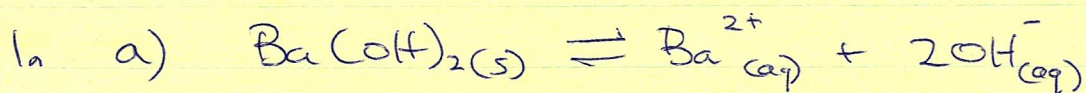
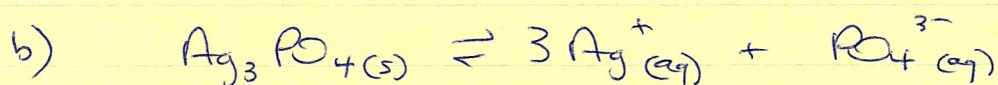


Solutions Practice Questions

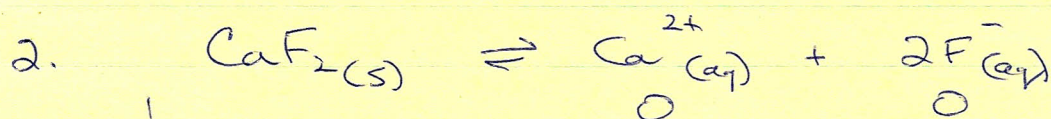
A. Calculating Solubility



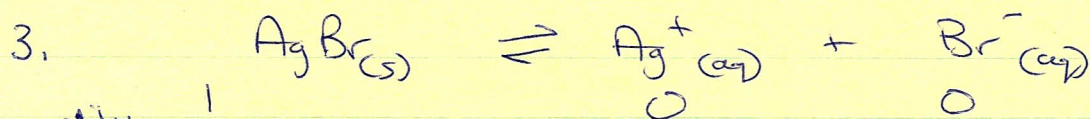
$$K_{sp} = [\text{Ba}^{2+}][\text{OH}^{-}]^2$$



