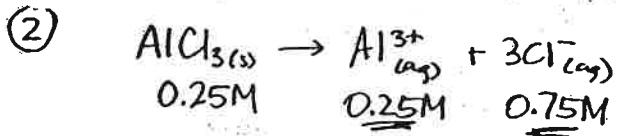
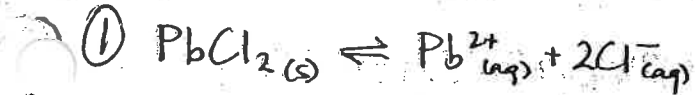


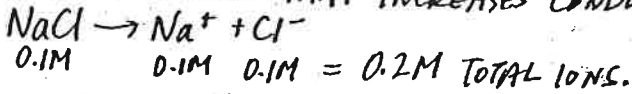
SOLUBILITY REVIEW ANSWER KEY



③ SOLUBILITY: THE EQUILIBRIUM CONCENTRATION OF A SUBSTANCE IN SOLUTION AT A GIVEN TEMPERATURE.

④ SATURATED SOLUTION: A SOLUTION IN WHICH THERE IS THE MAXIMUM AMOUNT OF SOLUTE IN SOLUTION SO THAT THE RATE OF DISSOLVING EQUALS THE RATE OF RECRYSTALLIZATION.

⑤ 0.1M NaCl is ^ABETTER CONDUCTOR AS NaCl DISSOCIATES INTO IONS, AND IT IS THE PRESENCE OF IONS THAT INCREASES CONDUCTION.

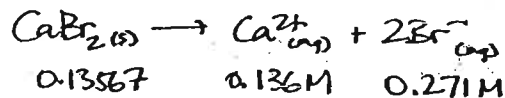


CH_3OH IS A MOLECULAR COMPOUND AND DOES NOT PRODUCE IONS IN SOLUTION

⑥ A 0.1M MgCl_2 SOLUTION CANNOT BE SATURATED BECAUSE MgCl_2 IS A 'SOLUBLE' COMPOUND (SEE TABLE), MEANING IT CAN PRODUCE A SOLUTION > 0.1 M.

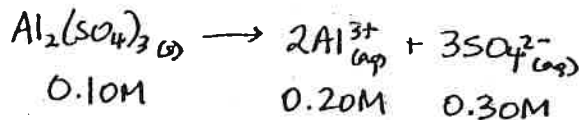
$\frac{6.78\text{g CaBr}_2}{199.9\text{g CaBr}_2} \times 1\text{mol CaBr}_2 = 0.033917\text{mol CaBr}_2$

$[\text{CaBr}_2] = \frac{0.033917\text{mol}}{0.2500\text{L}} = 0.13567\text{M}$



$[\text{Br}^{-}] = 0.271\text{M}$

⑧ $[\text{Al}_2(\text{SO}_4)_3] = \frac{0.050\text{mol}}{0.5000\text{L}} = 0.10\text{M}$

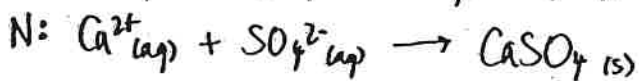
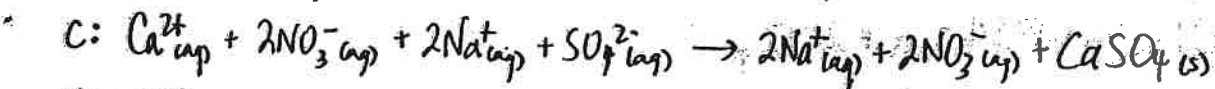
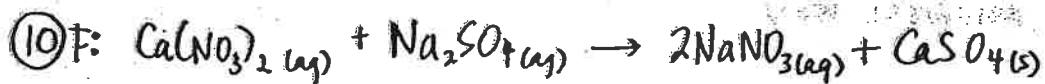


$[\text{Al}^{3+}] = 0.20\text{M}$, $[\text{SO}_4^{2-}] = 0.30\text{M}$

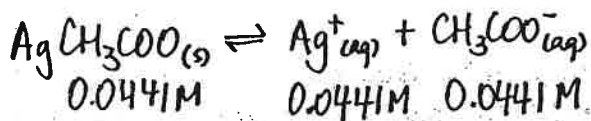
⑨ Add $\text{Sr}(\text{NO}_3)_2(aq)$ and the ppt SrSO_4 forms. Filter. - SO_4^{2-} separated

→ Add $\text{Ba}(\text{NO}_3)_2(aq)$ and the ppt $\text{Ba}(\text{OH})_2$ forms. Filter - OH^{-} separated

(cc) Add $\text{AgNO}_3(aq)$ and the ppt AgI forms. - I separated.] OPTIONAL STEP



