

Name: Key  
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**Chemistry 11  
STOICHIOMETRY  
OF EXCESS + LIMITING REACTANTS**

Until now all of the stoich problems we have completed assumed that all of the reactants are used up in the reaction. HOWEVER, sometimes chemical reactions are carried out so as to:

1. To ensure that all of another substance (toxic etc) is used up
2. unavailability - you only have a specific amount in stock.

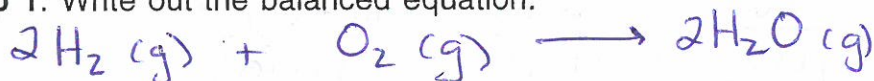
**IMPORTANT TERMINOLOGY:**

**Excess Reactant:** the substance that you have more than enough of.

**Limiting Reactant:** the substance that determines the amount of products that will form because you have a limited amount of it.

**Example 1.** If for the synthesis reaction between hydrogen gas and oxygen gas, 20.0 g of H<sub>2</sub> (g) reacts with 100.0 g of O<sub>2</sub> (g), which reactant is in excess and by how much?

**Step 1.** Write out the balanced equation:



**Step 2.** Use both masses to solve for the mass of the **same** product

$$20.0 \text{ g H}_2 \times \frac{1 \text{ mol H}_2}{2.0 \text{ g H}_2} \times \frac{2 \text{ mol H}_2\text{O}}{2 \text{ mol H}_2} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 180 \text{ g H}_2\text{O}$$
$$100.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{2 \text{ mol H}_2\text{O}}{1 \text{ mol O}_2} \times \frac{18.0 \text{ g H}_2\text{O}}{1 \text{ mol H}_2\text{O}} = 112.5 \text{ g H}_2\text{O}$$

**Step 3.** The substance that produces the least amount of product is the **LIMITING REACTANT**

$$\therefore 100.0 \text{ g O}_2 \text{ is LIMITING}$$

**Step 4.** To determine the amount of **EXCESS REACTANT** use the mass of the limiting reactant to solve for the actual mass of excess used:

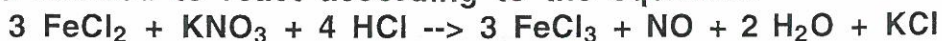
$$100.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.0 \text{ g O}_2} \times \frac{2 \text{ mol H}_2}{1 \text{ mol O}_2} \times \frac{2.0 \text{ g H}_2}{1 \text{ mol H}_2} = 12.5 \text{ g H}_2$$

$\therefore 13 \text{ g H}_2$

**Step 5.** Subtract the above value from the amount of excess you have.

$$\therefore 20.0 \text{ g} - 13 \text{ g} = \boxed{7 \text{ g H}_2 \text{ remains}}$$

Example 2. If 56.8 grams of  $\text{FeCl}_2$ , 14.0 g of  $\text{KNO}_3$  and 40.0 g of  $\text{HCl}$  are mixed and allowed to react according to the equation:



Which reactants are in excess and by how much?

Step 1. Write out the balanced equation:



Step 2. Use all masses to solve for the mass of the **same** product  $\Rightarrow \text{NO} = 30.0 \text{g}$  //  $\text{H}_2\text{O} \Rightarrow 18.0 \text{g}$

$$56.8 \text{g FeCl}_2 \times \frac{1 \text{ mol FeCl}_2}{126.8 \text{g}} \times \frac{1 \text{ mol NO}}{3 \text{ mol FeCl}_2} \times \frac{30.0 \text{g NO}}{1 \text{ mol NO}} = 4.48 \text{g NO} // 53.8 \text{g H}_2\text{O}$$

$$\rightarrow 14.0 \text{g KNO}_3 \times \frac{1 \text{ mol KNO}_3}{101.1 \text{g}} \times \frac{1 \text{ mol NO}}{1 \text{ mol KNO}_3} \times \frac{30.0 \text{g NO}}{1 \text{ mol NO}} = 4.16 \text{g NO} // 4.99 \text{g H}_2\text{O}$$

$$40.0 \text{g HCl} \times \frac{1 \text{ mol HCl}}{36.5 \text{g HCl}} \times \frac{1 \text{ mol NO}}{4 \text{ mol HCl}} \times \frac{30.0 \text{g NO}}{1 \text{ mol NO}} = 8.22 \text{g NO} // 19.86 \text{g H}_2\text{O}$$

Step 3. The substance that produces the least amount of product is the **LIMITING REACTANT**

$\therefore$  14.0 g of  $\text{KNO}_3$  is the **LIMITING REACTANT**.

Step 4. To determine the amount of **EXCESS REACTANTS** use the mass of the limiting reactant to solve for the actual mass of the excess used:

$$14.0 \text{g KNO}_3 \times \frac{1 \text{ mol KNO}_3}{101.1 \text{g KNO}_3} \times \frac{3 \text{ mol FeCl}_2}{1 \text{ mol KNO}_3} \times \frac{126.8 \text{g FeCl}_2}{1 \text{ mol FeCl}_2} = 52.7 \text{g FeCl}_2$$

$$14.0 \text{g KNO}_3 \times \frac{1 \text{ mol KNO}_3}{101.1 \text{g KNO}_3} \times \frac{4 \text{ mol HCl}}{1 \text{ mol KNO}_3} \times \frac{36.5 \text{g HCl}}{1 \text{ mol HCl}} = 20.2 \text{g HCl}$$

Step 5. Subtract the above values from the amount of excesses that you have.

$$\therefore 56.8 \text{g FeCl}_2 - 52.7 \text{g} = \boxed{4.1 \text{g FeCl}_2 \text{ in excess}}$$

$$40.0 \text{g HCl} - 20.2 \text{g HCl} = \boxed{19.8 \text{g HCl in excess}}$$