

1. Devise a scheme to precipitate separately each ion in a mixture of each of the following sets of ions, and write a net ionic equation for each reaction that occurs.

a. SO_4^{2-} and PO_4^{3-}

① First precipitate PO_4^{3-} by adding any cation except Alkali, H^+ , NH_4^+ , Ag^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+}
 eg. $\text{Al}^{3+}_{(aq)} + \text{PO}_4^{3-}_{(aq)} \rightarrow \text{AlPO}_4(s)$

② Then precipitate SO_4^{2-} using Ag^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} or Pb^{2+}
 eg. $\text{Ca}^{2+}_{(aq)} + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{CaSO}_4(s)$

b. Fe^{2+} , Pb^{2+} , and Mg^{2+}

① First precipitate Pb^{2+} using Cl^- , Br^- , I^- or SO_4^{2-} eg. $\text{Pb}^{2+}_{(aq)} + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{PbSO}_4(s)$

② Next precipitate Fe^{2+} using S^{2-} eg. $\text{Fe}^{2+}_{(aq)} + \text{S}^{2-}_{(aq)} \rightarrow \text{FeS}(s)$

③ Then precipitate Mg^{2+} using OH^- , PO_4^{3-} , CO_3^{2-} or SO_3^{2-} eg. $\text{Mg}^{2+}_{(aq)} + 2\text{OH}^-_{(aq)} \rightarrow \text{Mg}(\text{OH})_2(s)$

c. Br^- , CO_3^{2-} , and SO_4^{2-} 2 ways to proceed:

① First precipitate CO_3^{2-} using any cation except Alkali, H^+ , NH_4^+ , Ag^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , Pb^{2+} or Cu^+
 eg. $\text{Mg}^{2+}_{(aq)} + \text{CO}_3^{2-}_{(aq)} \rightarrow \text{MgCO}_3(s)$

② Then ppt Br^- using Cu^+
 $\text{Cu}^+_{(aq)} + \text{Br}^-_{(aq)} \rightarrow \text{CuBr}(s)$

or ② Then ppt SO_4^{2-} using Ca^{2+} , Sr^{2+} or Ba^{2+}
 $\text{Ba}^{2+}_{(aq)} + \text{SO}_4^{2-}_{(aq)} \rightarrow \text{BaSO}_4(s)$

③ ppt SO_4^{2-} using Ag^+ , Ca^{2+} , Sr^{2+} , Ba^{2+} , or Pb^{2+} ③ ppt Br^- using Ag^+ , Pb^{2+} or Cu^+

2. For each given solution, calculate the volume of stock solution required to prepare each of the following diluted solutions:

a. given 15 M NH_3 ; need 2.0 L of 0.40 M NH_3

$$V_c = \frac{M_D V_D}{M_c} = \frac{0.40\text{M} \times 2.0\text{L}}{15\text{M}} = 0.053\text{L} \text{ or } 53\text{mL}$$

b. given 6.0 M HCl ; need 5.0 L of 0.10 M HCl

$$V_c = \frac{0.10\text{M} \times 5.0\text{L}}{6.0\text{M}} = 0.083\text{L} \text{ or } 83\text{mL}$$

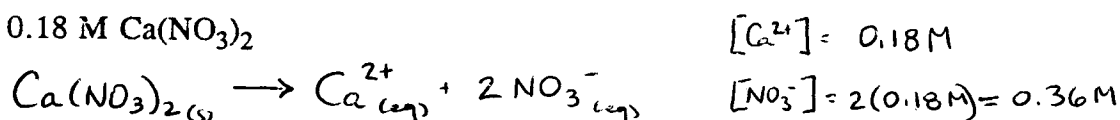
c. given 0.50 M KSCN ; need 4.0 L of 0.0020 M KSCN

$$V_c = \frac{0.0020\text{M} \times 4.0\text{L}}{0.50\text{M}} = 0.016\text{L} \text{ or } 16\text{mL}$$

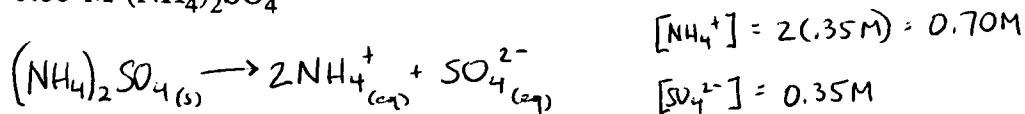
Key.