⑪ $\frac{1.84 \text{ g AgCH}_3\text{COO}}{166.9 \text{ g}} \Big| \frac{1 \text{ mol AgCH}_3\text{COO}}{166.9 \text{ g}} = 0.011025 \text{ mol}$ $[\text{AgCH}_3\text{COO}] = \frac{0.011025 \text{ mol}}{0.2500 \text{ L}}$
 $= 0.0441 \text{ M}$



$K_{sp} = [\text{Ag}^+][\text{CH}_3\text{COO}^-]$
 $= (0.0441)^2$
 $= 1.94 \times 10^{-3}$

⑫ $\text{Pb}(\text{IO}_3)_2 \rightleftharpoons \text{Pb}^{2+}(\text{aq}) + 2\text{IO}_3^-(\text{aq})$ $K_{sp} = [\text{Pb}^{2+}][\text{IO}_3^-]^2$
 $0.038 \text{ M} \quad 0.038 \text{ M} \quad 0.076$ $= (0.038)(0.076)^2$
 $= 2.2 \times 10^{-4}$

⑬ $\text{CaCO}_3(\text{s}) \rightleftharpoons \text{Ca}^{2+}(\text{aq}) + \text{CO}_3^{2-}(\text{aq})$ $K_{sp} = [\text{Ca}^{2+}][\text{CO}_3^{2-}]$
 $\boxed{7.071 \times 10^{-5}}$ $7.071 \times 10^{-5} \text{ M} \quad 7.071 \times 10^{-5}$ $5.0 \times 10^{-9} = x^2$
use stoich 1:1 $5.0 \times 10^{-9} = [\text{Ca}^{2+}][\text{CO}_3^{2-}]$ $\sqrt{5.0 \times 10^{-9}} = \sqrt{x^2}$
 $\text{Let } x = [\text{Ca}^{2+}]_{\text{eq}} = [\text{CO}_3^{2-}]_{\text{eq}}$ $7.071 \times 10^{-5} = x$

$[\text{CaCO}_3] = 7.1 \times 10^{-5} \text{ M}$

⑭ $\text{Ag}_2\text{CrO}_4(\text{s}) \rightleftharpoons 2\text{Ag}^+(\text{aq}) + \text{CrO}_4^{2-}(\text{aq})$ $K_{sp} = [\text{Ag}^+]^2[\text{CrO}_4^{2-}]$ $1.1 \times 10^{-12} = (2x)^2(x)$
 $\boxed{6.503 \times 10^{-5}}$ $6.503 \times 10^{-5} \text{ M}$ $1.1 \times 10^{-12} = [\text{Ag}^+]^2[\text{CrO}_4^{2-}]$ $1.1 \times 10^{-12} = 4x^2(x)$
stoich 1:1 $\text{Let } x = [\text{CrO}_4^{2-}]_{\text{eq}}, \text{ then}$ $1.1 \times 10^{-12} = 4x^3$
 $2x = [\text{Ag}^+]_{\text{eq}}$ $x = \sqrt[3]{\frac{1.1 \times 10^{-12}}{4}}$

Solubility in mol/L = 6.503×10^{-5}

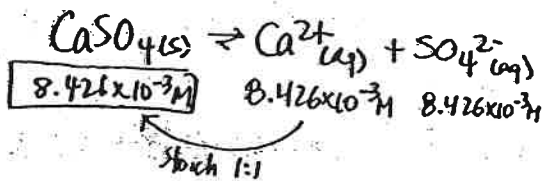
$x = 6.503 \times 10^{-5}$

in g/L (change moles to grams):

$\frac{6.503 \times 10^{-5} \text{ mol Ag}_2\text{CrO}_4}{1 \text{ mol Ag}_2\text{CrO}_4} \Big| \frac{331.8 \text{ g Ag}_2\text{CrO}_4}{1 \text{ mol Ag}_2\text{CrO}_4} = 2.2 \times 10^{-2}$

$2.2 \times 10^{-2} \text{ g/L}$

(15) FIND SOLUBILITY OF CaSO_4 FIRST:



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

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

$$7.1 \times 10^{-5} = [\text{Ca}^{2+}][\text{SO}_4^{2-}]$$

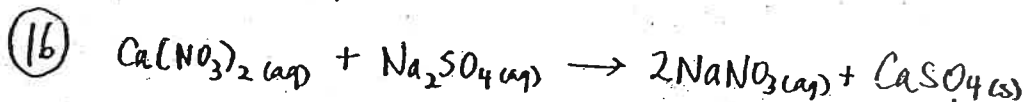
$$x = 8.426 \times 10^{-3}$$

$$\text{Let } x = [\text{Ca}^{2+}] = [\text{SO}_4^{2-}]$$

moles CaSO_4 that could dissolve in 50.0L: $(8.426 \times 10^{-3} \text{ M})(50.0 \text{ L}) = 0.4213 \text{ mol}$

$$\text{mass CaSO}_4: \frac{0.4213 \text{ mol CaSO}_4 \mid 136.2 \text{ g CaSO}_4}{1 \text{ mol CaSO}_4} = 57.38 \text{ g}$$

57g of CaSO_4 can dissolve in 50.0L water.



