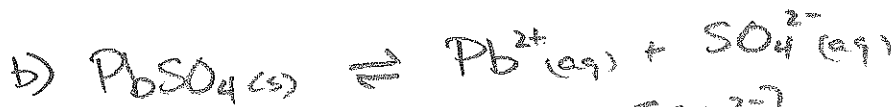


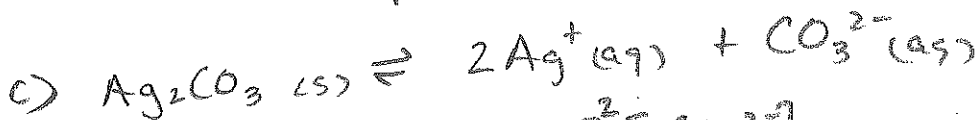
Solubility Product



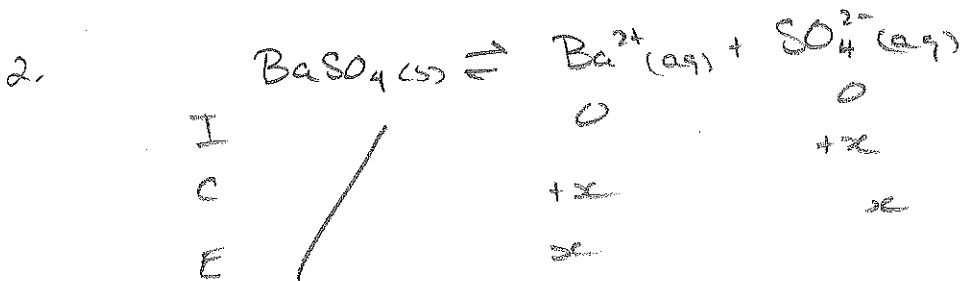
$$K_{sp} = [\text{Ca}^{2+}][\text{F}^-]^2$$



$$K_{sp} = [\text{Pb}^{2+}][\text{SO}_4^{2-}]$$



$$K_{sp} = [\text{Ag}^+]^2[\text{CO}_3^{2-}]$$



solubility $\text{BaSO}_4 = [\text{Ba}^{2+}] = [\text{SO}_4^{2-}]$

$$\text{solubility} = \frac{0.00245 \text{ g BaSO}_4}{L} \times \frac{1 \text{ mol BaSO}_4}{233.40} = 1.05 \times 10^{-5} \frac{\text{mol}}{L}$$

$$\therefore [\text{Ba}^{2+}]_{\text{eq'm}} = [\text{SO}_4^{2-}]_{\text{eq'm}} = 1.05 \times 10^{-5} \text{ mol/L}$$

$$K_{sp} = [\text{Ba}^{2+}][\text{SO}_4^{2-}]$$

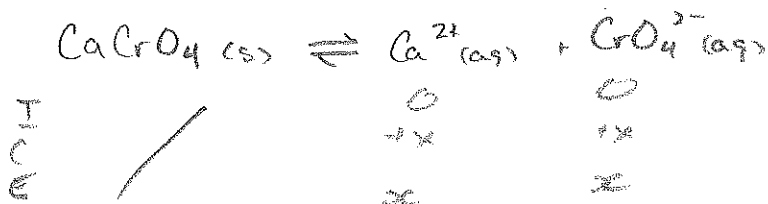
$$= (1.05 \times 10^{-5})(1.05 \times 10^{-5})$$

$$K_{sp} = 1.10 \times 10^{-10}$$

$$3. \quad \frac{0.649 \text{ g CaCrO}_4}{156 \text{ mL}} = \frac{x \text{ g}}{1000 \text{ mL}}$$

$$x = \frac{4.16 \text{ g CaCrO}_4}{1000 \text{ mL}}$$

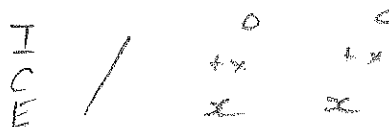
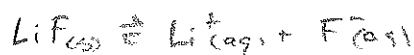
$$\begin{aligned} \text{solubility CaCrO}_4 &= 4.16 \text{ g CaCrO}_4 \times \frac{1 \text{ mol CaCrO}_4}{156.08 \text{ g CaCrO}_4} \\ &= 0.0267 \text{ mol CaCrO}_4 \end{aligned}$$



$$\text{solubility CaCrO}_4 = [\text{Ca}^{2+}]_{\text{eq'm}} = [\text{CrO}_4^{2-}]_{\text{eq'm}} = 0.0267 \frac{\text{mol}}{\text{L}}$$

$$\begin{aligned} K_{sp} &= [\text{Ca}^{2+}][\text{CrO}_4^{2-}] \\ &= (0.0267)(0.0267) \\ &= 7.1 \times 10^{-4} \end{aligned}$$