3. Write the dissociation equation for each of the following solutions, then calculate the concentration of each ion in the solution.

a. 0.18 M $\text{Ca}(\text{NO}_3)_2$



b. 0.35 M $(\text{NH}_4)_2\text{SO}_4$



c. 0.070 M $\text{Fe}(\text{ClO}_4)_3$



4. Calculate the concentration of each ion in each of the following solutions in which no reaction occurs.

a. 125 mL of 0.20 M MgCl_2 mixed with 375 mL of 0.40 M KCl

$$[\text{Mg}^{2+}] = \frac{125 \text{ mL} \times 0.20 \text{ M}}{(125 \text{ mL} + 375 \text{ mL})} = 0.050 \text{ M}$$

$$[\text{K}^+] = \frac{375 \text{ mL} \times 0.40 \text{ M}}{(125 \text{ mL} + 375 \text{ mL})} = 0.30 \text{ M}$$

$$[\text{Cl}^-] = \frac{(125 \text{ mL} \times 0.20 \text{ M} \times 2) + (375 \text{ mL} \times 0.40 \text{ M})}{125 \text{ mL} + 375 \text{ mL}} = 0.40 \text{ M}$$

b. 4.0 L of 0.25 M CuSO_4 mixed with 6.0 L of 0.75 M Na_2SO_4

$$[\text{Cu}^{2+}] = \frac{4.0 \text{ L} \times 0.25 \text{ M}}{4.0 \text{ L} + 6.0 \text{ L}} = 0.10 \text{ M}$$

$$[\text{Na}^+] = \frac{6.0 \text{ L} \times 0.75 \text{ M} \times 2}{4.0 \text{ L} + 6.0 \text{ L}} = 0.90 \text{ M}$$

$$[\text{SO}_4^{2-}] = \frac{(4.0 \text{ L} \times 0.25 \text{ M}) + (6.0 \text{ L} \times 0.75 \text{ M})}{4.0 \text{ L} + 6.0 \text{ L}} = 0.55 \text{ M}$$

c. 300 mL of 0.30 M CrBr_3 mixed with 700 mL of 0.10 M CaBr_2

$$[\text{Cr}^{3+}] = \frac{300 \text{ mL} \times 0.30 \text{ M}}{300 \text{ mL} + 700 \text{ mL}} = 0.090 \text{ M}$$

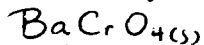
$$[\text{Ca}^{2+}] = \frac{700 \text{ mL} \times 0.10 \text{ M}}{300 \text{ mL} + 700 \text{ mL}} = 0.070 \text{ M}$$

$$[\text{Br}^-] = \frac{(300 \text{ mL} \times 0.30 \text{ M} \times 3) + (700 \text{ mL} \times 0.10 \text{ M} \times 2)}{300 \text{ mL} + 700 \text{ mL}} = 0.41 \text{ M}$$

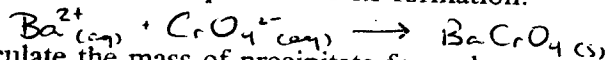
Key

5. 35 mL of 0.40 M BaCl₂ solution are mixed with 15 mL of 0.50 M K₂CrO₄, and a precipitate forms.

a. what is the identity of the precipitate?



b. write a net ionic equation for its formation.



c. calculate the mass of precipitate formed.