$$K_{sp} = [\text{Ag}^{+}]^3[\text{PO}_4^{3-}]$$



C	+x	+2x
E	x	2x



= solubility

C	+x	+x
E	x	x

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

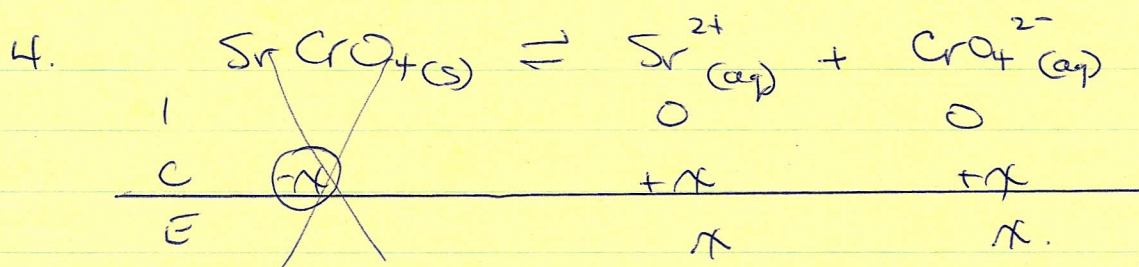
$$5.0 \times 10^{-13} = x^2$$

$$x = 7.1 \times 10^{-7}$$

a) ∴ solubility is $7.1 \times 10^{-7} \text{ mol/L}$

b) $m = (7.1 \times 10^{-7})(187.8) = 1.3 \times 10^{-4} \text{ g}$

solg = $1.3 \times 10^{-4} \text{ g/L}$ or $1.3 \times 10^{-5} \text{ g/100mL}$

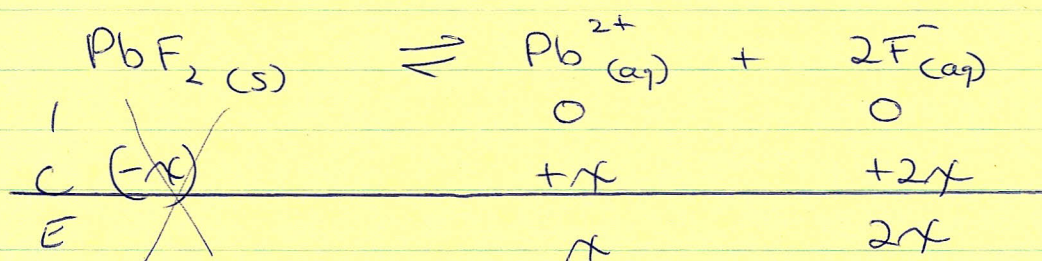


$$K_{sp} = [\text{Sr}^{2+}][\text{CrO}_4^{2-}]$$

$$3.6 \times 10^{-5} = x^2$$

$$x = 6.0 \times 10^{-3}$$

$\therefore$ sol'y of SrCrO_4 is $6.0 \times 10^{-3} \text{ mol/L}$



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

$$4.0 \times 10^{-8} = (x)(2x)^2$$

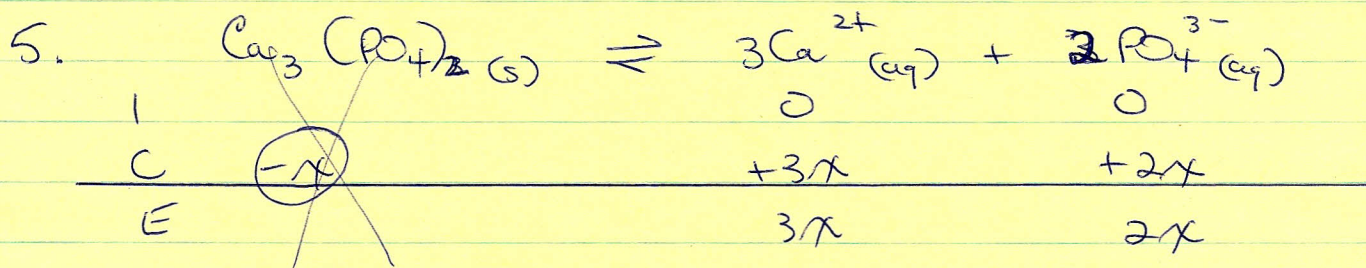
$$4.0 \times 10^{-8} = 4x^3$$

$$1.0 \times 10^{-8} = x^3$$

$$x = 2.2 \times 10^{-3}$$

$\therefore$ the sol'y of PbF_2 is $2.2 \times 10^{-3} \text{ mol/L}$

$\therefore \text{SrCrO}_4$ has the greatest sol'y.



$$K_{sp} = [\text{Ca}^{2+}]^3[\text{PO}_4^{3-}]^2$$

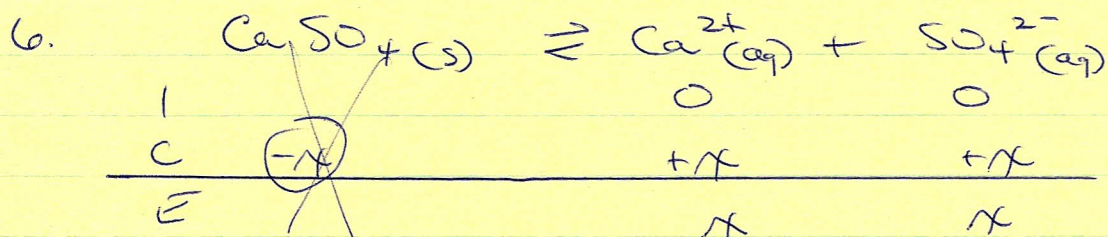
$$1.3 \times 10^{-32} = (3x)^3(2x)^2$$

$$1.3 \times 10^{-32} = 108x^5$$

$$\frac{1.3 \times 10^{-32}}{108} = x^5$$

$$x = 1.6 \times 10^{-7}$$

$\therefore$ the molar sol'y of $\text{Ca}_3(\text{PO}_4)_2$ is $1.6 \times 10^{-7} \text{ mol/L}$



$$6.1 \times 10^{-5} = x^2$$

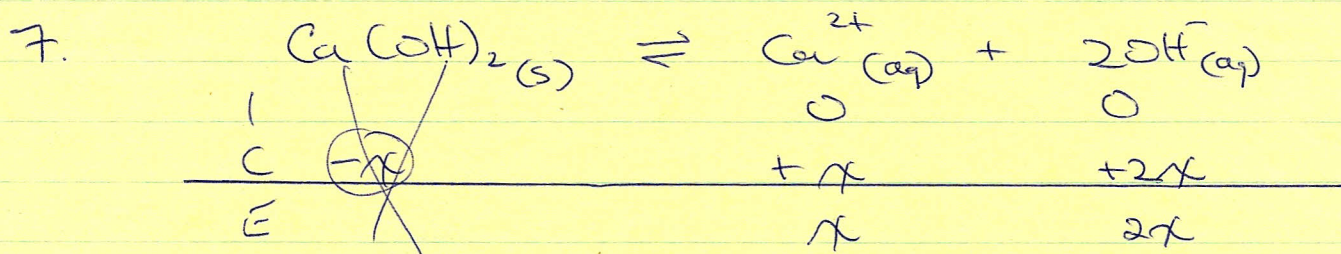
$$x = 7.8 \times 10^{-3}$$

$$\therefore \text{sol'y is } 7.8 \times 10^{-3} \text{ mol/L}$$

0.2504

$$\begin{aligned} \text{sol'y in g/250mL} &: 7.8 \times 10^{-3} \text{ mol/L} \times 136.14 \text{ g/mol} \times \\ &= \cancel{0.266 \text{ g}} \quad 0.27 \text{ g} \end{aligned}$$

$\therefore$ 0.27g of CaSO_4 is dissolved in 250mL of the saturated sol'n.



