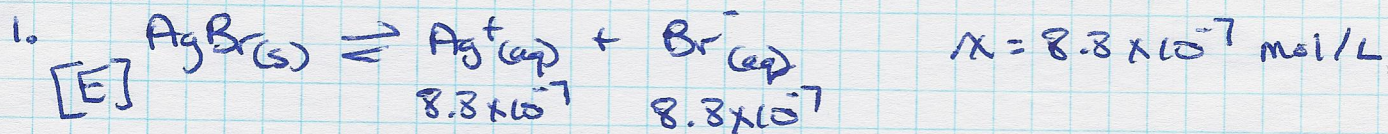
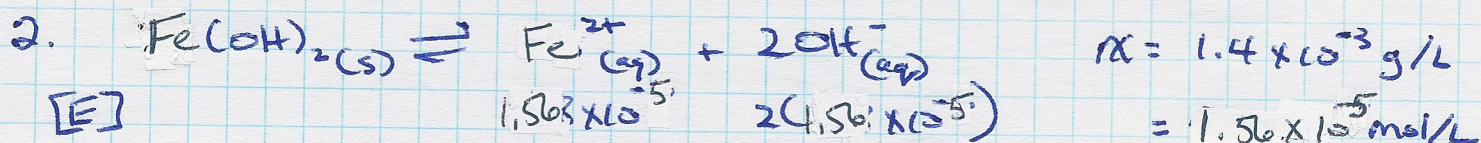


Solubility, Equilibrium + Solubility Product

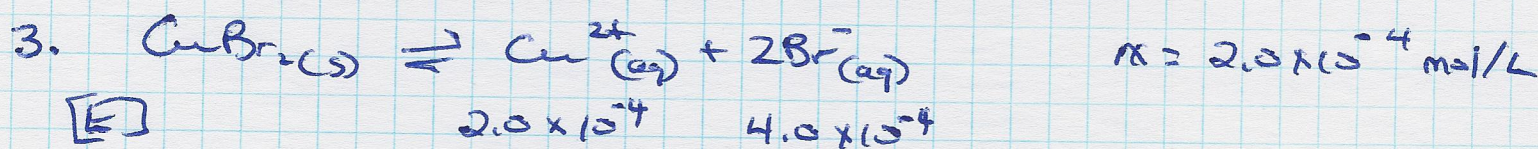
Calculating K_{sp}



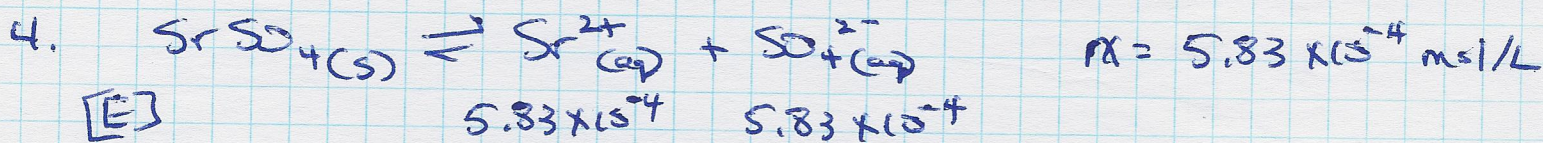
$$K_{sp} = [\text{Ag}^+][\text{Br}^-] = (8.8 \times 10^{-7})^2 = 7.7 \times 10^{-13}$$



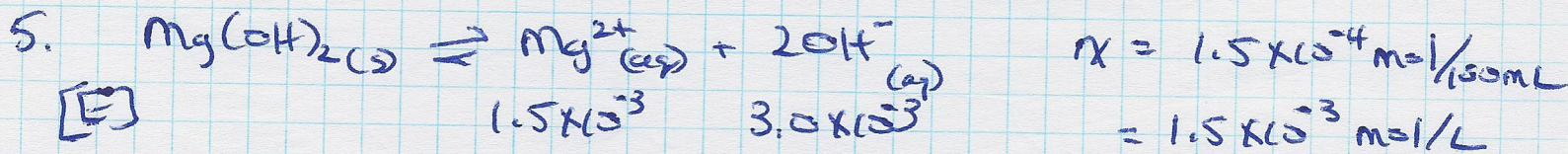
$$K_{sp} = [\text{Fe}^{2+}][\text{OH}^-]^2 = (1.56 \times 10^{-5})(3.11 \times 10^{-5})^2 = 1.5 \times 10^{-14}$$