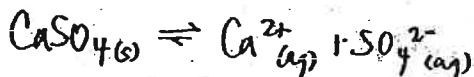
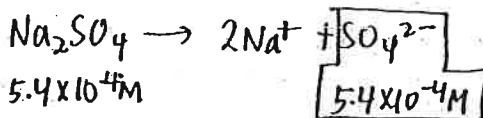
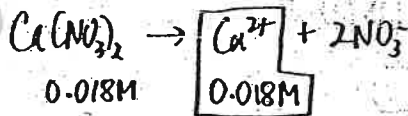
↑ POSSIBLE PPT.

$$[\text{Ca}(\text{NO}_3)_2]_f = \frac{(0.054 \text{ M})(0.0300 \text{ L})}{0.0100 \text{ L}}$$

$$[\text{Na}_2\text{SO}_4]_f = \frac{(8.1 \times 10^{-4} \text{ M})(0.0600 \text{ L})}{0.0100 \text{ L}}$$

$$= 0.018 \text{ M}$$

$$= 5.4 \times 10^{-4} \text{ M}$$



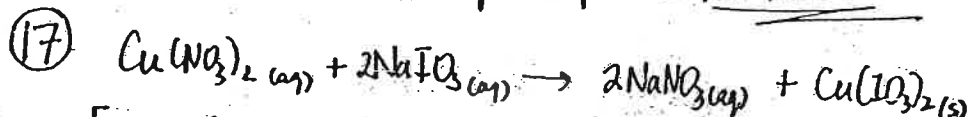
$$K_{sp} = [\text{Ca}^{2+}][\text{SO}_4^{2-}]$$

$$\text{TRIAL } K_{sp} = (0.018)(5.4 \times 10^{-4})$$

$$K_{sp} \text{ from table} = 7.1 \times 10^{-5}$$

$$= 9.7 \times 10^{-6}$$

TRIAL $K_{sp} < K_{sp} \therefore$ A PPT WILL NOT FORM

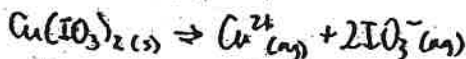
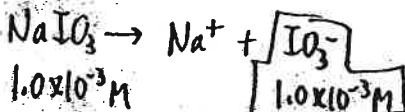
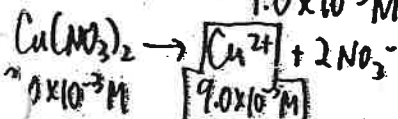


↑ POSSIBLE PPT.

$$[\text{Cu}(\text{NO}_3)_2]_f = \frac{(1.00 \times 10^{-2} \text{ M})(0.0900 \text{ L})}{0.1000 \text{ L}}$$

$$[\text{NaIO}_3]_f = \frac{(1.00 \times 10^{-2} \text{ M})(0.0100 \text{ L})}{0.1000 \text{ L}} = 1.0 \times 10^{-3} \text{ M}$$

$$= 9.0 \times 10^{-3} \text{ M}$$



$$\text{TRIAL } K_{sp} = (9.0 \times 10^{-3})(1.0 \times 10^{-3})^2$$

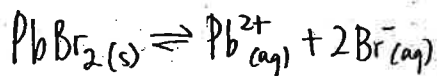
$$K_{sp} = [\text{Cu}^{2+}][\text{IO}_3^-]^2$$

$$= 9.0 \times 10^{-9}$$

$$\text{FROM TABLE} = 6.9 \times 10^{-8}$$

TRIAL $K_{sp} < K_{sp} \therefore$ A PPT WILL NOT FORM

(18) ppt is $PbBr_2$



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

K_{sp} from table = 6.6×10^{-6} $[Pb^{2+}] = 0.10M$

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

$$[Br^{-}] = \sqrt{\frac{6.6 \times 10^{-6}}{0.10}}$$

$$= \underline{8.124 \times 10^{-3}M}$$

$$\text{moles } Br^{-} = 8.124 \times 10^{-3}M \times 0.500L$$

$$= \underline{4.1 \times 10^{-3}}$$

(19) $PbCl_2(s) \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

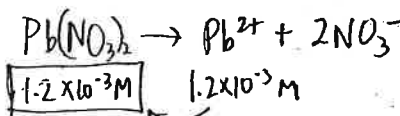
$$K_{sp} = [Pb^{2+}][Cl^{-}]^2$$

K_{sp} from table = 1.2×10^{-5} $[Cl^{-}] = 0.100M$

$$1.2 \times 10^{-5} = [Pb^{2+}][0.100]^2$$

$$[Pb^{2+}] = 1.2 \times 10^{-3}M$$

moles $Pb(NO_3)_2 = 1.2 \times 10^{-3}M \times 0.100L$
 $= 1.2 \times 10^{-4} \text{ mol}$