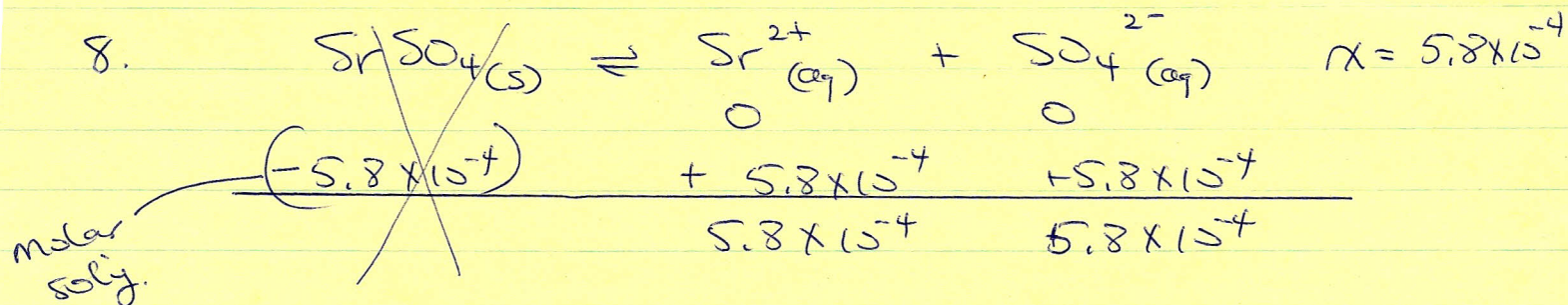
$$1.3 \times 10^{-6} = (x)(2x)^2$$

$$1.3 \times 10^{-6} = 4x^3$$

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

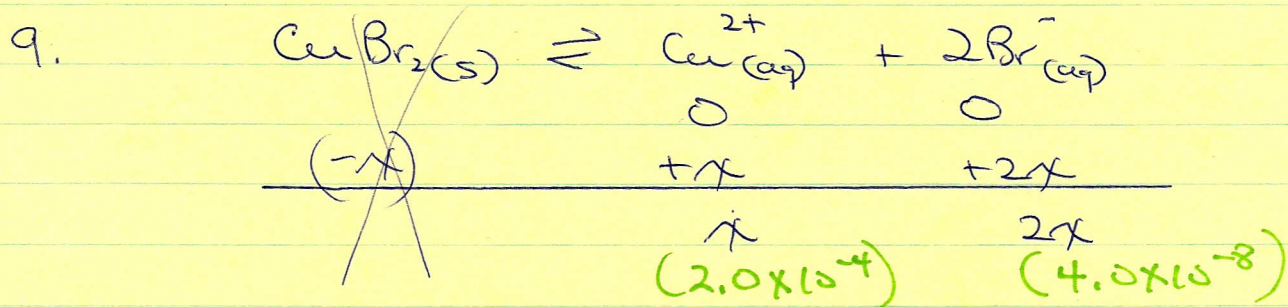
$$\therefore [\text{OH}^{-}] = 2(6.9 \times 10^{-3}) = 0.014 \text{ mol/L}$$

B. Calculating K_{sp}



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

$$= (5.8 \times 10^{-4})^2 = 3.4 \times 10^{-7}$$



$$x = 2.0 \times 10^{-4} \text{ mol/L}$$

$$K_{sp} = [\text{Cu}^{2+}][\text{Br}^{-}]^2 \quad \text{or}$$

$$= (x)(2x)^2$$

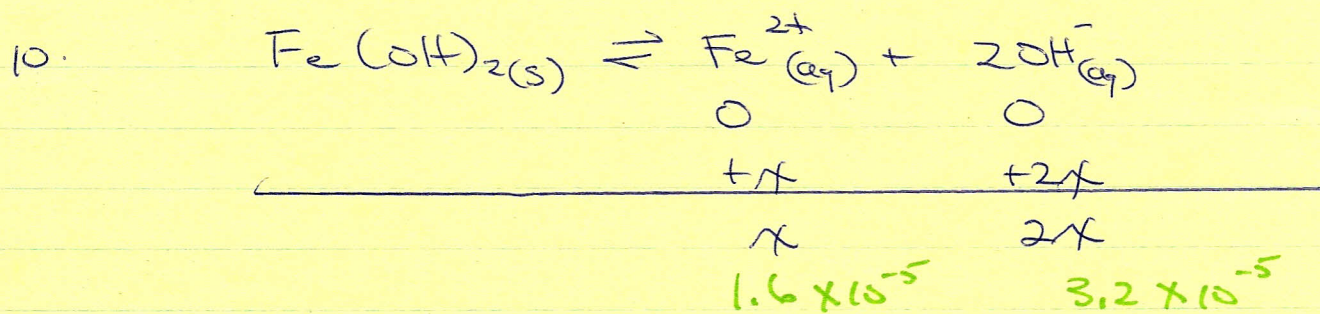
$$= 4x^3$$

$$= 4(2.0 \times 10^{-4})^3$$

$$= 3.2 \times 10^{-11}$$

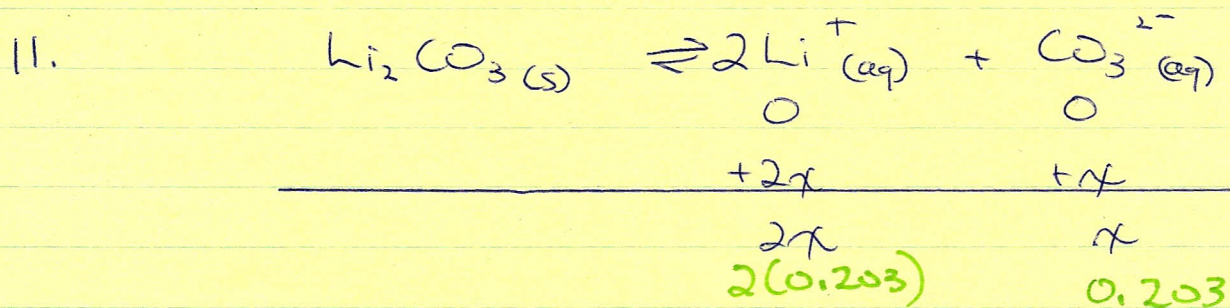
$$K_{sp} = (2.0 \times 10^{-4})(4.0 \times 10^{-8})^2$$

