Chem 220

Practice Problem Set One

Lisensky

A. ***For each problem, circle the (non-ratio) amount that can be converted.***

1. How many grams of $CaCl_2$ do you need to make 125 mL of 0.512 M $CaCl_2$ solution?

2. What volume of 28.9 M HF, when diluted to 125 mL, will give a 2.00 M HF solution?

3. How many liters of 0.30 M HCl solution are needed for complete reaction with 500 g $CaCO_3$ if they react as $2\ HCl + CaCO_3 \rightarrow CaCl_2 + H_2O + CO_2$?

4. If 34.42 mL of HCl is used to just neutralize 2.050 g Na_2CO_3 according to the reaction $Na_2CO_3 + 2\ HCl \rightarrow 2\ NaCl + CO_2 + H_2O$, what is the molarity of the HCl?

5. Calcium chloride and silver nitrate react as $CaCl_2 + 2\ AgNO_3 \rightarrow Ca(NO_3)_2 + 2\ AgCl$. If you mix 100 mL of 0.24 M $CaCl_2$ solution with 100 mL of 0.18 M $AgNO_3$ solution, how many grams of AgCl can you obtain?

6. Concentrated hydrochloric acid solution is 37% by weight hydrochloric acid (the rest is water). What is the actual weight of hydrochloric acid in 125g of concentrated solution?

7. The majority of the sulfur dioxide emissions (a major source of acid rain) in the United States today comes from sulfur in coal that is burned in power plants. Sulfur content varies widely, from 0.5% to 5% by weight of the coal, and may be present primarily as iron pyrite, a mineral that is fairly easily removed before burning, or as hard to remove organically bound sulfur. The (unbalanced) reactions for the combustion of sulfur in coal to form sulfur dioxide, the further reaction of sulfur dioxide with oxygen in the air to form sulfur trioxide, and the combination of sulfur trioxide with water to form sulfuric acid are:

   $$S + O_2 \rightarrow SO_2$$
   $$SO_2 + O_2 \rightarrow SO_3$$
   $$SO_3 + H_2O \rightarrow H_2SO_4$$

   A typical power plant will burn about 2×10^6 metric tonnes (a metric tonne is 1000 kg) of coal per year. If it is burning low sulfur coal from Wyoming or Montana that contains 1.5% sulfur by weight, what weight of sulfuric acid will be produced by the power plant each year?

8. Copper metal reacts with nitric acid,

   $$3\ Cu(s) + 8\ HNO_3(aq) \rightarrow 3\ Cu(NO_3)_2(aq) + 2\ NO(g) + 4\ H_2O(l)$$

   If 5.92 g $Cu(NO_3)_2$ is produced, how many grams of NO would have also formed?

9. Liquid benzene (C_6H_6) has a density of 0.88g/mL, and burns in oxygen to produce carbon dioxide and water. What weight in grams of oxygen is needed to complete the combustion of 39 mL benzene?

B. ***Write out the unit conversion in one formula.***

Doing this before picking up your calculator leads to fewer mistakes and makes it easier for others to follow what you have done. Since getting the correct answer and explaining how you did the calculations are both important, please strive for clarity in your writing by using the format required for this course.

Practice Problem Set One

Lisensky

It is assumed that you know how to obtain formula or molecular weights by adding up atomic weights; those steps are not shown here.

In all cases the conversion method, amounts → moles → amounts, has been used starting from the non-ratio amount given or requested in the problem.

The answer to Part A is the first item listed. The rest is the answer to Part B.