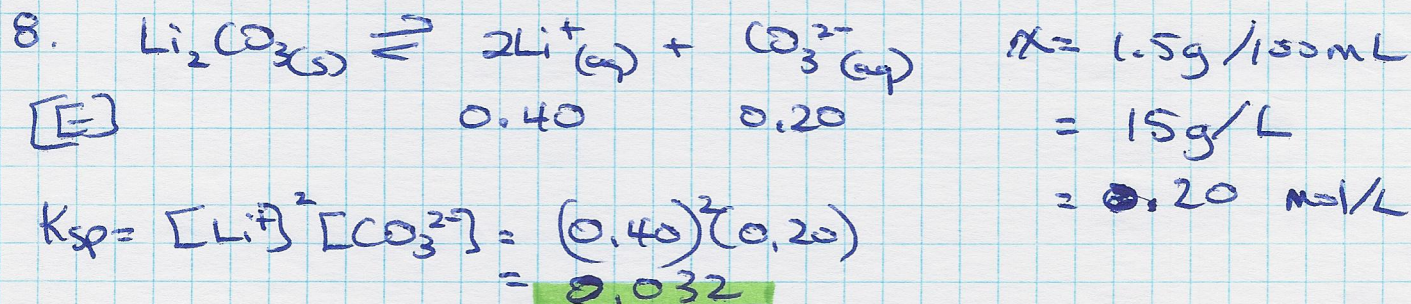
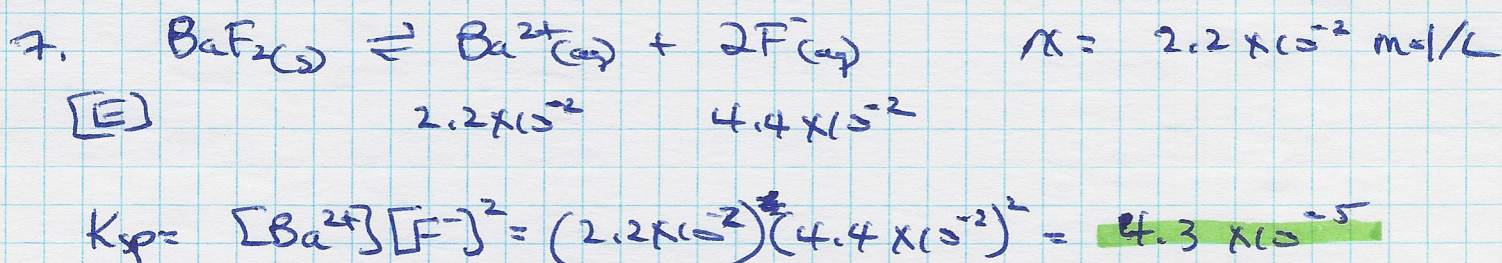
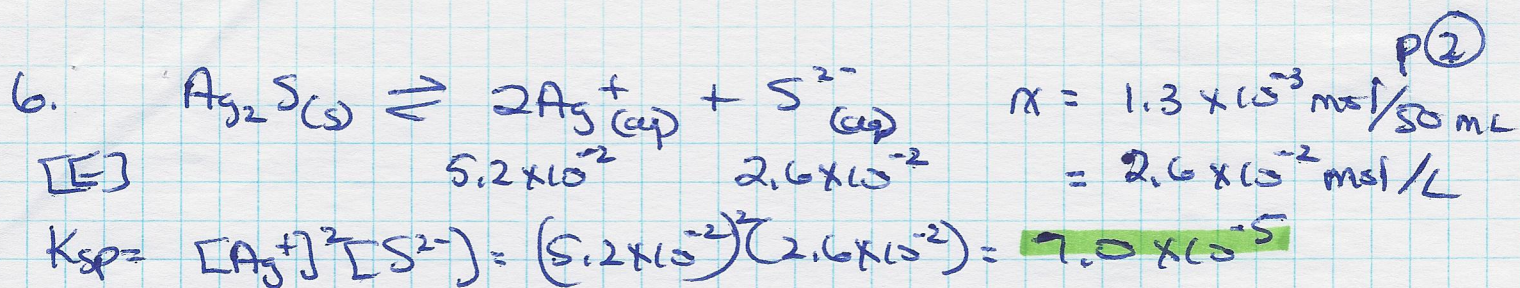
$$K_{sp} = [\text{Cu}^{2+}][\text{Br}^-]^2 = (2.0 \times 10^{-4})(4.0 \times 10^{-4})^2 = 3.2 \times 10^{-11}$$



