AP Free Response Practice ~~#1~~ [2010, 10 points]

1. Several reactions are carried out using AgBr, a cream-colored silver salt for which the value of the solubility-product constant, K_{sp}, is 5.0×10^{-13} at 298 K.

   a. Write the expression for the solubility-product constant, K_{sp}, of AgBr. [1 point]

   b. Calculate the value of $[Ag^+]$ in 50.0 mL of a saturated solution of AgBr at 298 K. [1 point]

   c. A 50.0 mL sample of distilled water is added to the solution described in part (b), which is in a beaker with some solid AgBr at the bottom. The solution is stirred and equilibrium is reestablished. Some solid AgBr remains in the beaker. Is the value of $[Ag^+]$ greater than, less than, or equal to the value you calculated in part (b) ? Justify your answer. [1 point]

   d. Calculate the minimum volume of distilled water, in liters, necessary to completely dissolve a 5.0 g sample of AgBr(*s*) at 298 K. (The molar mass of AgBr is 188 g mol^{-1}.) [2 points]

   e. A student mixes 10.0 mL of 1.5×10^{-4} *M* $AgNO_3$ with 2.0 mL of 5.0×10^{-4} *M* NaBr and stirs the resulting mixture. What will the student observe? Justify your answer with calculations. [3 points]

   f. The color of another salt of silver, AgI(*s*), is yellow. A student adds a solution of NaI to a test tube containing a small amount of solid, cream-colored AgBr. After stirring the contents of the test tube, the student observes that the solid in the test tube changes color from cream to yellow.

      i. Write the chemical equation for the reaction that occurred in the test tube. [1 point]

      ii. Which salt has the greater value of K_{sp}: AgBr or AgI ? Justify your answer. [1 point]

(a) $K_{sp} = [Ag^+][Br^-]$

(b) $K_{sp} = x^2 = 5.0E-13$

$\Rightarrow [Ag^+] = x = \sqrt{5.0E-13} = \boxed{7.1 \times 10^{-7} M}$

(c) $[Ag^+]$ = value calculated in (b). B/c some solid is present, $[Ag^+]$ is still @ equilibrium, + $[Ag^+]$ is independent of volume @ equilibrium.

(d) $5.0 g AgBr \times \frac{1 mol}{188 g} = 0.026596 mol AgBr \times \frac{1 L}{7.1E-7 mol}$ (from part (b))

$= \boxed{3.7 \times 10^4 L}$

(e) $[Ag^+] = \frac{mol}{L} = \frac{mmol}{mL} = \frac{(10.0\,mL)(1.5E{-}4\,M)}{(10.0 + 2.0)\,mL} = 1.3E{-}4\,M$

$[Br^-] = \frac{(2.0\,mL)(5.0E{-}4\,M)}{(10.0 + 2.0)\,mL} = 8.3 \times 10^{-5}\,M$

$Q = [Ag^+][Br^-] = (1.3E{-}4)(8.3E{-}5) = 1.1 \times 10^{-8} > 5.0E{-}13$ (Q > K)

Since $K < Q$, a precipitate will form to ↓[ions] in sol'n + reach equil.

(f)(i) $AgBr_{(s)} + NaI_{(aq)} \rightarrow AgI_{(s)} + NaBr_{(aq)}$

OR

$AgBr_{(s)} + I^-_{(aq)} \rightarrow AgI_{(s)} + Br^-_{(aq)}$

(ii) AgBr has the greater Ksp, b/c when ions for multiple salts are present, precipitate will be the less soluble salt. B/c the precipitate formed was yellow, $AgI_{(s)}$ must have formed, thus $K_{sp}(AgBr) > K_{sp}(AgI)$.