pressure at equilibrium is 0.33 atm. What is K_p?

7. For the equation: $N_2\ (g) + O_2\ (g) \leftrightarrow 2\ NO\ (g)$, you start with 2 M of each of the reactants. They react away to an extent of 27% to reach equilibrium. Calculate the value of K_c.

8. For the equation: $2\ NOBr\ (g) \leftrightarrow 2\ NO\ (g) + Br_2\ (g)$, you start with 0.75 M of the NOBr. At equilibrium, the NOBr has reacted away by 89%. Calculate the value of K_c.

Q vs. K

9. For the reaction: $2\ NOCl\ (g) \leftrightarrow 2\ NO\ (g) + Cl_2\ (g)$ $K_c = 1.2x10^{-3}$
   If the initial $[NOCl]_o = 0.15$ M, $[NO]_o = 0.75$ M, and $[Cl_2]_o = 0.05$ M, is the system at equilibrium?
   If not, which way will the reaction shift, left or right?

10. For the reaction: $NH_3\ (aq) + H_2O\ (l) \leftrightarrow NH_4^{+1}\ (aq) + OH^{-1}\ (aq)$ $K_c = 1.8x10^{-5}$
    If the initial $[NH_3]_o = 0.5$ M, $[NH_4^{+1}] = 0.0025$ M, and $[OH^{-1}] = 0.0025$ M, is the system at equilibrium?
    If not, which way will the reaction shift, left or right?

11. For the equation: $CS_2\ (g) + 3\ Cl_2\ (g) \leftrightarrow S_2Cl_2\ (g) + CCl_4\ (g)$, $K_c = 4.8x10^{-2}$. If you start with $[CS_2] = 0.025$ M, $[Cl_2] = 0.175$ M, $[S_2Cl_2]= 0.58$ M, and $[CCl_4] = 0.042$ M, is the reaction at equilibrium? If not, which way will the reaction go to reach equilibrium (left or right)?

Calculating Equilibrium Conditions

12. For the equation: $PCl_5\ (g) \leftrightarrow PCl_3\ (g) + Cl_2\ (g)$, you start with 0.25 atm of each of the products as well as the reactants. The K_p value is 0.125. Is the reaction at equilibrium? Prove it. What are the equilibrium pressures of all species?

13. For the equation: H_2O (g) + CO (g) ←→ CO_2 (g) + H_2 (g) $K_c = 0.235$
If 2 moles of each of H_2O and CO are put into a 10 L container, what is the concentration of all species at equilibrium?

14. For the equation: SO_2Cl_2 (g) ←→ SO_2 (g) + Cl_2 (g) $K_p = 4.8$
If enough SO_2Cl_2 is put into a container so its pressure is 8 atm, what is the equilibrium pressure of all species. What is the total pressure?

15. For the equation: $CaCO_3$ (s) ←→ CaO (s) + CO_2 (g) $K_p = 2.4$
If 200 g $CaCO_3$ is put into a 20 L container at 500 K, how many grams of it remain at equilibrium?

16. For the equation: 2 $KClO_3$ (s) ←→ 2 KCl (s) + 3 O_2 (g), you start with some $KClO_3$ that decomposes into the products. At equilibrium, there is some solid remaining and the total pressure in the flask is 0.58 atm. Calculate the value of K_p.

17. For the equation: NH_4Cl (s) ←→ NH_3 (g) + HCl (g), you start with some NH_4Cl that decomposes into the products. At equilibrium, there is some solid remaining and the total pressure in the flask is 1.8 atm. Calculate the value of K_p.

18. For the equation: $COBr_2$ (g) ←→ CO (g) + Br_2 (g), you start with 4 moles in a 10 L vessel of $COBr_2$. The reaction has a $K_c = 0.76$. What are the equilibrium concentrations of all species?

19. For the equation: H_2 (g) + CO_2 (g) ←→ H_2O (g) + CO (g), you start with 2 atm of each of the reactants and none of the products. The $K_p = 3.4$. What are the equilibrium pressures of all species?

20. For the equation: 2 CH_2Cl_2 (g) ←→ CH_4 (g) + CCl_4 (g), you start with 0.25 M of CH_2Cl_2 and is has a K_c value of 0.84. What are the equilibrium concentrations of all species?