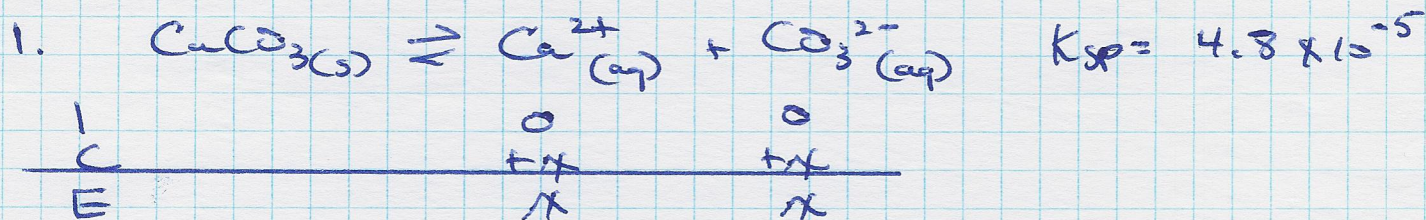
$$K_{sp} = [\text{Sr}^{2+}][\text{SO}_4^{2-}] = (5.83 \times 10^{-4})^2 = 3.4 \times 10^{-7}$$



$$K_{sp} = [\text{Mg}^{2+}][\text{OH}^-]^2 = (1.5 \times 10^{-3})(3.0 \times 10^{-3})^2 = 1.4 \times 10^{-8}$$



Calculating solubility from K_{sp}

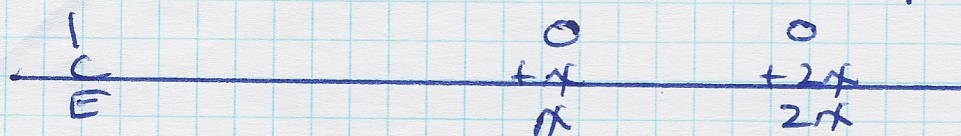
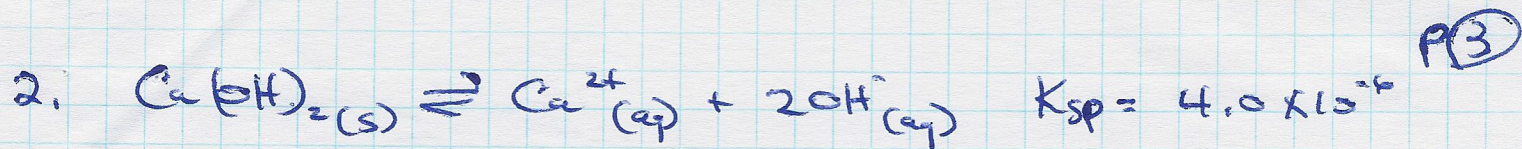


~~4.8~~ $K_{sp} = [\text{Ca}^{2+}] [\text{CO}_3^{2-}]$

$4.8 \times 10^{-5} = x^2$

$x = 6.9 \times 10^{-3}$

∴ solubility is $6.9 \times 10^{-3} \text{ mol/L}$



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

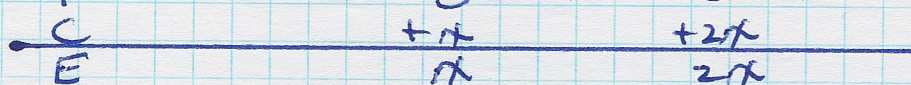
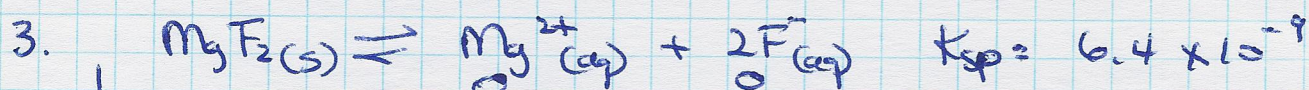
$$4.0 \times 10^{-6} = (x)(2x)^2$$