$$= 3.2 \times 10^{-11}$$



$$x = \frac{1.4 \times 10^{-3} \text{ g/L}}{89.87 \text{ g/mol}} = 1.6 \times 10^{-5} \text{ mol/L}$$

$$K_{sp} = (1.6 \times 10^{-5})(3.2 \times 10^{-5})^2 = 1.6 \times 10^{-14}$$

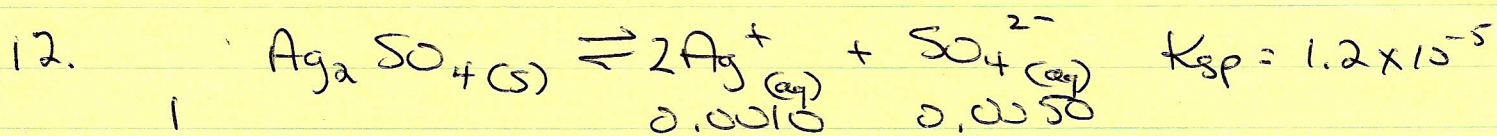


$$n = \frac{3.75 \text{ g}}{73.89} = 0.0508 \text{ mol}$$

$$x = \frac{n}{V} = \frac{0.0508 \text{ mol}}{0.250 \text{ L}} = 0.203 \text{ mol/L}$$

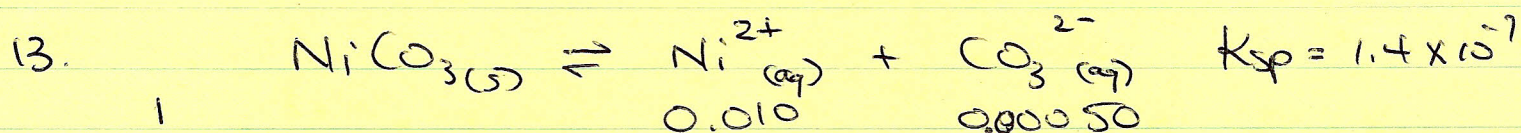
$$K_{sp} = (0.406)^2(0.203) = 0.0335$$

C. The Nature of Solutions.



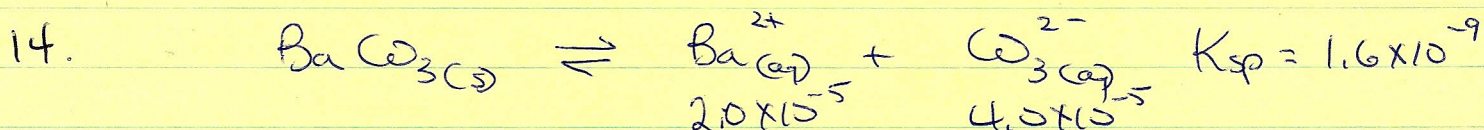
$$Q = (0.0010)^2 (0.0050) = 5.0 \times 10^{-9}$$

$Q < K_{\text{sp}}$ $\therefore$ the solution is unsaturated.



$$Q = (0.010)(0.00050) = 5.0 \times 10^{-6}$$

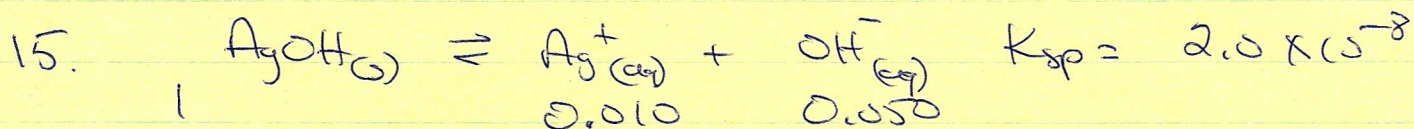
$Q > K_{\text{sp}}$ $\therefore$ the solution is supersaturated.



$$Q = (2.0 \times 10^{-5})(4.0 \times 10^{-5}) = 8.0 \times 10^{-10}$$

$Q < K_{\text{sp}}$ $\therefore$ the solution is unsaturated.