$$\text{mols Ba}^{2+} = 35 \text{ mL} \times 0.40 \text{ M} = 0.014 \text{ mols Ba}^{2+}$$

$$\text{mols CrO}_4^{2-} = 15 \text{ mL} \times 0.50 \text{ M} = 0.0075 \text{ mols CrO}_4^{2-}$$

CrO₄²⁻ is the limiting factor

$$\text{mols BaCrO}_4(s) = 0.0075 \text{ mols} \quad \text{mass} = 0.0075 \text{ mol} \times 253.3 \text{ g/mol} = 1.9 \text{ g}$$

d. calculate the concentration of each ion left in the mixed solution after precipitation has occurred.

$$[\text{CrO}_4^{2-}] = 0.00 \text{ M}$$

$$[\text{Ba}^{2+}] = \frac{0.014 \text{ mol} - 0.0075 \text{ mol}}{35 \text{ mL} + 15 \text{ mL}} = 0.13 \text{ M}$$

$$[\text{K}^+] = \frac{15 \text{ mL} \times 0.50 \text{ M} \times 2}{35 \text{ mL} + 15 \text{ mL}} = 0.30 \text{ M}$$

$$[\text{Cl}^-] = \frac{35 \text{ mL} \times 0.40 \text{ M} \times 2}{35 \text{ mL} + 15 \text{ mL}} = 0.56 \text{ M}$$

6. Calculate the concentration of the solute in each of the following diluted solutions:

a. 250 mL of 0.16 M Co(NO₃)₂ diluted to 8.0 L.

$$M_D = \frac{M_C V_C}{V_D} = \frac{0.16 \text{ M} \times 250 \text{ mL}}{8.0 \text{ L}} = 0.0050 \text{ M}$$

b. 12 mL of 0.20 M CuCl₂ diluted to 150 mL.

$$M_D = \frac{0.20 \text{ M} \times 12 \text{ mL}}{150 \text{ mL}} = 0.016 \text{ M}$$

c. 166 mL of 12 M HCl diluted to 5.0 L.

$$M_D = \frac{12 \text{ M} \times 166 \text{ mL}}{5.0 \text{ L}} = 0.40 \text{ M}$$

7. Calculate the molarity of a solution made by dissolving 31.5 g of NaNO₃ in enough water to make 435 mL of solution.

$$31.5 \text{ g} \div 85.09 \text{ g/mol} = 0.37 \text{ mols NaNO}_3$$

$$M = \frac{n}{V} = \frac{0.37 \text{ mol}}{435 \text{ mL}} = 0.852 \text{ M}$$

Key.

8. Calculate the molarity of a solution made by dissolving 408 g of $(\text{NH}_4)_3\text{PO}_4$ in enough water to make 9467 mL of solution.

$$Fw = 149.0 \text{ g/mol}$$

$$n = 408 \text{ g} \div 149.0 \text{ g/mol} = 2.74 \text{ mol}$$

$$M = \frac{n}{V} = \frac{2.74 \text{ mol}}{9467 \text{ mL}} = 0.289 \text{ M}$$

9. How many grams of NaCl are present in 1.440 L of a 1.21 M solution of NaCl?

$$n = M \cdot V = 1.21 \text{ M} \times 1.440 \text{ L} = 1.74 \text{ moles NaCl}$$

$$Fw = 58.5 \text{ g/mol}$$

$$\text{mass} = 1.74 \text{ moles} \times 58.5 \text{ g/mol} = 102 \text{ g}$$

10. What volume of solution would be made if 61.9 g of $\text{Cu}(\text{NO}_3)_2$ are used to make a 0.250 M solution of $\text{Cu}(\text{NO}_3)_2$?

$$Fw = 187.5 \text{ g/mol}$$

$$61.9 \text{ g} \div 187.5 \text{ g/mol} = 0.330 \text{ moles } \text{Cu}(\text{NO}_3)_2$$

$$V = \frac{n}{M} = \frac{0.330 \text{ moles}}{0.250 \text{ M}} = 1.32 \text{ L}$$