$$4.0 \times 10^{-6} = 4x^3$$

$$x = 1.0 \times 10^{-2}$$

∴ solubility is $1.0 \times 10^{-2} \text{ mol/L}$

OR **0.74 g/L**



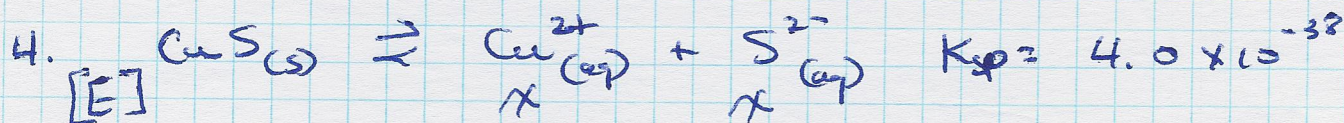
$$K_{\text{sp}} = [\text{Mg}^{2+}][\text{F}^{-}]^2$$

$$6.4 \times 10^{-9} = (x)(2x)^2 = 4x^3$$

$$x = 1.2 \times 10^{-3}$$

∴ solubility is $1.2 \times 10^{-3} \text{ mol/L}$

OR **0.075 g/L**



[E]

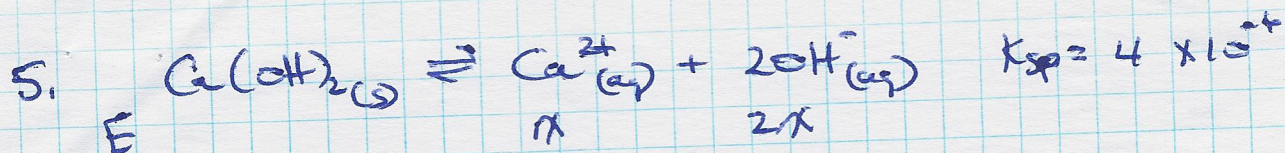
a) $4.0 \times 10^{-38} = x^2$
 $x = 2.0 \times 10^{-19}$

2.0×10^{-19} moles will dissolve in 1.0 L

b) $m = (2.0 \times 10^{-19})(95.61)$

$1.9 \times 10^{-17} \text{ g}$ will dissolve in 1.0 L

c) $[\text{S}^{2-}] = \text{2.0} \times 10^{-19} \text{ mol/L}$



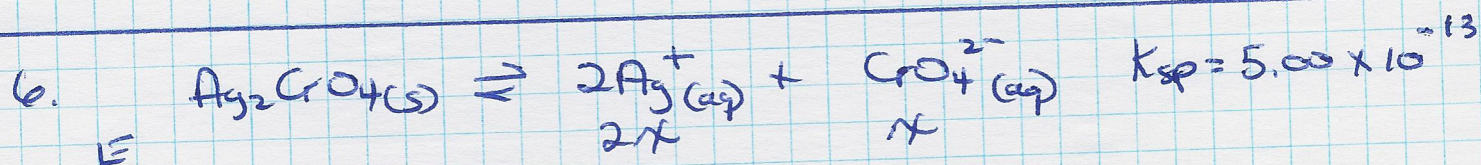
(4)

a) $4 \times 10^{-6} = (x)(2x)^2 = 4x^3$

$x = 1 \times 10^{-2}$

$1 \times 10^{-2} \text{ mol/L} \times 74.08 \text{ g/mol} = 0.74 \text{ g/L}$

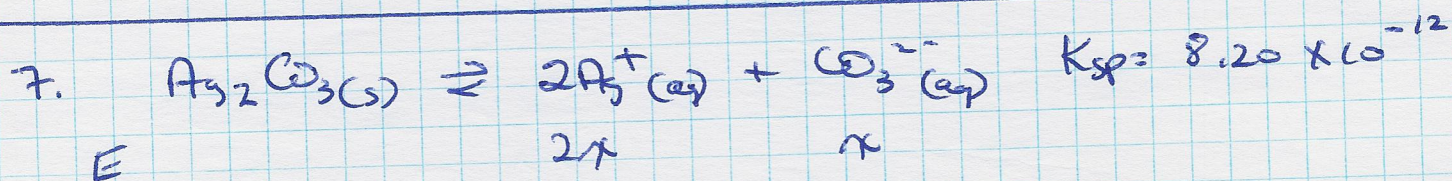
b) $[\text{OH}^{-}] = 2(1 \times 10^{-2}) = 2 \times 10^{-2} \text{ mol/L}$



