STUDENT SUCCESS CENTER
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

DETERMINING LIMITING AND EXCESS REAGENTS

These problems are a more real-world application of the stoichiometry practice, as typically one reactant will be consumed, leading the reaction to also stop.

Limiting Reagent

The *limiting reagent* in a chemical reaction is the reactant that will be consumed completely. Once there is no more of that reactant, the reaction cannot proceed. Therefor it limits the reaction from continuing.

Excess Reagent

The *excess reagent* is the reactant that could keep reacting if the other had not been consumed.

Examples

1. Let's start with a non-chemistry example that may make more sense.
   - Making a car is a lot more complicated than four wheels and a steering wheel, but let's say that it's all it takes.
     - You have 400 wheels and 125 steering wheels, which will you run out of first? How many of the other will be left over?
   - The way that it is best approached is finding out how many cars would be made based on each "reactant."

$$400\ \cancel{wheels} * \frac{1\ car}{4\ \cancel{wheels}} = 100\ cars$$

$$125\ \cancel{steering\ wheels} * \frac{1\ car}{1\ \cancel{steering\ wheel}} = 125\ cars$$

   - Because there are only enough wheels to create 100 cars, but the steering wheels can create 125 cars, the wheels are the *limiting reagent*. It is important to notice that the limiting reagent can be the reactant, which had more in the beginning. To find the amount of the excess (steering wheels), we need to find the amount needed to create the 100 cars.

$$100\ \cancel{cars} * \frac{1\ steering\ wheel}{1\ \cancel{car}} = 100\ steering\ wheels$$

   - Thus, we need 100 steering wheels to use up all the wheels.

$$125\ steering\ wheels\ to\ start - 100\ steering\ wheels\ needed$$
$$= 25\ steering\ wheels\ in\ excess$$

2. Now, if we introduce chemistry back into it, the concept is the same, just a little more complex.
   - If we have 14.8g of propane, and 34.4g of oxygen
     - Determine
       - The limiting reagent
       - The number of moles carbon dioxide produced
       - Mass of water produced
       - Mass of excess reagent
   - First, we need a chemical equation and moles of each component.

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

$$14.8g\ C_3H_8 * \frac{1\ mol\ C_3H_8}{44.1g\ C_3H_8} = .336\ mol\ C_3H_8$$

$$34.4g\ O_2 * \frac{1\ mol\ O_2}{32\ g\ O_2} = 1.075\ mol\ O_2$$

   - Now that we have the amounts of propane and oxygen, we can find out how much carbon dioxide will be produced the same way we found out how many cars we had.

$$.336\ molC_3H_8 * \frac{3\ mol\ CO_2}{1\ mol\ C_3H_8} = 1.01\ mol\ CO_2$$

$$1.075\ mol\ O_2 * \frac{3\ mol\ CO_2}{5\ mol\ O_2} = .645\ mol\ CO_2$$

   - This means
     - Oxygen is the limiting reactant
     - .645 moles of carbon dioxide will be formed.
   - We can also figure out how many mols of water are produced, and therefore how much mass.

$$1.075\ mol\ O_2 * \frac{4\ mol\ H_2O}{5\ mol\ O_2} * \frac{18.02g\ H_2O}{1\ mol\ H_2O} = 15.5\ g\ H_2O$$

   - Finally, we can find the excess needed.

$$1.075\ mol\ O_2 * \frac{1\ C_3H_8}{5\ O_2} = .215\ mol\ C_3H_8\ needed$$

$$.336\ molC_3H_8\ to\ start - .215\ mol\ C_3H_8\ needed = .121\ molC_3H_8\ in\ excess$$

$$.121\ molC_3H_8 * \frac{44.1g\ C_3H_8}{1\ mol\ C_3H_8} = 5.34\ g\ C_3H_8\ in\ excess$$