21. For the equation: NH_4HS (s) ←→ NH_3 (g) + H_2S (g), you start with 100 grams of NH_4HS (s) in a 2.5 L flask at 500 K. The K_p value is 1.45. How many grams of the solid remain at equilibrium?

LeChatelier's Principle

1. State LeChatelier's Principle.

2. For the following reaction: Heat + $CaCO_3$ (s) + CO_2 (g) + H_2O (l) $\leftrightarrow$ Ca^{+2} (aq) + 2 HCO_3^{-1} (aq)

What will be the effect of doing each of the following actions on the above equilibrium?

a) Adding $CaCO_3$ (s)	Left	Right	No Change
b) Removing Ca^{+2} (aq)	Left	Right	No Change
c) Removing CO_2 (g)	Left	Right	No Change
d) Adding $NaHCO_3$ (s)	Left	Right	No Change
e) Adding Ne (g)	Left	Right	No Change
f) Adding CO_2 (g)	Left	Right	No Change
g) Increasing temperature	Left	Right	No Change
h) Decreasing volume	Left	Right	No Change

3. For the following reaction: 2 SO_2 (g) + O_2 (g) $\leftrightarrow$ 2 SO_3 (g) + Heat

What will be the effect of doing each of the following actions on the above equilibrium?

a) Decreasing temperature	Left	Right	No Change
b) Increasing O_2 (g)	Left	Right	No Change
c) Decreasing SO_2 (g)	Left	Right	No Change
d) Increasing volume	Left	Right	No Change
e) Increasing SO_3 (g)	Left	Right	No Change
f) Adding N_2 (g)			

K_{sp}

1. For each of the substances below, write the solubility equation as well as the K_{sp} equation.
    a. $AgCl$
    b. PbI_2
    c. Ag_2CO_3
    d. $Ca_3(PO_4)_2$

Problem Solving with K_{sp}

1. Calculate the K_{sp} of $CaCrO_4$ if a saturated solution has $[Ca^{+2}] = 4.5 \times 10^{-5}$
2. Calculate the K_{sp} of $Fe(OH)_3$ if a saturated solution has $[Fe^{+3}] = 4.2 \times 10^{-6}$
3. Calculate the solubility (moles/L) of $PbCO_3$ if $K_{sp} = 7.4 \times 10^{-14}$
4. Calculate the solubility (moles/L) of Ag_2SO_4 if $K_{sp} = 1.2 \times 10^{-5}$
5. Calculate the solubility (mg/L) of $FePO_4$ if $K_{sp} = 9.4 \times 10^{-9}$
6. Calculate the solubility (mg/L) of $Al_2(CO_3)_3$ if $K_{sp} = 7.2 \times 10^{-25}$
7. How many mg of $CuCrO_4$ will dissolve in 50 mL of water ($K_{sp} = 9.4 \times 10^{-10}$)
8. If 100 mg of $CaCO_3$ ($K_{sp} = 3.4 \times 10^{-9}$) is put in 500 mL of water, how many mg remain undissolved?
9. Put the following substances in order of least soluble to most soluble.
    $AuCl$ ($K_{sp} = 2\times10^{-13}$) $PbCrO_4$ ($K_{sp} = 2.8\times10^{-13}$) $MnCO_3$ ($K_{sp} = 2.3\times10^{-11}$) $NiCO_3$ ($K_{sp} = 1.4\times10^{-7}$)
10. Put the following substances in order of least soluble to most soluble.
    $Zn(CN)_2$ ($K_{sp} = 8\times10^{-12}$) $AgBr$ ($K_{sp} = 5.\times10^{-13}$) $Pb(OH)_2$ ($K_{sp} = 1.4\times10^{-15}$) $BaSO_4$ ($K_{sp} = 1.1\times10^{-10}$)
11. Prove which of each of the substances below is the most soluble.
    a. $AgBr$ ($K_{sp} = 5.4\times10^{-13}$) vs. AgI ($K_{sp} = 8.5 \times 10^{-17}$)
    b. $PbCl_2$ ($K_{sp} = 1.7 \times 10^{-5}$) vs. $PbBr_2$ ($K_{sp} = 6.6 \times 10^{-6}$)
    c. $AgCl$ ($K_{sp} = 1.8 \times 10^{-10}$) vs. Ag_2CrO_4 ($K_{sp} = 1.1 \times 10^{-12}$)
    d. $CaCO_3$ ($K_{sp} = 3.4 \times 10^{-9}$) vs. $Mg(OH)_2$($K_{sp} = 5.6 \times 10^{-12}$)