4. LiF has higher K_{sp} \therefore ↑ solubility

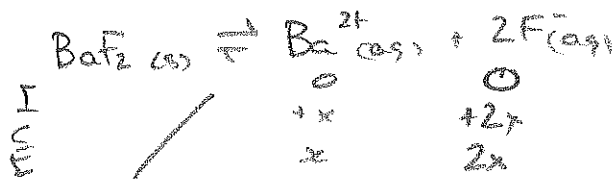


$$K_{sp} = [\text{Li}^+][\text{F}^-]$$

$$1.7 \times 10^{-3} = (x)(x)$$

$$x = 0.041$$

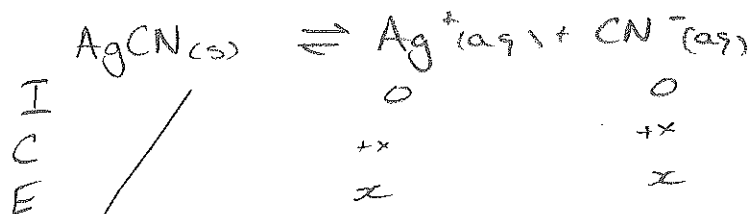
$$\begin{aligned} \text{solubility LiF} &= [\text{F}^-]_{\text{eq'm}} \\ &= [\text{Li}^+]_{\text{eq'm}} \\ &= 0.041 \text{ mol/L} \end{aligned}$$



$$\begin{aligned} K_{sp} &= [\text{Ba}^{2+}][\text{F}^-]^2 \\ 1.7 \times 10^{-6} &= (x)(2x)^2 \\ 4x^3 &= 1.7 \times 10^{-6} \\ x &= 7.5 \times 10^{-3} \end{aligned}$$

$$\begin{aligned} \text{solubility BaF}_2 &= [\text{Ba}^{2+}] = \frac{1}{2}[\text{F}^-] \\ &= 7.5 \times 10^{-3} \text{ mol/L} \end{aligned}$$

5.



$$\begin{aligned} \text{solubility AgCN} &= [\text{Ag}^+] \\ &= [\text{CN}^-] \\ &= 1.48 \times 10^{-8} \frac{\text{mol}}{\text{L}} \end{aligned}$$

$$K_{sp} = [\text{Ag}^+][\text{CN}^-]$$

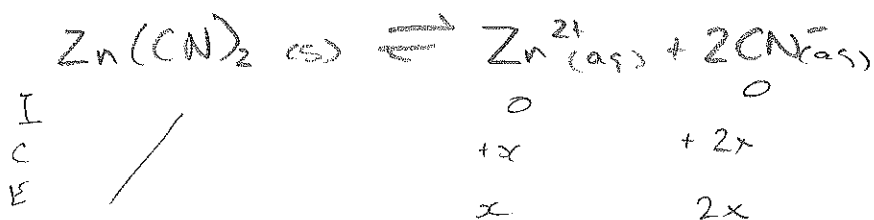
$$2.2 \times 10^{-16} = (x)(x)$$

$$x = 1.48 \times 10^{-8}$$

$$\text{sol AgCN} = 1.48 \times 10^{-8} \frac{\text{mol}}{\text{L}} \times \frac{133.89 \text{ g}}{1 \text{ mol}}$$

