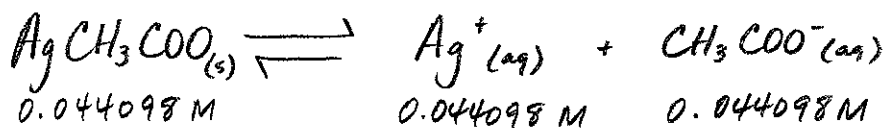


SOLUTION CHEM. REVIEW KEY



2. Solubility of AgCH_3COO : $\frac{1.84 \text{ g AgCH}_3\text{COO}}{166.9 \text{ g}} \times \frac{1 \text{ mol}}{1} = 0.011025 \text{ mol}$

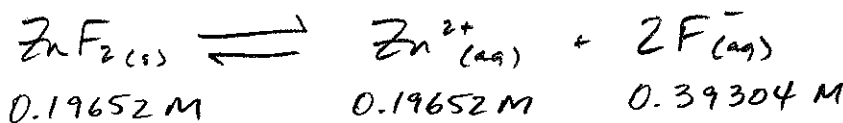
$$[\text{AgCH}_3\text{COO}] = \frac{\text{mol}}{V} = \frac{0.011025 \text{ mol}}{0.2500 \text{ L}} = 0.044098 \text{ M AgCH}_3\text{COO} \text{ (solubility)}$$



$$K_{sp} = [\text{Ag}^+][\text{CH}_3\text{COO}^-] = (0.044098)^2 = \boxed{1.94 \times 10^{-3}}$$

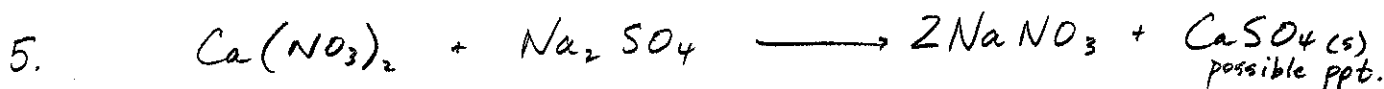
3. Solubility of ZnF_2 : $\frac{0.508 \text{ g ZnF}_2}{103.4 \text{ g}} \times \frac{1 \text{ mol}}{1} = 0.004913 \text{ mol}$

$$[\text{ZnF}_2] = \frac{\text{mol}}{V} = \frac{0.004913 \text{ mol}}{0.02500 \text{ L}} = 0.19652 \text{ M ZnF}_2 \text{ (solubility)}$$



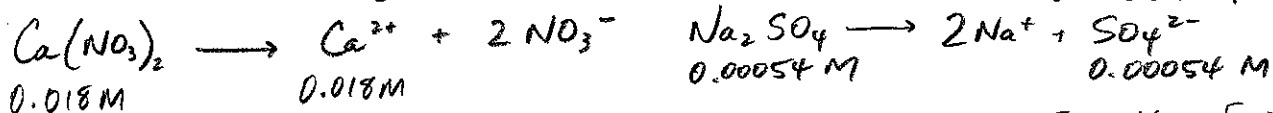
$$K_{sp} = [\text{Zn}^{2+}][\text{F}^-]^2 = (0.19652)(0.39304)^2 = \boxed{3.04 \times 10^{-2}}$$

4. Solubility - the maximum amount (equilibrium concentration) of a substance that dissociates in a solvent at a given temperature.



$$[\text{Ca}(\text{NO}_3)_2]_f = \frac{M_i V_i}{V_f} = \frac{(0.054 \text{ M})(0.0300 \text{ L})}{0.0900 \text{ L}} = 0.018 \text{ M}$$