1. $125 \text{ mL solution} \; \frac{0.512 \text{ mol CaCl}_2}{\text{L solution}} \frac{110 \text{ g CaCl}_2}{\text{mol CaCl}_2} \frac{.001}{\text{milli}} = 7.04 \text{ g CaCl}_2$

2. $125 \text{ mL solution} \; \frac{2.00 \text{ mol HF}}{\text{L solution}} \frac{\text{L conc}}{28.9 \text{ mol HF}} = 8.65 \text{ mL conc}$

3. $500 \text{ g CaCO}_3 \; \frac{\text{mol CaCO}_3}{100.087 \text{ g CaCO}_3} \frac{2 \text{ mol HCl}}{1 \text{ mol CaCO}_3} \frac{\text{L solution}}{0.30 \text{ mol HCl}} = 33 \text{ L solution}$

4. $$\frac{2.050 \text{ g Na}_2\text{CO}_3 \frac{\text{mol Na}_2\text{CO}_3}{105.989 \text{ g Na}_2\text{CO}_3} \frac{2 \text{ mol HCl}}{1 \text{ mol Na}_2\text{CO}_3}}{34.42 \text{ mL solution} \frac{.001}{\text{milli}}} = \frac{1.124 \text{ mol HCl}}{\text{L solution}}$$

   Hint: Start with an amount you can convert to moles (g Na_2CO_3 not mL solution.)
   See "Titrations" in the lab manual for a further discussion of titration calculations.

5. $100 \text{ mL} \; \frac{0.24 \text{ mol CaCl}_2}{\text{L}} \frac{2 \text{ mol AgCl}}{1 \text{ mol CaCl}_2} \frac{143.321 \text{ g AgCl}}{\text{mol AgCl}} \frac{.001}{\text{milli}} = 6.9 \text{ g AgCl (based on CaCl}_2\text{)}$

   $100 \text{ mL} \; \frac{0.18 \text{ mol AgNO}_3}{\text{L}} \frac{1 \text{ mol AgCl}}{1 \text{ mol AgNO}_3} \frac{143.321 \text{ g AgCl}}{\text{mol AgCl}} \frac{.001}{\text{milli}} = 2.6 \text{ g AgCl (based on AgNO}_3\text{)}$

   Hint: You are given two amounts. Start with both. There is enough $CaCl_2$ to produce 6.9 g AgCl, but only enough $AgNO_3$ to produce 2.6 g AgCl so 2.6 g AgCl will result.

6. $125 \text{ g solution} \; \frac{37 \text{ g HCl}}{100 \text{ g solution}} = 46 \text{ g HCl}$

   Hint: % is a ratio indicating how many out of 100.

7. $2\times10^6 \text{ tonne coal} \frac{10^6 \text{g}}{\text{tonne}} \frac{1.5 \text{ g S}}{100 \text{ g coal}} \frac{\text{mol S}}{32.066 \text{ g S}} \frac{1 \text{ mol SO}_2}{1 \text{ mol S}} \frac{1 \text{ mol SO}_3}{1 \text{ mol SO}_2} \frac{1 \text{ mol H}_2\text{SO}_4}{1 \text{ mol SO}_3} \frac{98.079 \text{ g H}_2\text{SO}_4}{\text{mol H}_2\text{SO}_4}$

   $= 9 \times 10^{10} \text{ g H}_2\text{SO}_4$

8. $5.92 \text{ g Cu(NO}_3)_2 \; \frac{\text{mol Cu(NO}_3)_2}{187.56 \text{ g Cu(NO}_3)_2} \frac{2 \text{ mol NO}}{3 \text{ mol Cu(NO}_3)_2} \frac{30.01 \text{ g NO}}{\text{mol NO}} = 0.631 \text{ g NO}$

9. Balanced combustion equation: $2\, C_6H_6 + 15\, O_2 \rightarrow 12\, CO_2 + 6\, H_2O$

   $39 \text{ mL C}_6\text{H}_6 \; \frac{0.88 \text{ g C}_6\text{H}_6}{\text{mL C}_6\text{H}_6} \frac{\text{mol C}_6\text{H}_6}{78.11 \text{ g C}_6\text{H}_6} \frac{15 \text{ mol O}_2}{2 \text{ mol C}_6\text{H}_6} \frac{32.00 \text{ g O}_2}{\text{mol O}_2} = 1.1 \times 10^2 \text{ g O}_2$