$5.00 \times 10^{-13} = (2x)^2 x = 4x^3$

$x = 5.00 \times 10^{-5}$

$\therefore [\text{Ag}^{+}] = 1.00 \times 10^{-4} \text{ mol/L}$



$8.20 \times 10^{-12} = (2x)^2(x) = 4x^3$

$x = 1.27 \times 10^{-4} \text{ mol/L}$

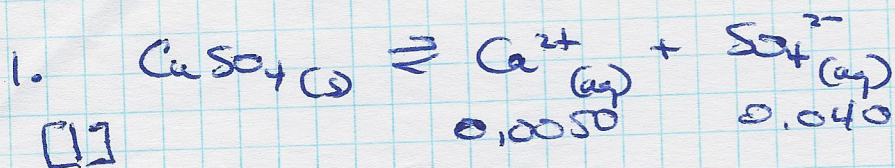
$[\text{Ag}^{+}] = 2(1.27 \times 10^{-4}) = 2.54 \times 10^{-4}$

fix $\rightarrow 1.27 \times 10^{-4} \times 275.81 = 3.50 \times 10^{-2} \text{ g/L}$

$(2.54 \times 10^{-4})(107.9) = 2.74 \times 10^{-2} \text{ g/L}$

WAPF

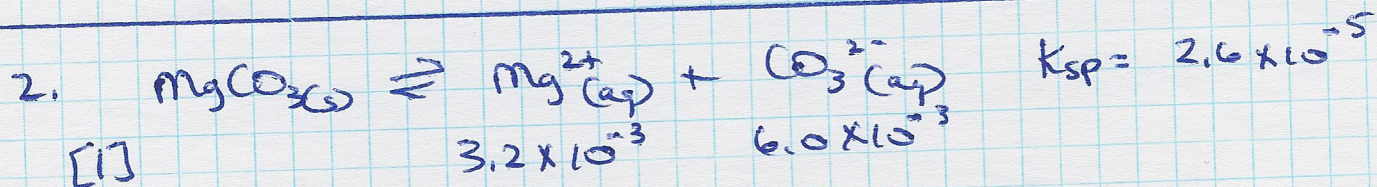
p5



$$[\text{CaCl}_2] = \frac{0.010 \times 20}{40} = 0.0050 \text{ M} = [\text{Ca}^{2+}]$$

$$[\text{Na}_2\text{SO}_4] = \frac{0.080 \times 20}{40} = 0.040 \text{ M} = [\text{SO}_4^{2-}]$$

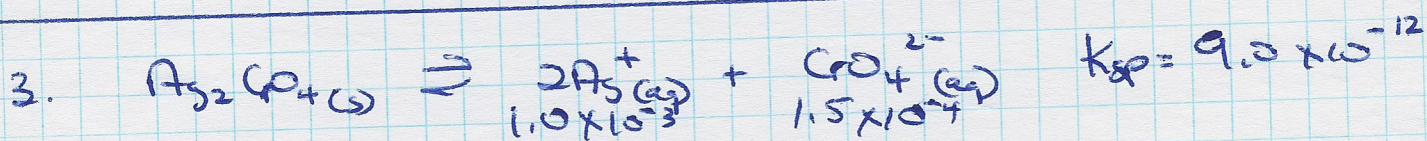
$$Q = (0.0050)(0.040) = 2.0 \times 10^{-4} \quad Q > K_{sp} \therefore \text{yes}$$



$$[\text{Mg}(\text{NO}_3)_2] = \frac{8.0 \times 10^{-3} \times 400}{100.0} = 3.2 \times 10^{-3} \text{ M} = [\text{Mg}^{2+}]$$

$$[\text{K}_2\text{CO}_3] = \frac{1.0 \times 10^{-2} \times 600}{100.0} = 6.0 \times 10^{-3} \text{ M} = [\text{CO}_3^{2-}]$$

$$Q = (3.2 \times 10^{-3})(6.0 \times 10^{-3}) = 1.9 \times 10^{-5} \quad Q < K_{sp} \therefore \text{NO}$$

