

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.
- Write the expression for the solubility-product constant, K_{sp} , of AgBr. [1 point]
 - Calculate the value of $[Ag^+]$ in 50.0 mL of a saturated solution of AgBr at 298 K. [1 point]
 - 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]
 - 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]
 - A student mixes 10.0 mL of $1.5 \times 10^{-4} \text{ M AgNO}_3$ with 2.0 mL of $5.0 \times 10^{-4} \text{ M NaBr}$ and stirs the resulting mixture. What will the student observe? Justify your answer with calculations. [3 points]
 - 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.
 - Write the chemical equation for the reaction that occurred in the test tube. [1 point]
 - Which salt has the greater value of K_{sp} : AgBr or AgI? Justify your answer. [1 point]

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

$$(b) K_{sp} = x^2 = 5.0 \times 10^{-13}$$

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

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

$$(d) 5.0 \text{ g AgBr} \times \frac{1 \text{ mol}}{188 \text{ g}} = 0.026596 \text{ mol AgBr} \times \frac{1 \text{ L}}{7.1 \times 10^{-7} \text{ mol}}$$

from part (b)

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

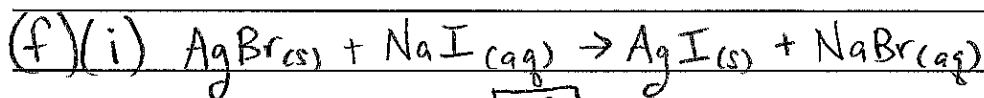
$$(e) [Ag^+] = \frac{\text{mol}}{L} = \frac{\text{mmol}}{\text{mL}} = \frac{(10.0 \text{ mL})(1.5 \times 10^{-4} \text{ M})}{(10.0 + 2.0) \text{ mL}} = 1.3 \times 10^{-4} \text{ M}$$

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

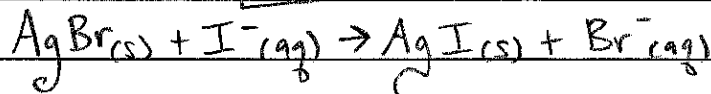
$$Q > K$$

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

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



OR



(ii) AgBr has the greater K_{sp} , 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 $K_{sp}(AgBr) > K_{sp}(AgI)$.