Common Ion Effect

1. Calculate the solubility (moles/L) of MgS ($K_{sp} = 5.2 \times 10^{-16}$) in:
    a. Pure water
    b. A 0.25 M solution of $MgCl_2$
2. Calculate the solubility (moles/L) of $PbCl_2$ ($K_{sp} = 1.7 \times 10^{-5}$) in:
    a. Pure water
    b. A 0.55 M solution of $NaCl$
3. Calculate the solubility (moles/L) of PbI_2 ($K_{sp} = 9.8 \times 10^{-9}$) in:
    a. Pure water
    b. A 0.005 M solution of AlI_3
4. Calculate what mass of Hg_2SO_4 ($K_{sp} = 6.5 \times 10^{-7}$) will dissolve per liter in:
    a. Pure water
    b. A 0.0075 M solution of Na_2SO_4
5. Calculate what mass of $CaCO_3$ ($K_{sp} = 3.4 \times 10^{-9}$) will dissolve per liter in:
    a. Pure water
    b. A 0.45 M solution of $CaCl_2$
6. Calculate what mass of $PbCl_2$ ($K_{sp} = 1.7 \times 10^{-5}$) will dissolve per liter in:
    a. Pure water
    b. A 0.067 M solution of $AlCl_3$
7. AgBr will be the least soluble in 0.10 M:
    a. $NaBr$ b. $CaBr_2$ c. $AlBr_3$ d. Ag_2SO_4 e. $AgNO_3$
8. MgF_2 will be least soluble in 0.25 M:
    a. KF b. $Mg(NO_3)_2$ c. MgC_2O_4 d. BaF_2 e. LiF

Precipitation

1. Will a ppt of $CaCO_3$ (K_{sp}= 3.4 x10^{-9}) form if [Ca^{+2}] = 4 x10^{-6} M and [CO_3^{-2}] = 4 x10^{-3}?
2. Will a ppt of Ag_2CrO_4 (K_{sp} = 1.1 x10^{-12}) form if [Ag^{+}] = 3x10^{-4} and [CrO_4^{-2}] = 2x10^{-4}?
3. Will a ppt of $BaCO_3$ (K_{sp} = 2.6 x10^{-9}) form if 50 mL of 4x10^{-5} M Ba^{+2} is mixed with 50 mL of 8x10^{-5} M CO_3^{-2}?
4. Will a ppt of $PbBr_2$ (K_{sp} = 6.6 x10^{-6}) form if 150 mL of 2x10^{-2} M $Pb(NO_3)_2$ is mixed with 50 mL of 3x10^{-2} M $AlBr_3$?
5. What concentration of [OH^{-1}] will cause a ppt of $Fe(OH)_2$ (K_{sp} = 4.9x10^{-17}) of a 2x10^{-5} M Fe^{+2} solution ?
6. What concentration of [$C_2O_4^{-2}$] will cause a ppt of $Ag_2C_2O_4$ (K_{sp} = 5.4x10^{-12}) of a 4x10^{-4} M Ag^{+1} solution?
7. What mass of $Ni(NO_3)_2$*7 H_2O (s) will cause a ppt of $NiCO_3$ (K_{sp} = 1.4x10^{-7}) of a 3.5x10^{-4} M CO_3^{-2} solution?
8. What mass of $Pb(NO_3)_2$ will cause a ppt of