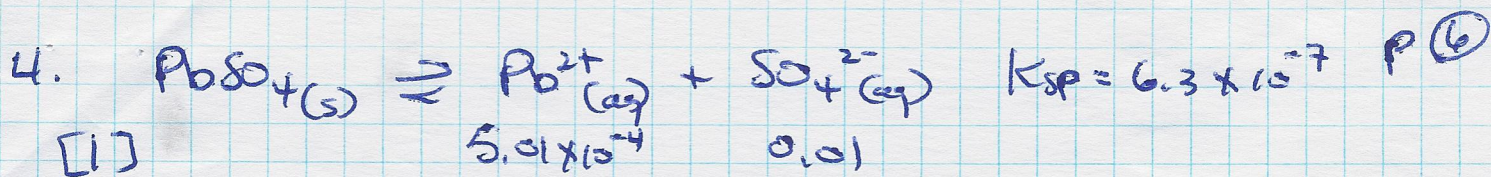


$$[\text{AgNO}_3] = \frac{4 \times 10^{-3} \times 25}{100} = 1 \times 10^{-3} \text{ M} = [\text{Ag}^+]$$

$$[\text{Na}_2\text{CrO}_4] = \frac{2.0 \times 10^{-4} \times 75}{100} = 1.5 \times 10^{-4} \text{ M} = [\text{CrO}_4^{2-}]$$

$$Q = (1.0 \times 10^{-3})^2 (1.5 \times 10^{-4}) = 1.5 \times 10^{-10}$$

$$Q > K_{sp} \therefore \text{Yes.}$$



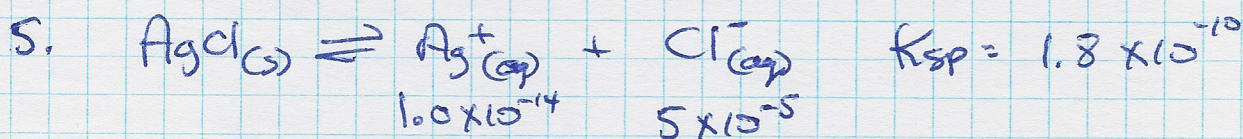
$$n_{\text{Pb(NO}_3)_2} = \frac{0.166 \text{ g}}{331.22} = 5.01 \times 10^{-4} \text{ mol in } 1.0 \text{ L}$$

$$[\text{Pb}^{2+}] = 5.01 \times 10^{-4} \text{ mol/L}$$

$$[\text{Na}_2\text{SO}_4] = 0.01 \text{ M} = [\text{SO}_4^{2-}]$$

$$Q = (5.01 \times 10^{-4})(0.01) = 5.01 \times 10^{-6}$$

$$Q > K_{sp} \quad \therefore \text{yes.}$$

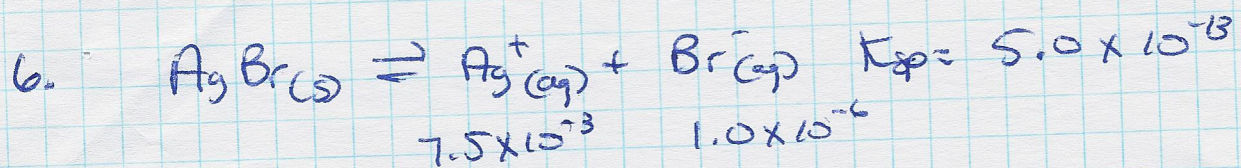


$$[\text{NaCl}] = \frac{1 \times 10^{-4} \times 25}{50} = 5 \times 10^{-5} \text{ M} = [\text{Cl}^-]$$

$$[\text{AgNO}_3] = \frac{2 \times 10^{-4} \times 25}{50} = 1 \times 10^{-4} = [\text{Ag}^+]$$

$$Q = (1.0 \times 10^{-4})(5 \times 10^{-5}) = 5 \times 10^{-9}$$

$$Q < K_{sp} \quad \therefore \text{NO.}$$

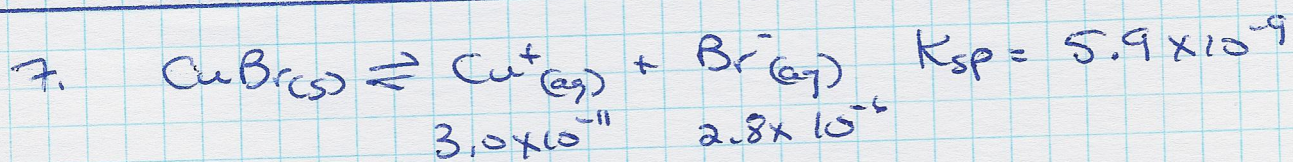


$$[\text{NaBr}] = \frac{4.0 \times 10^{-4} \times 25}{100} = 1.0 \times 10^{-6} \text{ M} = [\text{Br}^-]$$

