Stoichiometry Practice Problems

To prepare a solution of $AgNO_3$, 0.275 grams are placed in a 500-mL volumetric flask and diluted to volume. A 10.0 mL portion of this solution is transferred to a 250-mL volumetric flask and diluted to volume, what is the molarity of the resulting solution?

Concentration is a measure of an amount of solute per unit volume of solution. With molarity the solute is given in moles and the solution's volume in liters. Begin by using a ratio of grams of $AgNO_3$ to liters of solution and then covert the mass of $AgNO_3$ to moles; this gives the molarity of the first solution. In the solution below, note that I include the second dilution in the calculation as well. Since this involves a ratio of volumes, you can leave the two volumes in mL as the units will cancel out.

$$\frac{0.275\text{ g AgNO}_3}{0.500\text{ L}} \times \frac{1\text{ mol AgNO}_3}{169.91\text{ g AgNO}_3} \times \frac{10.0\text{ mL}}{250.0\text{ ml}} = 1.29 \times 10^{-4}\text{ M AgNO}_3$$

Metal carbonates decompose when they are heated, releasing CO_2 and the corresponding metal oxide, as shown by the following reaction

$$MCO_3(s) \rightarrow MO(s) + CO_2(g)$$

When a metal carbonate is heated it loses 35.1% of its mass. What is the metal in this metal carbonate assuming that it has a charge of +1 or +2?

One solution to this problem is to assume that we begin with exactly 100 grams of MCO_3. Since we lose 35.1% of this mass upon heating, then there must be 35.1 g of CO_2 and

$$35.1 \text{ g } CO_2 \times \frac{1 \text{ mol } CO_2}{44.01 \text{ g } CO_2} = 0.7975 \text{ mol } CO_2$$

in the sample. The reaction's stoichiometry tells us that each mole of MCO_3 produces one mole of CO_2; thus, we must also have 0.7975 mol MCO_3. The molar mass of MCO_3, therefore, is

$$\frac{100.0 \text{ g } MCO_3}{0.7975 \text{ mol } MCO_3} = 125.4 \text{ g/mol}$$

One mole of MCO_3 contains 12.01 g of carbon and 48.0 g of oxygen; subtracting this from the molar mass means that one mole of MCO_3 contains 65.4 g of M. If M is a divalent cation, then its atomic mass is 65.4 g/mol and if M is a monovalent cation, then its molar mass is 32.7 g/mol. Looking at the periodic table shows us that the only possible match is Zn^{2+}.