Separations by K_{sp}

1. A solution is made so that [Ca^{+2}] = 0.00050 and [Mg^{+2}] = 0.00050 as well. If $Cr_2O_7^{-2}$ is added, answer the following questions. Know that K_{sp} $CaCr_2O_7$ = 4.8 x10^{-7} and K_{sp} $MgCr_2O_7$ = 7.6 x10^{-8}
   a. Which will ppt 1st? At what [$Cr_2O_7^{-2}$] will it begin to ppt?
   b. What is the maximum [$Cr_2O_7^{-2}$] that can be made to ppt almost all of one and none of the other?
   c. What is the concentration of the less soluble ion under the conditions specified in "b"?
   d. What % of the less soluble ion remains in solution under the conditions specified in "b"?
2. A solution is made so that [Pb^{+2}] = 0.00250 and [Hg^{+2}] = 0.0075. If SO_4^{-2} is added, answer the following questions. Know that K_{sp} $PbSO_4$ = 2.5 x10^{-8} and K_{sp} $HgSO_4$ = 5.4 x10^{-7}
   a. Which will ppt 1st? At what [SO_4^{-2}] will it begin to ppt?
   b. What is the maximum [SO_4^{-2}] that can be made to ppt almost all of one and none of the other?
   c. What is the concentration of the less soluble ion under the conditions specified in "b"?
   d. What % of the less soluble ion remains in solution under the conditions specified in "b"?
3. A solution is made so that [Zn^{+2}] = 0.00250 and [Ag^{+1}] = 0.057. If F^{-1} is added, answer the following questions. Know that K_{sp} ZnF_2 = 4.8 x10^{-7} and K_{sp} AgF = 7.6 x10^{-8}
   a. Which will ppt 1st? At what [F^{-1}] will it begin to ppt?
   b. What is the maximum [F^{-1}] that can be made to ppt almost all of one and none of the other?
   c. What is the concentration of the less soluble ion under the conditions specified in "b"?
   d. What % of the less soluble ion remains in solution under the conditions specified in "b"?

Combination Problems

1. For the reaction at 2000 K

$$H_2\ (g) + CO_2\ (g) \leftrightarrow H_2O\ (g) + CO\ (g)$$

For an experiment, the equilibrium values of each substance are as follows:

$[H_2] = 0.20$ M
$[CO_2] = 0.30$ M
$[H_2O] = [CO] = 0.55$ M

a. What is the mole fraction of CO in the equilibrium mixture?
b. Calculate the value of K_c, the equilibrium constant for the reaction above.
c. Determine K_p in terms of K_c for this system.
d. When the system is cooled from 2000 K to a lower temperature, 30% of the CO is converted back to CO_2. Calculate the value of K_c at this lower temperature.
e. In a different experiment, 0.50 mole of H_2 is mixed with 0.50 mole of CO_2 in a 3.0 L reaction vessel at 2000 K. Calculate the equilibrium concentration, in M, of CO at this temperature.

2. For the reaction:

$$PCl_5\ (g) \leftrightarrow PCl_3\ (g) + Cl_2\ (g)$$

It is observed that greater amounts of PCl_3 and Cl_2 are produced as the temperature is increased.

a) What is the sign of ΔS^o for the reaction? Explain.
b) What change, if any, will occur in ΔG^o for the reaction as the temperature is increased? Explain.
c) If He gas is added to the original mixture at constant volume and temperature, what will happen to the partial pressure of Cl_2? Explain.
d) If the volume of the reaction mixture is decreased at constant temperature to half the original volume, what will happen to the number of moles of Cl_2 in the reaction vessel? Explain.

3. For the reaction:

$$C(s) + CO_2(g) \leftarrow\rightarrow 2\ CO(g)$$

Solid carbon and carbon dioxide gas at 1,160 K were placed in a rigid 2.00 L container, and the reaction represented above occurred. As the reaction proceeded, the total pressure in the container was monitored. When equilibrium was reached, there was still some C(*s*) remaining in the container. Results are recorded in the table below.

Time (hours)	Total Pressure of gases (atm)
0.0	5.00
2.0	6.26
4.0	7.09
6.0	7.75
8.0	8.37
10.0	8.37

(a) Write the expression for the equilibrium constant, K_p , for the reaction.

(b) Calculate the number of moles of $CO_2(g)$ initially placed in the container. (Assume that the volume of the solid carbon is negligible.)

(c) For the reaction mixture at equilibrium at 1,160 K, the partial pressure of the $CO_2(g)$ is 1.63 atm. Calculate:

(i) the partial pressure of CO(*g*) , and

(ii) the value of the equilibrium constant, K_p .