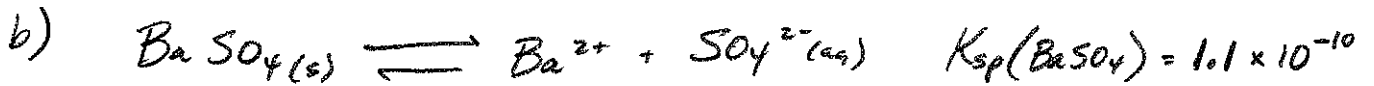
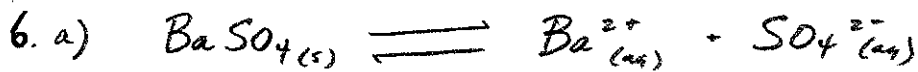
$$[\text{Na}_2\text{SO}_4]_f = \frac{M_i V_i}{V_f} = \frac{(8.1 \times 10^{-4} \text{ M})(0.0600 \text{ L})}{0.0900 \text{ L}} = 0.00054 \text{ M}$$



$$\text{CaSO}_4(s) \rightleftharpoons \text{Ca}^{2+} + \text{SO}_4^{2-} \quad \text{Trial } K_{sp} = [\text{Ca}^{2+}][\text{SO}_4^{2-}]$$

= (0.018)(0.00054)
= 9.7×10^{-6}

Trial $K_{sp} < K_{sp} \therefore$ no ppt. forms



$$K_{sp} = [Ba^{2+}][SO_4^{2-}] \quad \text{Let } x = [Ba^{2+}]$$

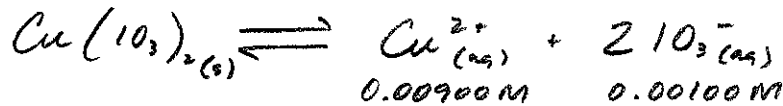
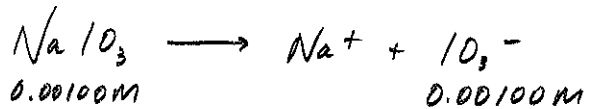
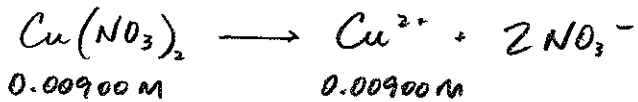
$$1.1 \times 10^{-10} = x^2$$

$$x = 1.0 \times 10^{-5} M = [Ba^{2+}]$$



$$[Cu(NO_3)_2]_f = \frac{M_i V_i}{V_f} = \frac{(0.0100 M)(0.0900 L)}{0.100 L} = 0.00900 M$$

$$[NaIO_3]_f = \frac{M_i V_i}{V_f} = \frac{(0.0100 M)(0.0100 L)}{0.100 L} = 0.00100 M$$

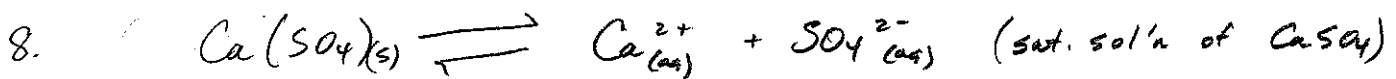


$$\text{Trial } K_{sp} = [Cu^{2+}][IO_3^-]^2$$

$$= (0.00900)(0.00100)^2$$

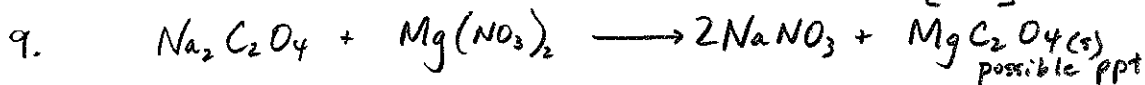
$$= 9.00 \times 10^{-9}$$

$$\text{Trial } K_{sp} < K_{sp} \therefore \text{no ppt. forms.}$$



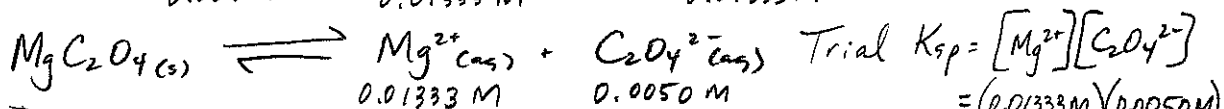
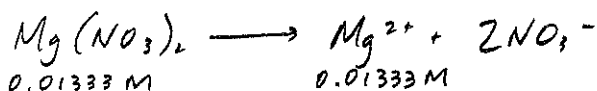
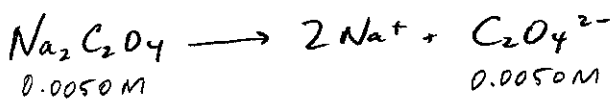
$CaSO_4$ equilibrium shifts \textcircled{L} : amount of $CaSO_4$ increases (it is the ppt.)