D. Will a Precipitate Form?



$$Q = (0,012)(0,050) = 5,0 \times 10^{-4}$$

① $> K_{sp}$ ∴ yes a ppte will form

16. Which ppt? $\text{Na}^+ + \text{NO}_3^-$ are always spectator ions $\therefore$ will a ppt of PbCl_2 form?



* Both solns have been diluted in half $\therefore$
see [Pb²⁺] will be 0.0010 M + [Cl⁻] will be
note below 0.050 M.

$$Q_1 = (0.0019)(0.050)^2 = 2.5 \times 10^{-6}$$

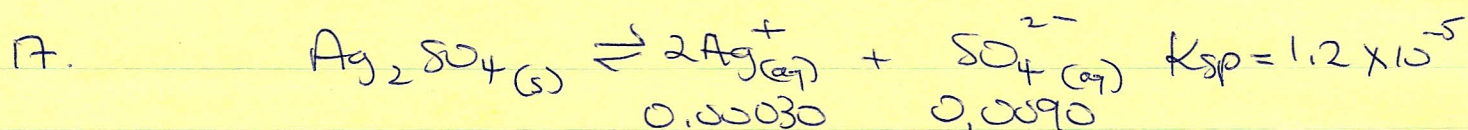
$Q < K_{sp}$ so no ppt will form

NOTE:

$$[NaCl] = [Cl^-] \quad \text{using } C_1V_1 = C_2V_2$$
$$(100)(0.10) = C_2(200)$$
$$C_2 = 0.050$$

$$[\text{Pb}(\text{NO}_3)_2] = [\text{Pb}^{2+}] \quad \text{using} \quad C_1 V_1 = C_2 V_2$$
$$(0.0020)(100) = C_2(200)$$
$$C_2 = 0.0010$$

8.



$$[AgNO_3] = [Ag^+] = \frac{C_1 V_1}{C_2 V_2} \quad \text{or Dilution factor}$$

$$(0.0030)(10.0) = C_2(100.0) = \frac{1}{10} \text{ th. for } Ag^+$$

$$C_2 = 0.00030$$

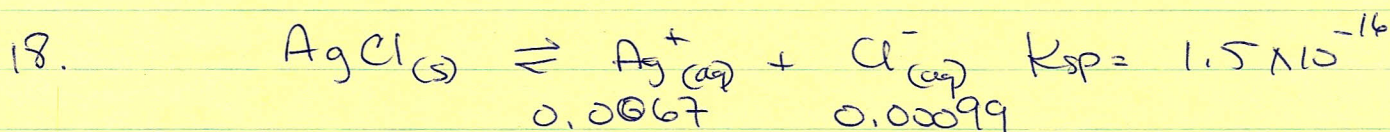
$$[N_2S_4] = [S_4^{2-}] = (0.010)(90.0) = G_2(100.0)$$

$$G_2 = 0.0090$$

$$\Phi = (0,0030)^2 (0,0090) = 8,1 \times 10^{-10}$$

Dil'n factor for
 $\text{SO}_4^{2-} = 9/10$
 $\approx 90\%$
 $[\text{SO}_4^{2-}] = (0.90)(0.010)$
 $= 0.0090 \text{ M}$

$Q < K_{sp} \implies$ NO a ppte will NOT form.



$$[AgNO_3] = [Ag^+] : (0.010)(100) = C_2(150) \quad \text{or use } 2/3 \text{ dil'n}$$

$$C_2 = 0.0067 M \quad (67\%)$$

$$[\text{Cr}] \neq [\text{AlCl}_3] = (0.0010)(50) = C_2 (150) \quad \text{or use } \frac{1}{3} \text{ dil'n (33\%)} \\ C_2 = 0.0033 \text{ M}$$

$$[A^-] = 3(0.00033) = 0.00099 \text{ M}$$

$$Q = (0.0067)(0.00099) = 6.6 \times 10^{-6} \quad Q > K_{sp} \therefore \text{YES!}$$

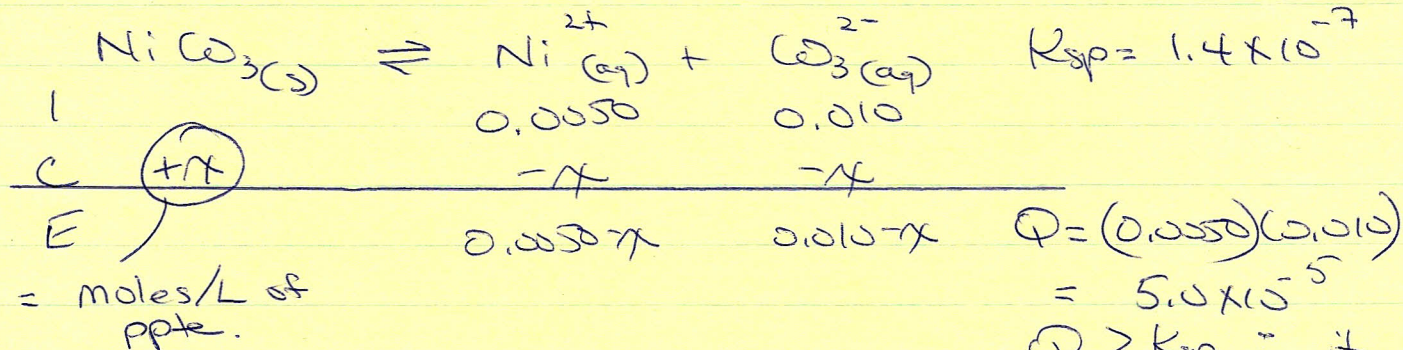
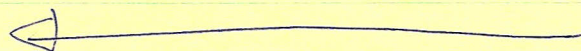
E. How much Precipitate Will Form?