$$= \frac{1.98 \times 10^{-6} \text{ g AgCN}}{1 \text{ L}}$$

$$= \frac{1.98 \times 10^{-7} \text{ g AgCN}}{100 \text{ mL}}$$



$$K_{sp} = [\text{Zn}^{2+}][\text{CN}^-]^2$$

$$3.0 \times 10^{-16} = (x)(2x)^2$$

$$4x^3 = 3.0 \times 10^{-16}$$

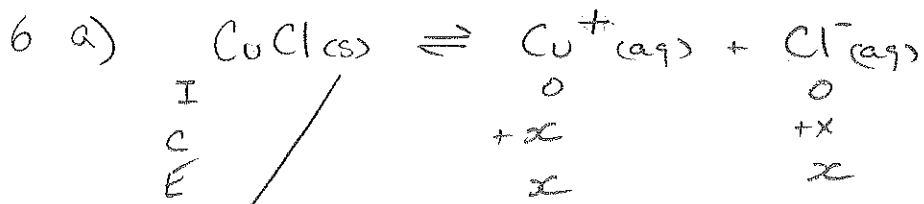
$$x = 4.2 \times 10^{-6}$$

$$\text{Solubility Zn(CN)}_2 = [\text{Zn}^{2+}] = \frac{1}{2} [\text{CN}^-]$$

$$= 4.2 \times 10^{-6} \frac{\text{mol}}{\text{L}} \times \frac{117.43 \text{ g}}{1 \text{ mol Zn(CN)}_2}$$

$$= \frac{4.9 \times 10^{-4} \text{ g Zn(CN)}_2}{1 \text{ L}}$$

$$= \frac{4.9 \times 10^{-5} \text{ g Zn(CN)}_2}{100 \text{ mL}}$$



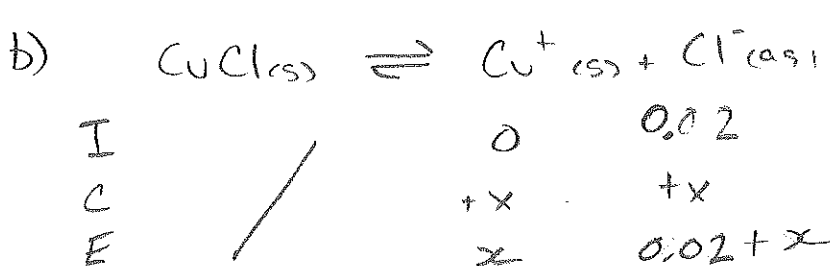
$$K_{sp} = [\text{Cu}^+][\text{Cl}^-]$$

$$1.9 \times 10^{-7} = (x)(x)$$

$$x = 4.4 \times 10^{-4}$$

$$\text{solubility} = [\text{Cu}^+] = [\text{Cl}^-]$$

$$= 4.4 \times 10^{-4} \text{ mol/L}$$



$$[\text{Cl}^-]_{\text{I}} = [\text{HCl}] \times \text{molar ratio}$$

$$= 0.02 \frac{\text{mol HCl}}{\text{L}} \times \frac{1 \text{ mol Cl}^-}{1 \text{ mol HCl}}$$

$$= 0.02 \frac{\text{mol Cl}^-}{\text{L}}$$

check

$$\frac{[\text{Cl}^-]_{\text{I}}}{K_{sp}}$$

$$= \frac{0.02}{1.9 \times 10^{-7}}$$

$$\gg 500$$

$$\therefore 0.02 + x \approx 0.02$$

$$K_{sp} = [\text{Cu}^+][\text{Cl}^-]$$

$$1.9 \times 10^{-7} = (x)(0.02)$$

$$x = 9.5 \times 10^{-6}$$

proof

$$\frac{x}{[\text{Cl}^-]_{\text{I}}} \times 100\%$$

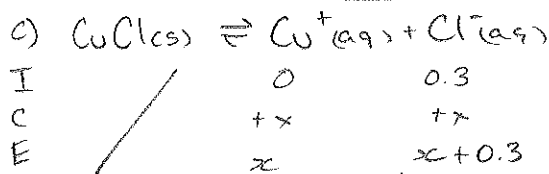
$$\frac{9.5 \times 10^{-6}}{0.02} \times 100\%$$

$$= 0.0475\%$$

$$\text{solubility CuCl} = [\text{Cu}^+]$$

$$= 9.5 \times 10^{-6} \frac{\text{mol}}{\text{L}}$$

\therefore ass. valid



$$K_{sp} = [\text{Cu}^+][\text{Cl}^-]$$

$$1.9 \times 10^{-17} = x(0.3)$$

$$x = 6.3 \times 10^{-17}$$

$$\text{solubility CuCl}_2 = [\text{Cu}^+]$$

$$= 6.3 \times 10^{-17} \frac{\text{mol}}{\text{L}}$$

check

$$\frac{[\text{Cl}^-]_{\text{I}}}{K_{sp}} = \frac{0.3}{1.9 \times 10^{-17}}$$

$$\gg 500$$

$$\therefore 0.3 + x \approx 0.3$$

proof

$$\frac{x}{[\text{Cl}^-]_{\text{I}}} \times 100\%$$

$$\frac{6.3 \times 10^{-17}}{0.3} \times 100\% \ll 5\%$$

$$\frac{z}{\text{mol}} = 4.25 \times 10^{-11} =$$

solubility $\text{Mg}(\text{OH})_2 = [\text{Mg}^{2+}]$

$$4.25 \times 10^{-11} \times 1000 \times 1000 \times 1000 = 4.25 \times 10^{-8}$$