$$[\text{AgNO}_3] = \frac{1.0 \times 10^{-2} \times 75}{100} = 7.5 \times 10^{-3} \text{ M} = [\text{Ag}^+]$$

$$Q = (7.5 \times 10^{-3})(1.0 \times 10^{-6}) = 7.5 \times 10^{-9}$$

$$Q > K_{\text{sp}} \quad \therefore \text{Yes.}$$



$$[\text{NaBr}] = \frac{4.0 \times 10^{-6} \times 70}{100} = 2.8 \times 10^{-6} \text{ M} = [\text{Br}^-]$$

$$[\text{CuNO}_3] = \frac{1.0 \times 10^{-10} \times 30}{100} = 3.0 \times 10^{-11} = [\text{Cu}^+]$$

$$Q = (3.0 \times 10^{-11})(2.8 \times 10^{-6}) = 8.4 \times 10^{-17}$$

$$Q < K_{\text{sp}} \quad \therefore \text{NO.}$$

Common Ion Effect



	0	0.10
C	+ x	+ x
E	x	0.10 + x

$$K_{\text{sp}} = 2.0 \times 10^{-10}$$

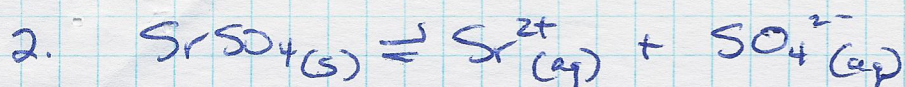
$$[\text{NaCl}] = 0.10 \text{ M} = [\text{Cl}^-]$$

$$2.0 \times 10^{-10} = x(0.10)$$

$$x = 2.0 \times 10^{-9}$$

Note: in water
 $x = 1.4 \times 10^{-5}$
 $\therefore x$ is insignificant

$\therefore$ the solubility in NaCl is $2.0 \times 10^{-9} \text{ mol/L}$



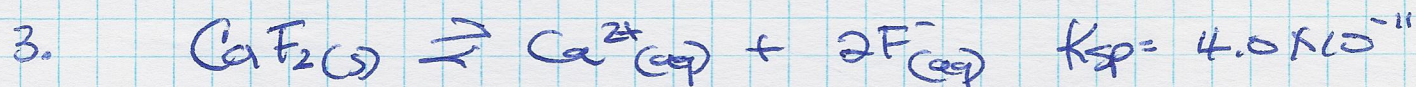
I	0	0.20
C	+x	+x
E	x	0.20+x

sol'y in water = 8.5×10^{-5}
in CI
 $x \ll 8.5 \times 10^{-5}$
 $\therefore$ insignificant

$$7.2 \times 10^{-9} = x(0.20)$$

$$x = 3.6 \times 10^{-8}$$

$\therefore$ sol'y in Na_2SO_4 is $3.6 \times 10^{-8} \text{ mol/L}$



I	0	0.025
C	+x	+2x
E	x	0.025+2x

sol'y in water:

$$4.0 \times 10^{-11} = (x)(0.025)^2$$

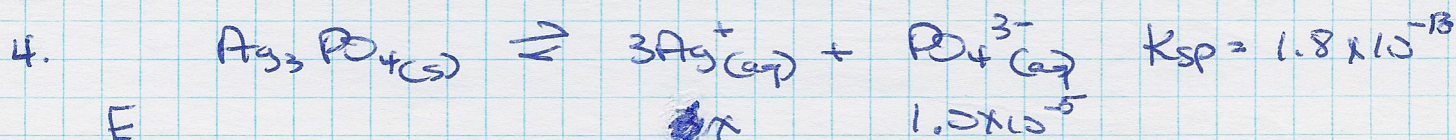
$$x = 6.4 \times 10^{-8}$$

$$4.0 \times 10^{-11} = 4x^3$$

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

$\therefore x \ll 3 \times 10^{-4}$
 $\therefore$ insign.

$\therefore$ sol'y of CaF_2 in NaF is $6.4 \times 10^{-8} \text{ mol/L}$



E

x

1.0×10^{-5}

$$1.8 \times 10^{-18} = (x)^3(1.0 \times 10^{-5})$$

$$x = 5.6 \times 10^{-5} = [\text{Ag}^{+}] \text{ at equil - any value}$$

greater than this will cause a precipitate.

$\therefore [\text{AgNO}_3] > 5.6 \times 10^{-5} \text{ mol/L}$