Solubility Equilibrium Practice Test

1. (a) calcium hydroxide has low solubility, (⇌)
calcium chloride is more soluble (→)
(b) calcium hydroxide will have a lower concentration

2. saturated has the max amount of solute dissolved in it; solid is in equilibrium with its ions

3. (a) low sol. $Cu(OH)_2(s) \rightleftharpoons Cu^{2+}(aq) + 2OH^-(aq)$
(b) sol. $Sn(NO_3)_2(s) \rightarrow Sn^{2+}(aq) + 2NO_3^-(aq)$
(c) sol. $NaCl(s) \longrightarrow Na^+(aq) + Cl^-(aq)$
(d) low sol. $Ag_2CO_3(s) \rightleftharpoons 2Ag^+(aq) + CO_3^{2-}(aq)$

4. (a) $CuNO_3(aq) + HCl(aq) \rightleftharpoons CuCl(s) + HNO_3(aq)$
$Cu^+(aq) + NO_3^-(aq) + H^+(aq) + Cl^-(aq) \rightleftharpoons CuCl(s) + H^+(aq) + NO_3^-(aq)$
$Cu^+(aq) + Cl^-(aq) \rightleftharpoons CuCl(s)$
(b) $(NH_4)_2CO_3(aq) + MgBr_2(aq) \rightleftharpoons MgCO_3(s) + 2NH_4Br(aq)$
$2NH_4^+(aq) + CO_3^{2-}(aq) + Mg^{2+}(aq) + 2Br^-(aq) \rightleftharpoons MgCO_3(s) + 2NH_4^+(aq) + 2Br^-(aq)$
$Mg^{2+}(aq) + CO_3^{2-}(aq) \rightleftharpoons MgCO_3(s)$

5. (a) $Ba(OH)_2$ $BaSO_4$ $Ba_3(PO_4)_2$
most → least
(b) $Ba(OH)_2(s) \rightleftharpoons Ba^{2+}(aq) + 2OH^-(aq)$
$K_{sp} = 5.0 \times 10^{-3} = [Ba^{2+}][OH^-]^2$
$= 4x^3$
$x = 0.108$
$[Ba(OH)_2] = 0.108$ mol/L
(c) $Ba_3(PO_4)_2(s) \rightleftharpoons 3Ba^{2+}(aq) + 2PO_4^{3-}(aq)$
$K_{sp} = [Ba^{2+}]^3[PO_4^{3-}]^2$
$3 \times 10^{-23} = 108x^5$
$x = 1.2 \times 10^{-5}$
$[Ba^{2+}] = 3.6 \times 10^{-5}$ mol/L

(d) $BaSO_4(s) \rightleftharpoons Ba^{2+}(aq) + SO_4^{2-}(aq)$

$K_{sp} = [Ba^{2+}][SO_4^{2-}]$

$1.1 \times 10^{-10} = x^2$

$x = 1.0 \times 10^{-5} = [BaSO_4]$

$m = MCV = \frac{233.40 g}{mol} \times \frac{1.0 \times 10^{-5} mol}{L} \times 0.2500 L$

$= 5.8 \times 10^{-4} g$

6. $Zn(CN)_2(s) \rightleftharpoons Zn^{2+}(aq) + 2CN^-(aq)$

$\qquad x \qquad 2x$

$K_{sp} = [Zn^{2+}][CN^-]^2$ $\qquad x = 1.26 \times 10^{-4} mol/L$

$= (1.26 \times 10^{-4})(2 \cdot 1.26 \times 10^{-4})^2$

$= 8.0 \times 10^{-12}$

7. solid is $PbSO_4$ $\qquad K_{sp} = 1.8 \times 10^{-8}$

$PbSO_4(s) \rightleftharpoons Pb^{2+}(aq) + SO_4^{2-}(aq)$

$[Pb^{2+}] = 0.000185 \left(\frac{500.0}{625.0}\right) = 0.000148 mol/L$

$[SO_4^{2-}] = 0.00760 \left(\frac{125.0}{625.0}\right) = 0.00152 mol/L$

$Q_{sp} = [Pb^{2+}][SO_4^{2-}]$

$= 2.24 \times 10^{-7}$

$Q_{sp} > K_{sp}$, so precipitate!

8. solid is Ag_3PO_4 $\qquad K_{sp} = 8.9 \times 10^{-17}$

$Ag_3PO_4(s) \rightleftharpoons 3Ag^+(aq) + SO_4^{2-}(aq)$

$[Ag^+] = 0.00500 \left(\frac{1}{2}\right) = 0.00250 mol/L$

$[PO_4^{3-}] = 0.00135 \left(\frac{1}{2}\right) = 0.000675 mol/L$

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

$= 1.05 \times 10^{-11}$

$Q_{sp} > K_{sp}$, so precipitate!

9. (a) solid is Ag_2SO_4 $K_{sp} = 1.2 \times 10^{-5}$

$Ag_2SO_4(s) \rightleftharpoons 2Ag^+(aq) + SO_4^{2-}(aq)$

$[Ag^+] = 0.55\left(\frac{25}{313}\right) = 0.044 \text{ mol/L}$

$[SO_4^{2-}] = 0.050\left(\frac{188}{313}\right) = 0.0300 \text{ mol/L}$

$K_{sp} = [Ag^+]^2[SO_4^{2-}]$

$= (0.044)^2(0.0300)$

$= 5.8 \times 10^{-5}$

(b) have to add more solution to be able to detect the solid with your weak human eyes