$$[Ca^{2+}] \uparrow \downarrow = \uparrow \quad [SO_4^{2-}] \downarrow$$

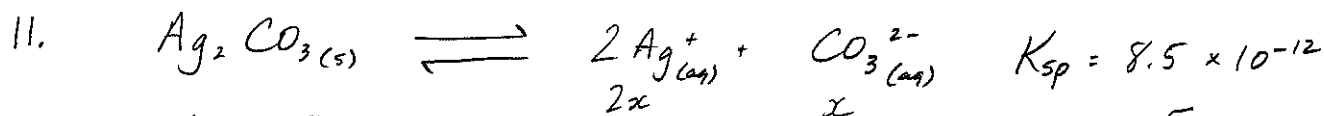
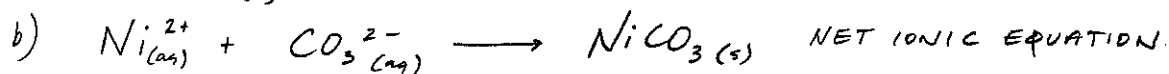
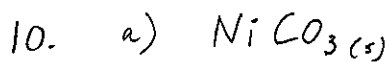


$$[Na_2C_2O_4]_f = \frac{M_i V_i}{V_f} = \frac{(0.015 M)(0.0750 L)}{0.225 L} = 0.0050 M$$

$$[Mg(NO_3)_2]_f = \frac{M_i V_i}{V_f} = \frac{(0.020 M)(0.1500 L)}{0.225 L} = 0.01333 M$$



$$\text{Trial } K_{sp} < K_{sp} \therefore \text{no ppt. forms}$$



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

$$8.5 \times 10^{-12} = (2x)^2 (x)$$

$$8.5 \times 10^{-12} = 4x^3$$

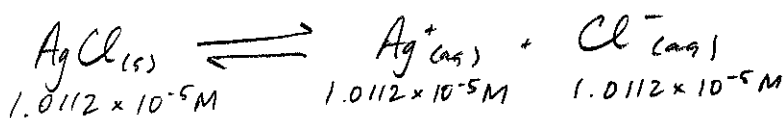
$$x = 1.2856 \times 10^{-4} \text{ M} = [\text{CO}_3^{2-}] = [\text{Ag}_2\text{CO}_3] \text{ (saturated solution)}$$

$$\text{mol Ag}_2\text{CO}_3 = MV = (1.2856 \times 10^{-4} \text{ M})(0.50 \text{ L}) = 6.4282 \times 10^{-5} \text{ mol Ag}_2\text{CO}_3$$

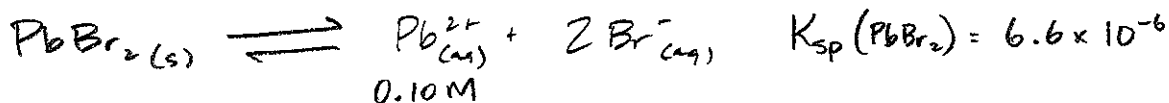
$$\frac{6.4282 \times 10^{-5} \text{ mol Ag}_2\text{CO}_3}{1 \text{ mol}} \times \frac{275.8 \text{ g}}{1 \text{ mol}} = 1.8 \times 10^{-2} \text{ g} = 0.018 \text{ g Ag}_2\text{CO}_3$$

