Solution to Extra Problem 3.1 Using the "Set" Method

$$2\ Al(s) + 3\ Cl_2(g) \rightarrow 2\ AlCl_3(s)$$

$$\text{mol Al} = (2.70\,\text{g Al})\left(\frac{\text{mol Al}}{26.98\,\text{g Al}}\right) = 0.100\ \text{mol Al}$$

$$\text{mol } Cl_2 = (4.05\ \text{g } Cl_2)\left(\frac{\text{mol } Cl_2}{70.90\ \text{g } Cl_2}\right) = 0.0571_2\ \text{mol } Cl_2$$

(a) To determine the limiting reagent, take the number of moles of each reactant and divide by its stoichiometric coefficient in the balanced reaction equation. The smaller result identifies the limiting reagent. Then, use the number of moles of that reagent (*not* the number obtained by dividing by its coefficient) for all subsequent calculations.

Al: 0.100/2 = 0.0500 $\qquad$ Cl_2: 0.0571/3 = 0.0190

Therefore, Cl_2 is the limiting reagent.

(b) Calculate the grams of $AlCl_3$ on the basis of the moles of Cl_2, the limiting reagent.

$$\text{g } AlCl_3 = (0.0571_2\ \text{mol } Cl_2)\left(\frac{2\ \text{mol } AlCl_3}{3\ \text{mol } Cl_2}\right)\left(\frac{133.33\ \text{g } AlCl_3}{\text{mol } AlCl_3}\right) = 5.08\ \text{g } AlCl_3$$

(c) Calculate the number of grams of Al used, based on the limiting reagent Cl_2. Then subtract the grams of Al used from the grams of Al given (2.70 g) to find the grams of Al left over.

$$\text{g Al used} = (0.0571_2\ \text{mol } Cl_2)\left(\frac{2\ \text{mol Al}}{3\ \text{mol } Cl_2}\right)\left(\frac{26.98\ \text{g Al}}{\text{mol Al}}\right) = 1.03\ \text{g Al}$$

g Al left = 2.70 g – 1.03 g = 1.67 g