$$19. \quad [\text{Ni}^{2+}] = \frac{0.010}{2} = 0.0050 \text{ M}$$

($\frac{1}{2}$ or 50%
dil'n)

$$[\text{CO}_3^{2-}] = \frac{0.020}{2} = \frac{0.010 \text{ M}}{\cancel{0.010 \text{ M}}}$$

(50% dil'n)



$$Q = (0.0050)(0.010) = 5.0 \times 10^{-5}$$

$Q > K_{sp}$ $\therefore$ it
will ppt.

$$1.4 \times 10^{-7} = (0.0050 - x)(0.010 - x)$$

$$1.4 \times 10^{-7} = 5.0 \times 10^{-5} - 0.015x + x^2$$

$$x^2 - 0.015x + 5.0 \times 10^{-5} = 0$$

$$x = 0.010 \text{ or } 0.0050$$

$\uparrow$
too large

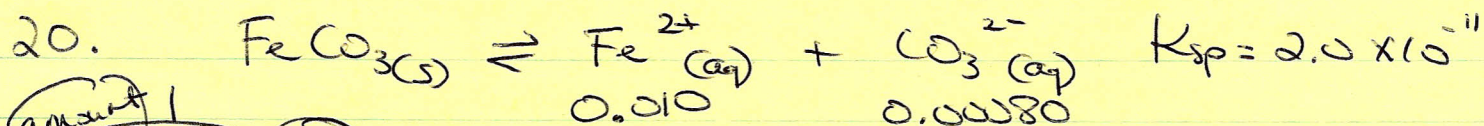
*NOTE:

$$5.0 \times 10^{-5} - 1.4 \times 10^{-7} = 4.986 \times 10^{-5}$$

to 2 significant
digits = 5.0×10^{-5}

$$m = 0.0050 \text{ mol/L} \times 1 \text{ L} \times 118.70$$

$$= 0.59 \text{ g}$$



amount of ppt in mol/L	C	+x	
	E	-x	-x
		0.010 - x	0.00080 - x

$$\begin{aligned}
 [\text{Fe}^{3+}] &= [\text{Fe}(\text{NO}_3)_2] \\
 &= \frac{1}{3} (0.030) \\
 &= 0.010 \text{ M}
 \end{aligned}$$

$$\frac{100 \text{ mL}}{300 \text{ mL}} = \frac{1}{3} \text{ dilution (or } 33.3\%)$$

$$\begin{aligned}
 [\text{CO}_3^{2-}] &= [\text{Na}_2\text{CO}_3] \\
 &= \frac{2}{3} (0.00120) \\
 &= 0.00080 \text{ M}
 \end{aligned}$$

$$\frac{200 \text{ mL}}{300 \text{ mL}} = \frac{2}{3} \text{ dilution (or } 66.7\%)$$

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

$$* 2.0 \times 10^{-11} = (0.010 - x)(0.00080 - x)$$

* this value will become insignificant when terms are collected.

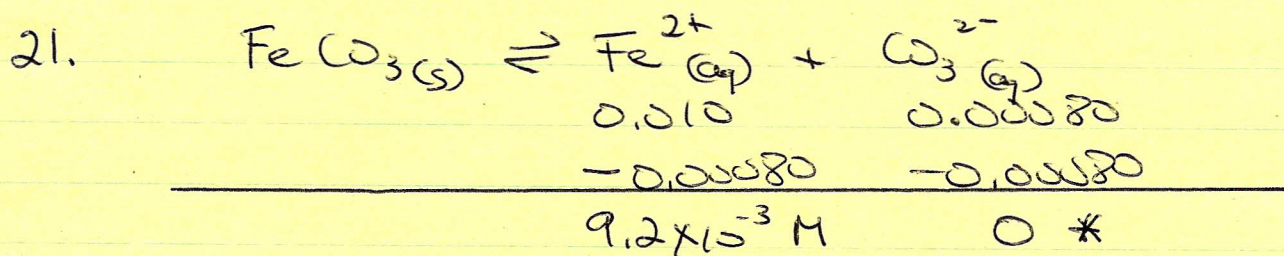
$$\therefore 0 = (0.010 - x)(0.00080 - x)$$

$$x = 0.010 \text{ or } 0.00080$$

too large

$$\begin{aligned}
 \therefore \text{amount of ppt} &= 0.00080 \text{ mol/L - only have 300 mL} \\
 &= 0.0008 \text{ mol/L} \times 0.300 \text{ L} \\
 &= 2.4 \times 10^{-4} \text{ mol / 300 mL} \\
 &= 2.4 \times 10^{-4} \text{ mol} \times 115.86 \text{ g / 300 mL} \\
 &= 0.028 \text{ g / 300 mL}
 \end{aligned}$$

mm of FeCO_3



* not possible $\Rightarrow$ value of x must be slightly less than 0.00080 (eliminating K_{sp} + rounding has contributed to this) (see NOTE below)