12. Solubility of AgCl : $\frac{0.0029 \text{ g AgCl}}{143.4 \text{ g}} \times \frac{1 \text{ mol}}{1 \text{ mol}} = 2.0223 \times 10^{-5} \text{ mol}$

$$[\text{AgCl}] = \frac{\text{mol}}{V} = \frac{2.0223 \times 10^{-5} \text{ mol}}{2.0 \text{ L}} = 1.0112 \times 10^{-5} \text{ M AgCl (solubility)}$$



$$K_{sp} = [\text{Ag}^+][\text{Cl}^-] = (1.0112 \times 10^{-5})^2 = 1.0 \times 10^{-10}$$



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

$$6.6 \times 10^{-6} = (0.10)[\text{Br}^-]^2$$

$$6.6 \times 10^{-5} = [\text{Br}^-]^2$$

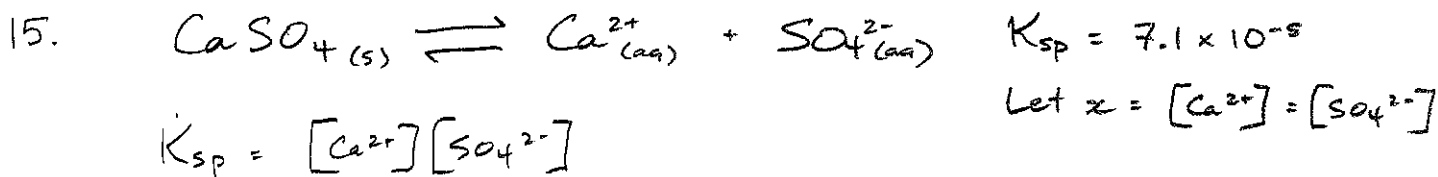
$$[\text{Br}^-] = 0.008124 \text{ M}$$

$$\text{mol Br}^- = MV = (0.008124 \text{ M})(0.500 \text{ L}) = 4.1 \times 10^{-3} \text{ mol Br}^-$$

14. 1. DECREASE TEMPERATURE

2. INTRODUCE A "COMMON ION."

- either i) Add AgNO_3
- or ii) Add NaIO_3



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

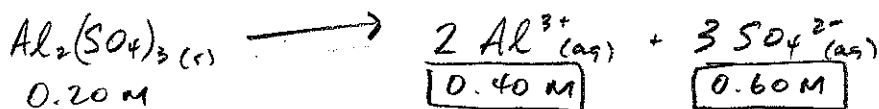
$$7.1 \times 10^{-5} = x^2$$

$$x = 8.4261 \times 10^{-3} \text{ M} = [\text{Ca}^{2+}] = [\text{CaSO}_4] \text{ (1:1 ratio)}$$

$$\text{mol CaSO}_4 = MV = (8.4261 \times 10^{-3} \text{ M})(50.0 \text{ L}) = 0.42131 \text{ mol}$$

$$\frac{0.42131 \text{ mol CaSO}_4 / 136.2 \text{ g}}{1 \text{ mol}} = \boxed{57 \text{ g CaSO}_4}$$

16. $M = \frac{\text{mol}}{V} = \frac{0.050 \text{ mol}}{0.25 \text{ L}} = 0.20 \text{ M Al}_2(\text{SO}_4)_3$

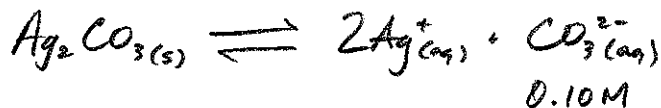


b. Answers may vary ... NaOH is one possibility

c. OH^- forms ppt. with Ca^{2+} \therefore equil. above shifts \textcircled{R} , thus increasing the solubility of CaSO_4 .

18. Answers may vary... i) Add NaCl (for Cl^-) to ppt. Pb^{2+} as PbCl_2 .

ii) Add Na_2SO_4 (for SO_4^{2-}) to ppt Sr^{2+} as SrSO_4 .