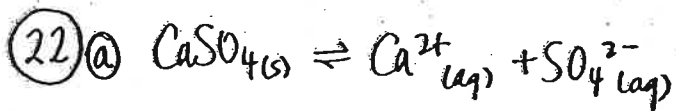
$$\text{mass } Pb(NO_3)_2 = \frac{1.2 \times 10^{-4} \text{ mol} \mid 331.2 \text{ g } Pb(NO_3)_2}{1 \text{ mol } Pb(NO_3)_2} = 0.03974$$
$$= \underline{0.040g}$$

(20) $MgCO_3(s) \rightleftharpoons Mg^{2+}_{(aq)} + CO_3^{2-}_{(aq)}$

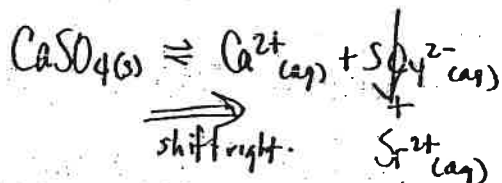
- adding $Ca(NO_3)_2(s)$ produces $Ca^{2+}_{(aq)}$ and $NO_3^{-}_{(aq)}$ ions
- $Ca^{2+}_{(aq)}$ is low solubility with $CO_3^{2-}_{(aq)}$, so they will react to form $CaCO_3(s)$
- thus, $[CO_3^{2-}]$ decreases, so a shift right occurs and more solid $MgCO_3$ dissolves, increasing the solubility of $MgCO_3$.

(21) $Ag_2CrO_4(s) \rightleftharpoons 2Ag^{+}_{(aq)} + CrO_4^{2-}_{(aq)}$

- adding K_2CrO_4 produces $K^{+}_{(aq)}$ and $CrO_4^{2-}_{(aq)}$ ions
 - $CrO_4^{2-}_{(aq)}$ is low solubility with $Ag^{+}_{(aq)}$, so a ppt of $Ag_2CrO_4(s)$ forms, causing a shift right and therefore more Ag_2CrO_4 dissolves, increasing its solubility
 - adding $AgNO_3$ produces $Ag^{+}_{(aq)}$ and $NO_3^{-}_{(aq)}$ ions.
 - this increases $[Ag^{+}]$, causing a shift left so more $Ag_2CrO_4(s)$ ppts, thereby decreasing its solubility.
- $\therefore Ag_2CrO_4$ is least soluble in a solution of $AgNO_3(aq)$.



(b) Add a salt that would have an ion which precipitates with either Ca^{2+} or SO_4^{2-} .
e.g. add $\text{Sr}(\text{NO}_3)_2$



Thus, $[\text{SO}_4^{2-}]$ decreases and the equl shifts right, causing more solid CaSO_4 to dissolve

(23) Find ^{max} $[\text{Ag}^+]$ before ppt forms for each situation.

AgCl:

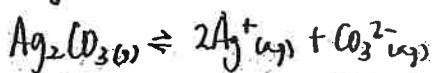


$$K_{sp} = [\text{Ag}^+][\text{Cl}^-]$$

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

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

Ag_2CO_3 :



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

$$8.5 \times 10^{-12} = [\text{Ag}^+]^2 (0.10)$$

$$[\text{Ag}^+] = \sqrt{\frac{8.5 \times 10^{-12}}{0.10}}$$

$$[\text{Ag}^+] = 9.2 \times 10^{-6} \text{ M}$$

AgCl will form a ppt first as it will take less Ag^+ before saturation.
Therefore, a WHITE ppt will form first.

(24)

$$\begin{array}{r} 93.47 \text{ g} \\ - 89.05 \text{ g} \\ \hline 4.42 \text{ g MgBr}_2 \end{array}$$

$$\frac{4.42 \text{ g MgBr}_2}{184.1 \text{ g MgBr}_2} \times 1 \text{ mol MgBr}_2 = 0.02401 \text{ mol}$$

$$[\text{MgBr}_2] = \frac{0.02401 \text{ mol}}{0.02500 \text{ L}} = 0.960 \text{ M}$$

The solubility of MgBr_2 is 0.960 M