To determine $[\text{CO}_3^{2-}]$:

$$2.0 \times 10^{-11} = [\text{Fe}^{2+}][\text{CO}_3^{2-}]$$

$$2.0 \times 10^{-11} = (9.2 \times 10^{-3})[\text{CO}_3^{2-}]$$

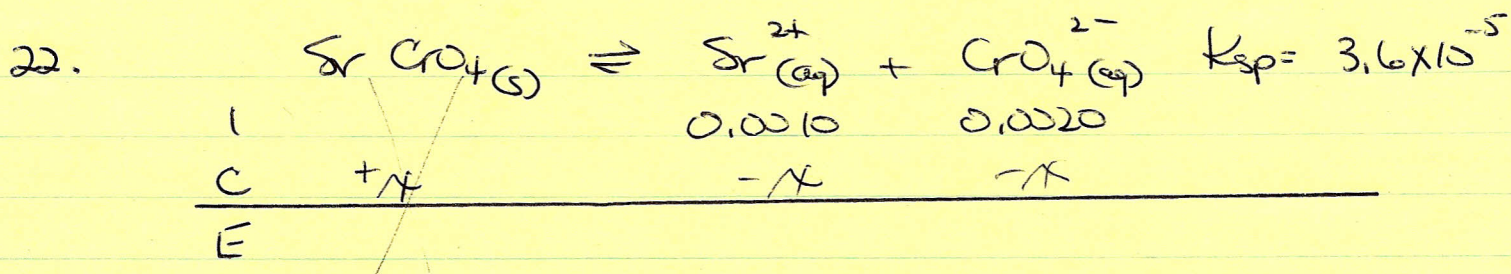
$$[\text{CO}_3^{2-}] = \frac{2.0 \times 10^{-11}}{9.2 \times 10^{-3}} = 2.2 \times 10^{-9} \text{ M.}$$

NOTE: Resolving for x would give us

$$0.00080 - x = 2.2 \times 10^{-9}$$

$$x = 7.999978 \times 10^{-4}$$

The difference between this value of x + $x = 0.00080$ is meaningless in terms of the amount of ppt formed + $[\text{Fe}^{2+}]$



$$[\text{Sr}^{2+}] = [\text{Sr}(\text{NO}_3)_2] \\ = 0.0010 \text{ M}$$

$$\frac{200 \text{ mL}}{400 \text{ mL}} = \frac{1}{2} \text{ dilution (50\%)}$$

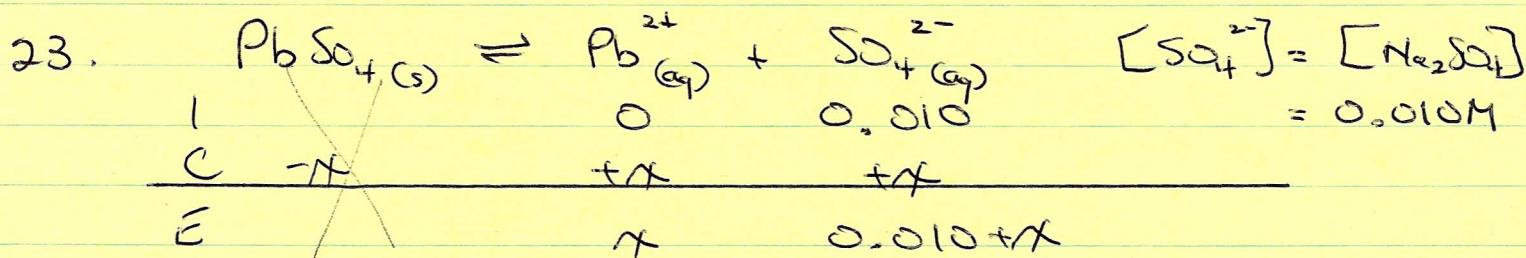
$$[\text{CrO}_4^{2-}] = [\text{Na}_2\text{CrO}_4] \\ = 0.0020 \text{ M}$$

$$\frac{200 \text{ mL}}{400 \text{ mL}} = \frac{1}{2} \text{ dilution (50\%)}$$

$$Q = (0.0010)(0.0020) = 2.0 \times 10^{-6}$$

$Q < K_{sp}$ $\therefore$ NONE of the SrCrO_4 will precipitate.

23. F. COMMON ION



$$1.3 \times 10^{-8} = x(0.010 + x)$$

$$1.3 \times 10^{-8} = 0.010x + x^2$$

$$x^2 + 0.010x - 1.3 \times 10^{-8} = 0$$

$$x = (1.3 \times 10^{-6}) \text{ or } -0.010$$

* NOTE - the same answer would have been obtained if the "x" in $0.010 + x$ had been deemed insignificant

