

For each of the following; write out the complete balanced equation, full ionic equation, and net ionic equation for the reaction and calculate the concentration of the unknown solution.

1. 27.4 mL of 0.150 M hydrochloric acid is required to neutralize 30.0 mL of a potassium hydroxide solution of unknown concentration.

Equations:



Unknown Concentration:

$$27.4 \text{ mL HCl} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.150 \text{ mol HCl}}{1 \text{ L}} \right) \left(\frac{1 \text{ mol KOH}}{1 \text{ mol HCl}} \right) = 0.00411 \text{ mol KOH}$$

$$[\text{KOH}] = \frac{0.00411 \text{ mol}}{0.0300 \text{ L}} = \boxed{0.137 \text{ M KOH}}$$

2. 33.5 mL of 0.200 M sodium hydroxide is required to neutralize 22.5 mL of a sulfuric acid solution of unknown concentration.

Equations:



or



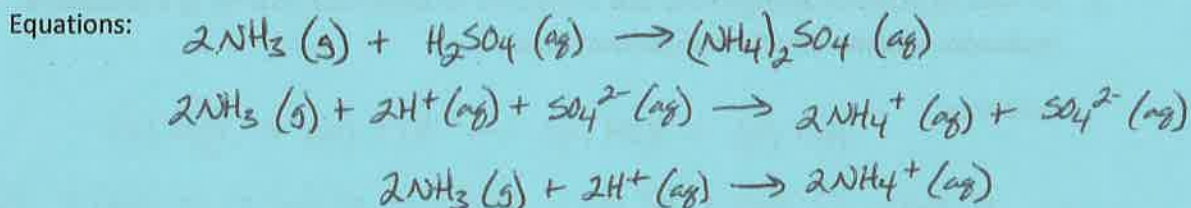
Unknown Concentration:

$$33.5 \text{ mL NaOH} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.200 \text{ mol NaOH}}{1 \text{ L}} \right) \left(\frac{1 \text{ mol H}_2\text{SO}_4}{2 \text{ mol NaOH}} \right) = 0.00335 \text{ mol H}_2\text{SO}_4$$

$$[\text{H}_2\text{SO}_4] = \frac{0.00335 \text{ mol}}{0.0225 \text{ L}} = \boxed{0.149 \text{ M H}_2\text{SO}_4}$$

For each of the following; write out the complete balanced equation, full ionic equation, and net ionic equation for the reaction and calculate the molarity, mass, or volume of reagent/product depending on the question.

3. 29.8 g of ammonia gas needs to be completely reacted by a 0.250M sulfuric acid solution.

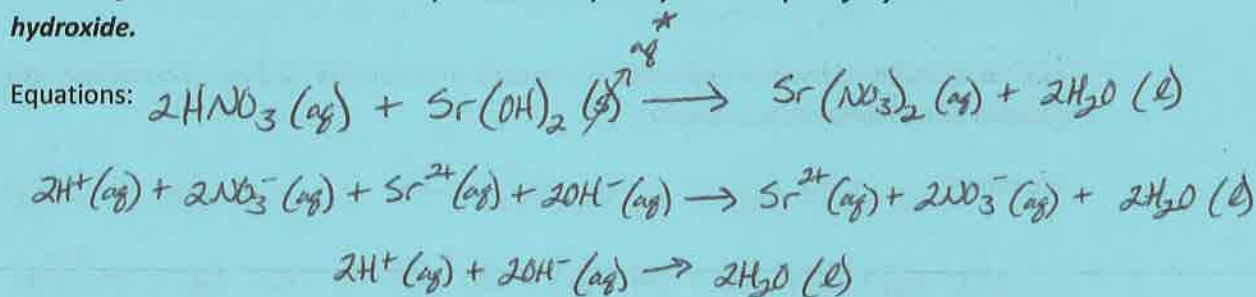


How much (mL) 0.250 M sulfuric acid solution would be required?

$$29.8 \text{ g}_{\text{NH}_3} \left(\frac{1 \text{ mol}_{\text{NH}_3}}{17.034 \text{ g}} \right) \left(\frac{1 \text{ mol}_{\text{H}_2\text{SO}_4}}{2 \text{ mol}_{\text{NH}_3}} \right) \left(\frac{1 \text{ L}}{0.250 \text{ mol}_{\text{H}_2\text{SO}_4}} \right) \left(\frac{1000 \text{ mL}}{1 \text{ L}} \right) = 3498 \text{ mL}_{\text{H}_2\text{SO}_4}$$

$$= 3.50 \times 10^3 \text{ mL}_{\text{H}_2\text{SO}_4}$$

4. 51.5 mL of 0.50M nitric acid was required to completely react a spill of crystalline strontium hydroxide.