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

$$1.8 \times 10^{-10} = (0.10)[\text{Ag}^+]$$

$$[\text{Ag}^+] = 1.8 \times 10^{-9} \text{ M}$$

ppt. would begin to form when $1.8 \times 10^{-9} \text{ M Ag}^+$ added.

\therefore ppt. would be $\text{AgCl}(s)$ (wh/ite)

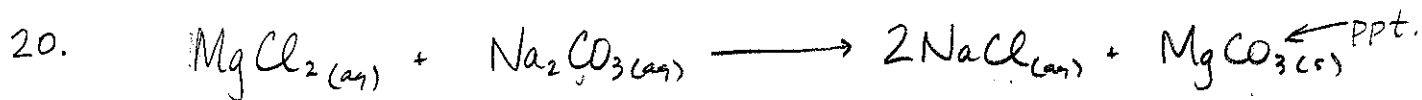
$$K_{sp} = [\text{Ag}^+]^2[\text{CO}_3^{2-}]$$

$$6.2 \times 10^{-12} = (0.10)[\text{Ag}^+]^2$$

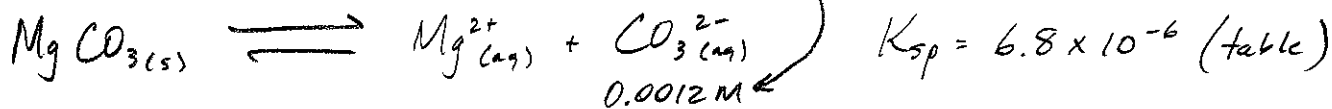
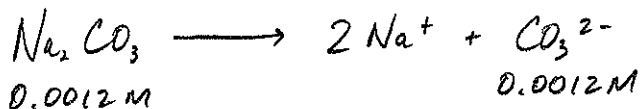
$$6.2 \times 10^{-11} = [\text{Ag}^+]^2$$

$$[\text{Ag}^+] = 7.874 \times 10^{-6} \text{ M}$$

ppt. would begin to form when $7.9 \times 10^{-6} \text{ M Ag}^+$ added.



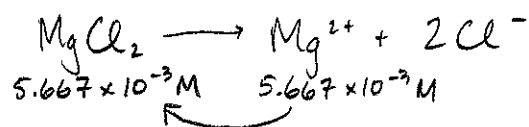
$$[\text{Na}_2\text{CO}_3]_f = \frac{M_i V_i}{V_f} = \frac{(0.0030 \text{ M})(0.0400 \text{ L})}{0.100 \text{ L}} = 0.0012 \text{ M}$$



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

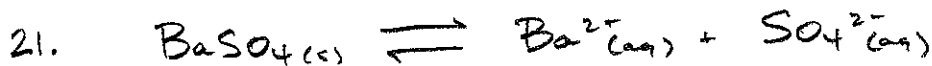
$$6.8 \times 10^{-6} = [\text{Mg}^{2+}](0.0012 \text{ M})$$

$$[\text{Mg}^{2+}] = 5.667 \times 10^{-3} \text{ M}$$



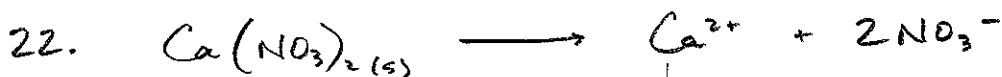
$$[\text{MgCl}_2]_i = \frac{M_f V_f}{V_i} = \frac{(5.667 \times 10^{-3} \text{ M})(0.100 \text{ L})}{0.0600 \text{ L}}$$

$$\boxed{[\text{MgCl}_2]_i = 9.4 \times 10^{-3} \text{ M}}$$



ONE POSSIBILITY: Add $\text{Ba}(\text{NO}_3)_2$ (to provide "common" ion Ba^{2+})