#23 cont'd

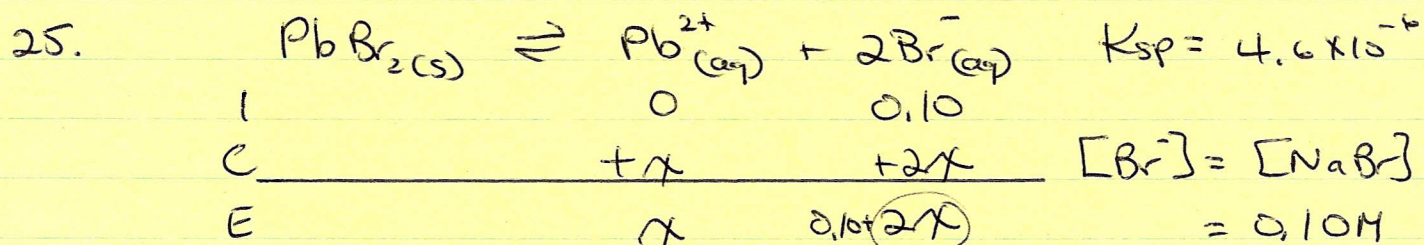
$$\text{ie } 1.3 \times 10^{-8} = x(0.010)$$

$$x = 1.3 \times 10^{-6}$$

$$\therefore [\text{Pb}^{2+}] = 1.3 \times 10^{-6} \text{ M.}$$

$$24. \quad \text{mass dissolved} = 1.3 \times 10^{-6} \text{ mol/L} \times 1 \text{ L} \times 303.26 \text{ g/mol}$$

$$= 3.9 \times 10^{-4} \text{ g}$$



$$4.6 \times 10^{-6} = x(0.10)^2$$

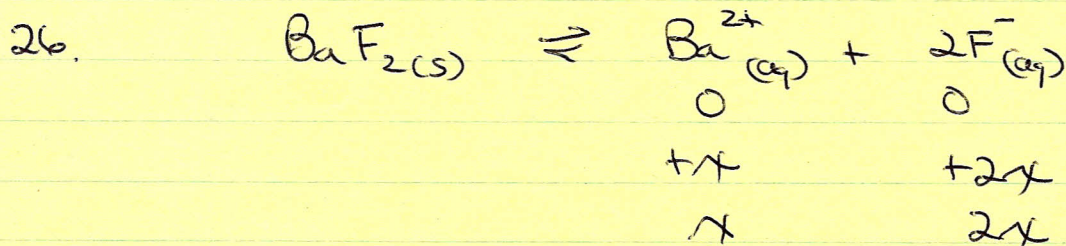
$$4.6 \times 10^{-6} = 0.010x$$

$$x = 4.6 \times 10^{-4}$$

$$\therefore [\text{Pb}^{2+}] = 4.6 \times 10^{-4} \text{ M}$$

insignificant.

* NOTE - if $2x$ is kept in, we will have to solve a cubic - I did this + got $x = 4.6 \times 10^{-4}$



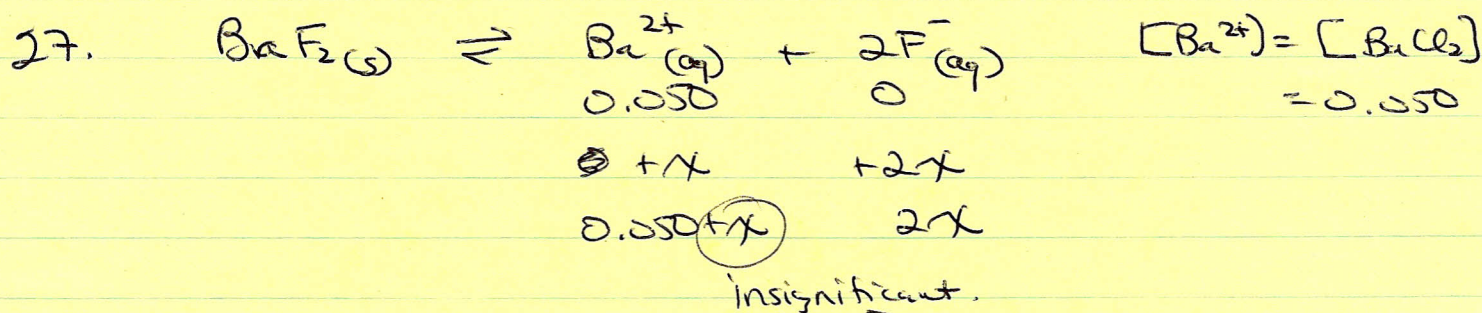
$$2.4 \times 10^{-5} = (x)(2x)^2$$

$$2.4 \times 10^{-5} = 4x^3$$

$$x = 0.018$$

26. Cont'd

$$\begin{aligned}
 \text{amount dissolved} &= 0.018 \text{ mol/L} \\
 &= 0.018 \text{ mol/L} \times 0.400 \text{ L} \times 175.30 \\
 &= 1.26 \text{ or } \boxed{1.3 \text{ g}}
 \end{aligned}$$



$$2.4 \times 10^{-5} = (0.050)(2x)^2$$

$$2.4 \times 10^{-5} = (0.050)(4)x^2$$

$$2.4 \times 10^{-5} = 0.20x^2$$

$$x^2 = 1.2 \times 10^{-4}$$

$$x = 0.011$$

If the cubic had been solved, $x = 0.010$ - unlike #25, dismissing " x " does make a slight difference - this is b/c the K_{sp} is a little larger in this question.

$$\begin{aligned}
 \text{amount dissolved} &= 0.011 \text{ mol/L} \\
 &= 0.011 \text{ mol/L} \times 0.400 \text{ L} \times 175.30 \\
 &= 0.77 \text{ g}
 \end{aligned}$$