Culver City H.S. • AP Chemistry

Name KEY
Period ___ Date ___/___/___

16 • Solubility Equilibria

PRACTICE FRQ

Answer the following questions that relate to solubility of salts of lead and barium.

(a) A saturated solution is prepared by adding excess $PbI_{2(s)}$ to distilled water to form 1.0 L of solution at 25°C. The concentration of $Pb^{2+}{}_{(aq)}$ in the saturated solution is found to be 1.3×10^{-3} *M*. The chemical equation for the dissolution of $PbI_{2(s)}$ in water is shown below.

$$PbI_{2(s)} \leftrightarrows Pb^{2+}(aq) + 2\, I^{-}(aq)$$

(i) Write the equilibrium-constant expression for the equation.

$K_{sp} = [Pb^{2+}][I^{-}]^2$

(ii) Calculate the molar concentration of $I^{-}(aq)$ in the solution.

$[Pb^{2+}] = 1.3 \times 10^{-3}$ $\underline{M}$

$[I^{-}] = 2.6 \times 10^{-3}$ $\underline{M}$

(iii) Calculate the value of the equilibrium constant, K_{sp}.

$K_{sp} = (1.3 \times 10^{-3})(2.6 \times 10^{-3})^2$

$= 8.788 \times 10^{-9}$

$= \boxed{8.8 \times 10^{-9}}$

(b) A saturated solution is prepared by adding $PbI_{2(s)}$ to distilled water to form 2.0 L of solution at 25°C. What are the molar concentrations of $Pb^{2+}(aq)$ and $I^{-}(aq)$ in the solution? Justify your answer.

$[Pb^{2+}] = 1.3 \times 10^{-3}$ $\underline{M}$

$[I^{-}] = 2.6 \times 10^{-3}$ $\underline{M}$

The molar concentrations do not change because the temp. is still at 25 °C. Solubility is temperature dependent

(c) Solid NaI is added to a saturated solution of PbI_2 at 25°C. Assuming that the volume of the solution does not change, does the molar concentration of $Pb^{2+}(aq)$ in the solution increase, decrease, or remain the same? Justify your answer.

$PbI_2 \leftrightarrows Pb^{2+} + 2I^{-}$

the addition of $NaI_{(s)}$ increases the $[I^{-}]$ in solution and shifts the equilibrium towards the reactants.

Therefore, the $[Pb^{2+}]$ decreases.

(d) The value of K_{sp} for the salt $BaCrO_4$ is 1.2×10^{-10}. When a 500. mL sample of 8.2×10^{-6} M $Ba(NO_3)_2$ is added to 500. mL of 8.2×10^{-6} M Na_2CrO_4, no precipitate is observed.

(i) Assuming that volumes are additive, calculate the molar concentrations of $Ba^{2+}(aq)$ and $CrO_4^{2-}(aq)$ in the 1.00 L of solution.

$$[Ba^{2+}] = \frac{(.500\,L)(8.2\times10^{-6}\,\underline{M})}{1.00\,L} = 4.1\times10^{-6}\,\underline{M}$$

$$[CrO_4^{2-}] = \frac{(.500\,L)(8.2\times10^{-6}\,\underline{M})}{1.00\,L} = 4.1\times10^{-6}\,\underline{M}$$

(ii) Use the molar concentrations of $Ba^{2+}(aq)$ ions 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.

$$Q_{sp} = [Ba^{2+}][CrO_4^{2-}]$$
$$= (4.1\times10^{-6})(4.1\times10^{-6})$$
$$= 1.681\times10^{-11}$$

$$K_{sp} = 1.2\times10^{-10}$$

$$Q_{sp} < K_{sp}$$

Therefore, more $BaCrO_4$ can dissolve in the solution and a precipitate does not form.