EQUIL. SHIFTS \textcircled{L} , FORMING MORE $\text{BaSO}_4(\text{s})$

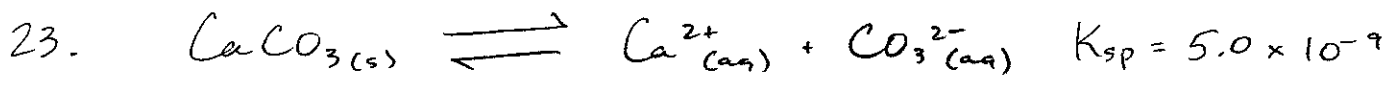


↓
 Ca^{2+} forms ppt w/ CO_3^{2-}



$$[\text{CO}_3^{2-}] \downarrow \uparrow = \downarrow$$

EQUIL. SHIFTS \textcircled{R} TO DISSOLVE MORE $\text{MgCO}_3(\text{s})$



$K_{sp} = [\text{Ca}^{2+}][\text{CO}_3^{2-}] \quad \text{Let } x = [\text{Ca}^{2+}] = [\text{CO}_3^{2-}]$
 $5.0 \times 10^{-9} = x^2$

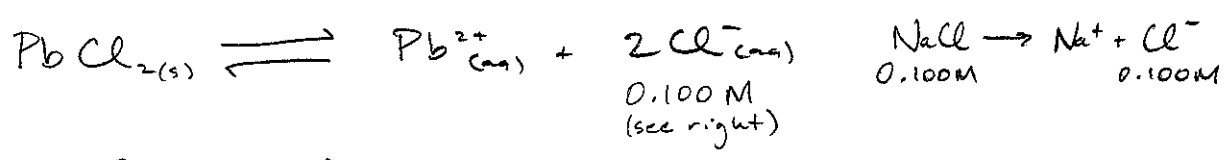
$x = 7.071 \times 10^{-5} \text{ M}$

$[\text{Ca}^{2+}] = 7.071 \times 10^{-5} \text{ M} = [\text{CaCO}_3] \quad (1:1 \text{ ratio above})$

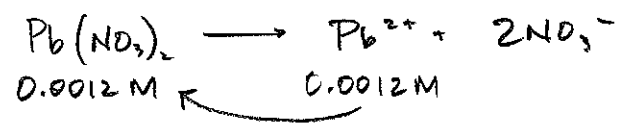
$\frac{7.071 \times 10^{-5} \text{ mol CaCO}_3}{1 \text{ L}} \left| \frac{100.1 \text{ g}}{1 \text{ mol}} \right. = \boxed{7.1 \times 10^{-3} \text{ g/L}}$

24. - ADD $\text{Mg}(\text{NO}_3)_2$ to each beaker.

- Mg^{2+} will form ppt. with CO_3^{2-} but not with SO_4^{2-} .
- the beaker w/out ppt. is the one with Na_2SO_4 .

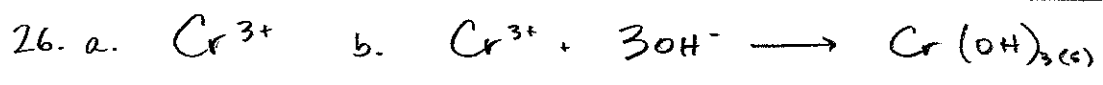


$K_{sp} = [\text{Pb}^{2+}][\text{Cl}^-]^2$
 $1.2 \times 10^{-5} = [\text{Pb}^{2+}][0.100]^2$
 $[\text{Pb}^{2+}] = 0.0012 \text{ M}$



$\text{mol Pb}(\text{NO}_3)_2 = MV = (0.0012 \text{ M})(0.1000 \text{ L}) = 0.00012 \text{ mol Pb}(\text{NO}_3)_2$

$\frac{0.00012 \text{ mol Pb}(\text{NO}_3)_2}{1 \text{ mol}} \left| \frac{331.2 \text{ g}}{1 \text{ mol}} \right. = \boxed{0.040 \text{ g Pb}(\text{NO}_3)_2}$



$\text{NaOH} \rightarrow \text{OH}^-$ will form ppt. w/ Ca^{2+} and shift equil. (R) thereby increasing the solubility of $\text{CaCO}_3(s)$.