$$\frac{x}{x} \times 10000$$

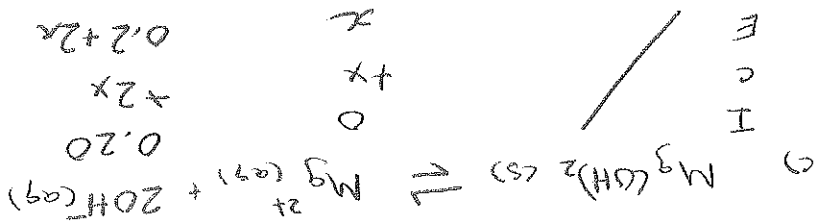
$$\frac{x}{x}$$

$$\frac{0.2}{0.2} \gg 500$$

check

$$x = 4.25 \times 10^{-11}$$

$$K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2 = x(0.2)^2 = 1.7 \times 10^{-12}$$



$$\frac{z}{\text{mol}} = 1.3 \times 10^{-6} =$$

solubility $\text{Mg}(\text{OH})_2 = \frac{1}{2}[\text{OH}^-]$

$$1.3 \times 10^{-6} \times 1000 \times 1000 \times 1000 = 1.3 \times 10^{-3}$$

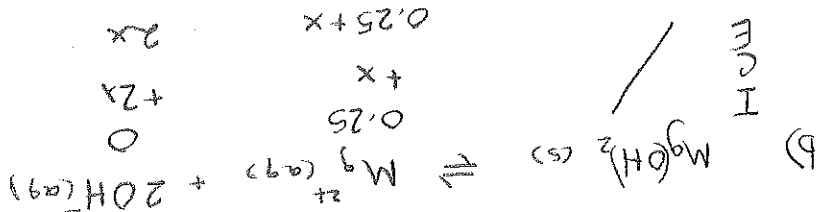
$$\frac{x}{x} \times 10000$$

$$\frac{0.25}{1.7 \times 10^{-12}} \gg 500$$

check

$$4x^2 = 6.8 \times 10^{-12} \Rightarrow x = 1.3 \times 10^{-6}$$

$$K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2 = (0.25)(2x)^2 = 1.7 \times 10^{-12}$$

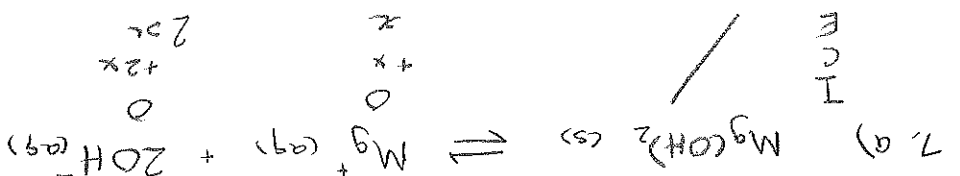


$$x = 1.2 \times 10^{-4}$$

$$4x^3 = 7.1 \times 10^{-12} \Rightarrow x = 1.2 \times 10^{-4}$$

$$7.1 \times 10^{-12} = (x)(2x)^2$$

$$K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2$$



$$\frac{z}{\text{mol}} = 1.2 \times 10^{-4} =$$

$$[\text{OH}^-] = \frac{1}{2}[\text{Mg}^{2+}]$$

solubility $\text{Mg}(\text{OH})_2 = [\text{Mg}^{2+}]$

8.

