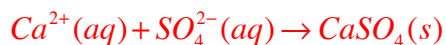1. A solution contains one or more of the following ions: $Ag^+$, $Ca^{2+}$ and $Cu^{2+}$. When you add sodium chloride to the solution, no precipitate forms. When you add sodium sulfate to the solution, a white precipitate forms. You filter off the precipitate and add sodium carbonate to the remaining solution, producing another precipitate. Which ions were present in the original solution? Write net ionic equations for the formation of each of the precipitates observed.

$$Ca^{2+}(aq) + SO_4^{2-}(aq) \rightarrow CaSO_4(s)$$
$$Cu^{2+}(aq) + CO_3^{2-}(aq) \rightarrow CuCO_3(s)$$
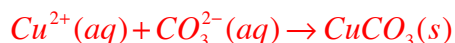
$Ag^+$ is not present because no precipitate forms when NaCl is added.

2. A solution contains one or more of the following ions: $Hg_2^{2+}$, $Ba^{2+}$, and $Fe^{2+}$ When you add potassium chloride to the solution, a precipitate forms. The precipitate is filtered off, and you add potassium sulfate to the remaining solution, forming no precipitate. When you add potassium carbonate to the remaining solution, a precipitate forms. Which ions were present in the original solution? Write net ionic equations for the formation of each of the precipitates observed.

$$Hg_2^{2+}(aq) + 2Cl^-(aq) \rightarrow Hg_2Cl_2(s)$$
$$Fe^{2+}(aq) + CO_3^{2-}(aq) \rightarrow FeCO_3(s)$$
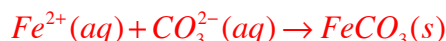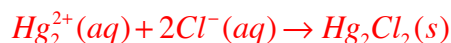
$Ba^{2+}$ is not present because since the addition of $K_2SO_4$ did not yield a precipitate.

3. You want to analyze a cadmium nitrate solution. What mass of NaOH is needed to precipitate the $Cd^{2+}$ ions from 35.0 mL of 0.500 M $Cd(NO_3)_2$ solution?
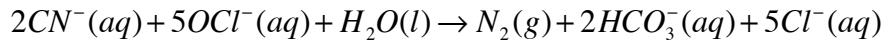
1.4 g NaOH

4. Toxic chromate can be precipitated from an aqueous solution by bubbling $SO_2$ gas through the solution. How many grams of $SO_2$ are required to treat $3.0*10^8$ L of 0.050 mM $CrO_4^{2-}$?

$$2CrO_4^{2-}(aq) + 3SO_2(g) + 4H^+(aq) \rightarrow Cr_2(SO_4)_3 + 2H_2O(l)$$
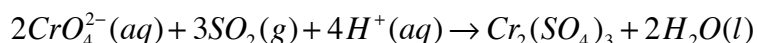
1.4 * $10^6$ g
5. Toxic cyanide ions can be removed from wastewater by adding hypochlorite:

$$2CN^-(aq)+5OCl^-(aq)+H_2O(l) \rightarrow N_2(g)+2HCO_3^-(aq)+5Cl^-(aq)$$

How many liters of 0.125 M OCl⁻ solution are required to remove CN⁻ in $3.4*10^6$L wastewater in which the concentration is 0.58 mg/L?

1500 L

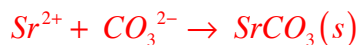6. To determine the concentration of $SO_4^{2-}$ ion in a sample of groundwater, 100 mL of the sample is treated with 0.0250 M $Ba(NO_3)_2$, forming insoluble $BaSO_4$. If 3.19 mL of the $Ba(NO_3)$ solution is required to reach the end point of the titration, what is the molarity of the $SO_4^{2-}$ ?

$8.00*10^{-4}$ M $SO_4^{2-}$

7. We prepare a solution by mixing 0.10 L of 0.12 M sodium chloride with 0.23 L of a 0.18 M $MgCl_2$ solution. What volume of a 0.20 M silver nitrate solution do we need to precipitate all the Cl⁻ ion in the solution as silver chloride?

0.47 L $AgNO_3$

8. You are mixing 0.200 L of 0.200 M $Na_2CO_3$ solution with 0.300 L of 0.100 M $SrCl_2$ solution. Identify the precipitate that will form, determine the mass of the precipitate and calculate the concentration of the ion in solution that is in excess for the precipitation reaction.

$$Sr^{2+} + CO_3^{2-} \rightarrow SrCO_3(s)$$
mass($SrCO_3$) = 4.43 g
concentration($CO_3^{2-}$) = 0.02 M

9. You are mixing 0.500L of 0.250M $FeCl_3$ solution with 0.500L of 0.400 M $K_2SO_4$ solution. Identify the precipitate that will form, determine the mass of the precipitate and calculate the concentration of the ion in solution that is in excess for the precipitation reaction.

$$2Fe^{3+}(aq)+3SO_4^{2-}(aq) \rightarrow Fe_2(SO_4)_3(s)$$
25g $Fe_2(SO_4)_3$
0.0125 M $SO_4^{2-}$(aq)