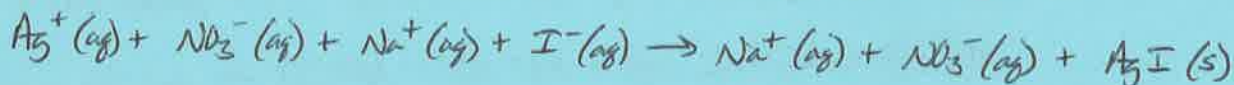


as soon as (aq) HNO_3 is spilled on it, the crystal will dissolve in the water present
How much did the sample of strontium hydroxide weigh?

$$51.5 \text{ mL}_{\text{HNO}_3} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.50 \text{ mol}_{\text{HNO}_3}}{1 \text{ L}} \right) \left(\frac{1 \text{ mol}_{\text{Sr}(\text{OH})_2}}{2 \text{ mol}_{\text{HNO}_3}} \right) \left(\frac{121.64 \text{ g}}{1 \text{ mol}_{\text{Sr}(\text{OH})_2}} \right) = 1.6 \text{ g}_{\text{Sr}(\text{OH})_2}$$

5. 95 mL of a 0.24 M silver nitrate is required to completely react 80 mL of sodium iodide.

Equations:



What was the concentration of the sodium iodide solution?

$$95 \text{ mL } \underset{\text{AgNO}_3}{\left(\frac{1 \text{ L}}{1000 \text{ mL}} \right)} \left(\overset{\text{AgNO}_3}{\frac{0.24 \text{ mol}}{1 \text{ L}}} \right) \left(\frac{1 \text{ mol NaI}}{1 \text{ mol AgNO}_3} \right) = 0.0228 \text{ mol NaI}$$

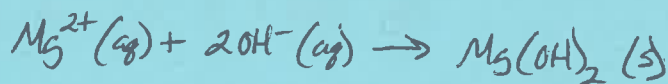
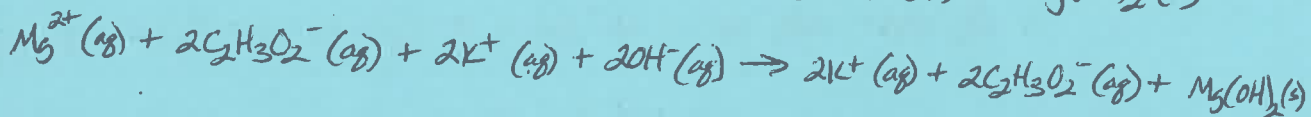
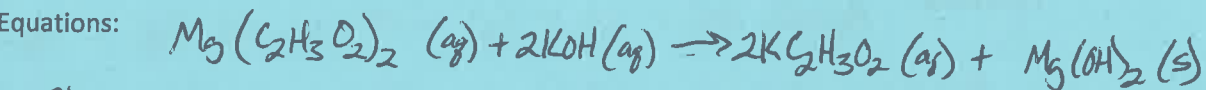
$$[\text{NaI}] = \frac{0.0228 \text{ mol}}{0.080 \text{ L}} = \boxed{0.29 \text{ M NaI}}$$

6. What characteristic did problems 1-5 all have in common? (ie: what type of problem do they represent?)

- Double Displacement (except #3)
- All are acid/base reactions
- All are solution stoich problems using molarity ($\frac{\text{mol}}{\text{L}}$) as a conversion factor.
- All were not limiting reagent problems (perfect amounts were combined for neutralization, ie neither acid or base left over)

7. 8.4g of magnesium acetate is combined with 7.31g of potassium hydroxide in water, creating a final volume solution of 250 mL.