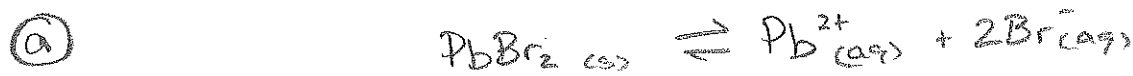


$$\begin{aligned} [\text{Pb}^{2+}] &= [\text{Pb}(\text{NO}_3)_2] \times \text{mol ratio} \times \frac{V_{\text{Pb}(\text{NO}_3)_2}}{V_T} \\ &= 0.015 \frac{\text{mol Pb}(\text{NO}_3)_2}{\text{L}} \times \frac{1 \text{ mol Pb}^{2+}}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{35.6 \text{ mL}}{59.28 \text{ mL}} \\ &= 0.009 \frac{\text{mol Pb}^{2+}}{\text{L}} \end{aligned}$$

$$\begin{aligned} [\text{Cl}^-] &= [\text{NaCl}] \times \text{mol ratio} \times \frac{V_{\text{NaCl}}}{V_T} \\ &= 0.012 \frac{\text{mol NaCl}}{\text{L}} \times \frac{1 \text{ mol Cl}^-}{1 \text{ mol NaCl}} \times \frac{23.68 \text{ mL}}{59.28 \text{ mL}} \\ &= 0.00479 \frac{\text{mol Cl}^-}{\text{L}} \end{aligned}$$

$$\begin{aligned} Q_{\text{sp}} &= [\text{Pb}^{2+}][\text{Cl}^-]^2 \\ &= (0.009)(0.00479)^2 \\ &= 2.07 \times 10^{-7} \end{aligned}$$

$Q_{\text{sp}} < K_{\text{sp}}$ \therefore no ppt



$$[\text{Pb}^{2+}] = [\text{Pb}(\text{NO}_3)_2] \times \text{mol ratio} \times \frac{V}{V_T}$$

$$= 0.01 \text{ mol Pb}(\text{NO}_3)_2 \times \frac{1 \text{ mol Pb}^{2+}}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{50.0 \text{ mL}}{100 \text{ mL}}$$

$$= 0.005 \frac{\text{mol Pb}^{2+}}{\text{L}}$$

$$[\text{Br}^-] = [\text{KBr}] \times \text{mol ratio} \times \frac{V}{V_T}$$

$$= 0.01 \frac{\text{mol KBr}}{\text{L}} \times \frac{1 \text{ mol Br}^-}{1 \text{ mol KBr}} \times \frac{50.00 \text{ mL}}{100 \text{ mL}}$$

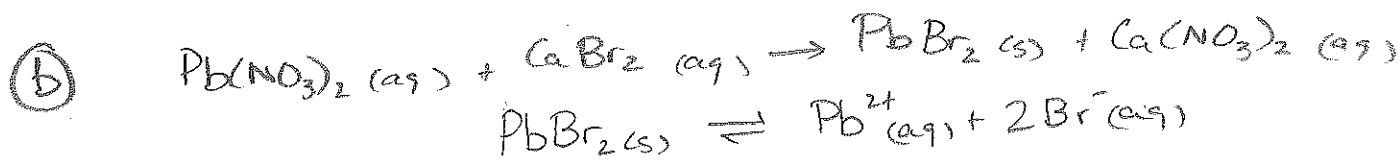
$$= 0.005 \frac{\text{mol Br}^-}{\text{L}}$$

$$Q_{sp} = [\text{Pb}^{2+}][\text{Br}^-]^2$$

$$= (0.005)(0.005)^2$$

$$= 1.25 \times 10^{-7}$$

$Q_{sp} < K_{sp}$
 \therefore no ppt



$$[\text{Pb}^{2+}] = [\text{Pb}(\text{NO}_3)_2] \times \text{mol ratio} \times \frac{V}{V_T}$$

$$= 0.0100 \text{ mol Pb}(\text{NO}_3)_2 \times \frac{1 \text{ mol Pb}^{2+}}{1 \text{ mol Pb}(\text{NO}_3)_2} \times \frac{50.0 \text{ mL}}{125.0 \text{ mL}}$$

$$= 4.00 \times 10^{-3} \frac{\text{mol Pb}^{2+}}{\text{L}}$$

$$[\text{Br}^-] = [\text{CaBr}_2] \times \text{mol ratio} \times \frac{V}{V_T}$$

$$= 0.0526 \text{ mol CaBr}_2 \times \frac{2 \text{ mol Br}^-}{1 \text{ mol CaBr}_2} \times \frac{75.0 \text{ mL}}{125 \text{ mL}}$$

$$= 6.312 \times 10^{-2} \text{ mol/L}$$

$$Q_{sp} = [\text{Pb}^{2+}][\text{Br}^-]^2$$

$$= (4 \times 10^{-3})(6.312 \times 10^{-2})^2$$

$$= 1.6 \times 10^{-5}$$

$Q_{sp} > K_{sp}$
 \therefore ppt.