(d) If a suitable solid catalyst were placed in the reaction vessel, would the final total pressure of the gases at equilibrium be greater than, less than, or equal to the final total pressure of the gases at equilibrium without the catalyst? Justify your answer. (Assume that the volume of the solid catalyst is negligible.)

(e) In another experiment involving the same reaction, a rigid 2.00 L container initially contains 10.0 g of C(*s*) , plus CO(*g*) and $CO_2(g)$, each at a partial pressure of 2.00 atm at 1,160 K. Predict whether the partial pressure of $CO_2(g)$ will increase, decrease, or remain the same as this system approaches equilibrium. Justify your prediction with a calculation.

4. Answer the following questions:
   a. A saturated solution is prepared by adding excess $PbI_2(s)$ to distilled water to form 1.0 L of solution at 25 ^oC. The concentration of Pb^{+2} (aq) in the saturated solution is found to be $1.3x10^{-3}$ M. The chemical equation for the dissolution of $PbI_2(s)$ in water is shown below:

$$PbI_2\ (s)\ \leftrightarrow\ Pb^{+2}\ (aq)\ +\ 2\ I^{-1}\ (aq)$$

      i) Write the equilibrium-constant expression for the equation.
      ii) Calculate the molar concentration of I^{-1} (aq) in the solution.
      iii) Calculate the value of the equilibrium constant, K_{sp}.
   b. A saturated solution is prepared by PbI_2 (s) to distilled water to form 2.0 L of solution at 25 ^oC. What are the molar concentrations of Pb^{+2} (aq) and I^{-1} (aq) in the solution? Justify your answer.
   c. Soild NaI is added to a saturated solution of PbI_2 at 25 ^oC. Assuming that the volume of the solution does not change, does the molar concentration of Pb^{+2} (aq) in the solution increase, decrease, or stay the same? Justify your answer.

5. The value of K_{sp} for the salt $BaCrO_4$ is $1.2x10^{-10}$. When a 500. mL sample of $8.2x10^{-6}$ M $Ba(NO_3)_2$ is added to 500. mL of $8.2x10^{-6}$ M Na_2CrO_4, no precipitate is observed.
      i) Assuming the volumes are additive, calculate the molar concentrations of Ba^{+2} (aq) and CrO_4^{-2} (aq) in the 1.00 L of solution.
      ii) Use the molar concentrations of Ba^{+2} (aq) and CrO_4^{-2} (aq) ions as determined above to show why a precipitate does not form. You must include a calculation as part of your answer.

6. Silver chromate dissociates in water according the equation below:

$$Ag_2CrO_4\ (s)\ \leftrightarrow\ 2\ Ag^{+1}\ (aq)\ +\ CrO_4^{-2}\ (aq)\quad K_{sp} = 2.6x10^{-12} \text{ at } 25\ ^oC$$

   a) Write the equilibrium-constant expression for the dissolving of Ag_2CrO_4 (s)
   b) Calculate the concentration, in M, of Ag^{+1} (aq) in a saturated solution of Ag_2CrO_4 at 25^oC
   c) Calculate the maximum mass, in grams, of Ag_2CrO_4 that can dissolve in 100. mL of water at 25 ^oC.
   d) A 0.100 mol sample of solid $AgNO_3$ is added to a 1.00 L saturated solution of Ag_2CrO_4. Assuming no volume change, does $[CrO_4^{-2}]$ increase, decrease, or stay the same? Justify.

7. In a saturated solution of Ag_3PO_4 at 25 ^oC, the concentration of Ag^{+1} (aq) is $5.3x10^{-5}$ M. The equilibrium constant expression for the dissolving of Ag_3PO_4 (s) in water is shown below:

$$K_{sp} = [Ag^{+1}]^3[PO_4^{-3}]$$

   a) Write the balanced equation for the dissolving of Ag_3PO_4 in water.
   b) Calculate the value of K_{sp} for Ag_3PO_4 at 25 ^oC.
   c) A 1.00 L sample of saturated Ag_3PO_4 solution is allowed to evaporate at 25 ^oC to a final volume of 500. mL. What is the $[Ag^{+1}]$ in the solution? Justify your answer.