Equations:



How much precipitate would be produced? (Need to know limiting reagent)

①

$$8.4 \text{ g Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \left(\frac{1 \text{ mol}}{142.40 \text{ g}} \right) = 0.059 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$$

② $0.059 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \left(\frac{2 \text{ mol KOH}}{1 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2} \right) = 0.118 \text{ mol KOH needed}$

$$7.31 \text{ g KOH} \left(\frac{1 \text{ mol}}{56.11 \text{ g}} \right) = 0.130 \text{ mol KOH}$$

③ $0.059 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \left(\frac{1 \text{ mol Mg}(\text{OH})_2}{1 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2} \right) \left(\frac{58.33 \text{ g}}{1 \text{ mol Mg}(\text{OH})_2} \right) = 3.4 \text{ g Mg}(\text{OH})_2$

HAVE

What would be the concentration of the aqueous product?

$$0.059 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \left(\frac{2 \text{ mol KC}_2\text{H}_3\text{O}_2}{1 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2} \right) = 0.118 \text{ mol KC}_2\text{H}_3\text{O}_2$$

$$[\text{KC}_2\text{H}_3\text{O}_2] = \frac{0.118 \text{ mol}}{0.250 \text{ L}} = 0.47 \text{ M KC}_2\text{H}_3\text{O}_2$$

How many more grams of either reactant (determine the right one) must be added so that each is completely reacted?

Need more limiting reactant → how much to react all the excess?

① $0.130 \text{ mol KOH (excess)} \left(\frac{1 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2}{2 \text{ mol KOH}} \right) = 0.065 \text{ mol needed Mg}(\text{C}_2\text{H}_3\text{O}_2)_2$

② $\frac{0.065 \text{ mol (need)} - 0.059 \text{ mol (have)}}{0.007 \text{ mol (short)}}$

③ $0.007 \text{ mol Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 \left(\frac{142.40 \text{ g}}{1 \text{ mol}} \right) = 0.997 \text{ g Mg}(\text{C}_2\text{H}_3\text{O}_2)_2 = 1.0 \text{ g (s.f.)}$

8. 55.4 mL of a 0.38 M potassium hydroxide solution is mixed with 76.0 mL of a 0.29 M hydrochloric acid solution.

Equations:



Determine the mL of water produced.

$$\underset{\text{KOH}}{55.4 \text{ mL}} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.38 \text{ mol}}{1 \text{ L}} \right) = 0.02105 \text{ mol KOH} \quad \text{* (mixing 1:1 ratio)}$$

$$0.02105 \text{ mol KOH} \left(\frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol KOH}} \right) \left(\frac{18.02 \text{ g}}{1 \text{ mol}} \right) \left(\frac{1 \text{ mL}}{1 \text{ g}} \right) = \boxed{0.38 \text{ mL H}_2\text{O}}$$

$$\underset{\text{HCl}}{76.0 \text{ mL}} \left(\frac{1 \text{ L}}{1000 \text{ mL}} \right) \left(\frac{0.29 \text{ mol}}{1 \text{ L}} \right) = 0.02204 \text{ mol HCl}$$

Determine the grams of salt produced.

$$0.02105 \text{ mol KOH} \left(\frac{1 \text{ mol KCl}}{1 \text{ mol KOH}} \right) \left(\frac{74.55 \text{ g}}{1 \text{ mol KCl}} \right) = \boxed{1.6 \text{ g KCl}}$$

Calculate the concentration of excess acidic/basic ion (H^+/OH^-).

$$\begin{array}{r} 0.02204 \text{ mol HCl (have)} \\ - 0.02105 \text{ mol HCl (neutralized by KOH)} \\ \hline 0.00099 \text{ mol HCl (excess)} \end{array}$$

$$0.00099 \text{ mol HCl} \left(\frac{1 \text{ mol H}^+}{1 \text{ mol HCl}} \right) = 0.00099 \text{ mol H}^+$$

$$\frac{0.00099 \text{ mol H}^+}{0.1314 \text{ L (total volume after mixing)}} = \boxed{0.0075 \text{ M H}^+ \text{ excess}}$$

How many additional mL of either reactant (determine the right one) would be required to neutralize the solution? More KOH needed (HCl left over in excess)

$$0.00099 \text{ mol HCl} \left(\frac{1 \text{ mol KOH}}{1 \text{ mol HCl}} \right) \left(\frac{1 \text{ L}}{0.38 \text{ mol KOH}} \right) \left(\frac{1000 \text{ mL}}{1 \text{ L}} \right) = \boxed{2.6 \text{ mL KOH needed}}$$

9. How were questions 7 & 8 different from questions 1-5? (ie: what type of problem do they represent?)

- Limiting Reagent Problems

- Solving for amount of excess left over, how much more limiting would be needed to use it up, etc in addition to theoretical yield