

GENERAL CHEMISTRY

STANDARD 8.6

8.6: Use stoichiometry to determine the limiting reactant of a reaction

DEFINITIONS

- **Limiting Reactant:** A reactant that is totally consumed when the chemical reaction is complete
 - Limiting reactants are totally consumed before all other reactants
 - The other reactant(s) is/are called excess reactants
- **Theoretical Yield:** The amount of product theoretically created by creating all of the limiting reactant into product

EXAMPLE PROBLEM

- Consider the respiration chemical reaction:
 - $\text{C}_6\text{H}_{12}\text{O}_6 (\text{s}) + 6 \text{O}_2 (\text{g}) \rightarrow 6 \text{CO}_2 (\text{g}) + 6 \text{H}_2\text{O} (\text{g}) + \text{energy}$
- What mass of carbon dioxide forms in the reaction with 25 grams of glucose with 40. grams of oxygen?

Stoichiometry must be completed on both reactants to see which one makes less product

| | | | | |
|--|--|---|----------------------|----------------------|
| 25 g $\text{C}_6\text{H}_{12}\text{O}_6$ | 1 mol $\text{C}_6\text{H}_{12}\text{O}_6$ | 6 mol CO_2 | 44.0 g CO_2 | = 37 g CO_2 |
| | 180. g $\text{C}_6\text{H}_{12}\text{O}_6$ | 1 mol $\text{C}_6\text{H}_{12}\text{O}_6$ | 1 mol CO_2 | |
| 40. g O_2 | 1 mol O_2 | 6 mol CO_2 | 44.0 g CO_2 | = 55 g CO_2 |
| | 32.0 g O_2 | 6 mol O_2 | 1 mol CO_2 | |

Always go with the lesser amount of product made

Glucose is the limiting reactant and 37 g of carbon dioxide is formed

ANOTHER EXAMPLE PROBLEM

- Consider the following chemical reaction:
 - $4 \text{C}_2\text{H}_3\text{Br}_3 + 11 \text{O}_2 \rightarrow 8 \text{CO}_2 + 6 \text{H}_2\text{O} + 6 \text{Br}_2$
- What mass of bromine is created if 76.4 g of $\text{C}_2\text{H}_3\text{Br}_3$ reacts with 49.1 g of O_2 ? How much excess reactant is left over?

Stoichiometry must be completed on both reactants to see which one makes less product

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|--|---|---|-----------------------|------------------------|
| 76.4 g $\text{C}_2\text{H}_3\text{Br}_3$ | 1 mol $\text{C}_2\text{H}_3\text{Br}_3$ | 6 mol Br_2 | 159.8 g Br_2 | = 68.6 g Br_2 |
| | 266.8 g $\text{C}_2\text{H}_3\text{Br}_3$ | 4 mol $\text{C}_2\text{H}_3\text{Br}_3$ | 1 mol Br_2 | |
| 49.1 g O_2 | 1 mol O_2 | 6 mol Br_2 | 159.8 g Br_2 | = 11.2 g Br_2 |
| | 32.0 g O_2 | 11 mol O_2 | 1 mol Br_2 | |

Always go with the lesser amount of product made

Oxygen is the limiting reactant and 11.2 g of bromine is formed

ANOTHER EXAMPLE PROBLEM

- Now, to find the amount of excess reactant:
 - Subtract the amount of Br_2 created by the limiting reactant from the amount of Br_2 created from the excess reactant:
 - $68.6 \text{ g} - 11.2 \text{ g} = 57.4 \text{ g CO}_2$ in excess
 - Now convert this number back from grams of Br_2 to grams of the excess reactant:

$$\begin{array}{c|c|c|c}
 57.4 \text{ g Br}_2 & 1 \text{ mol Br}_2 & 4 \text{ mol C}_2\text{H}_3\text{Br}_3 & 266.8 \text{ g C}_2\text{H}_3\text{Br}_3 \\
 \hline
 & 159.8 \text{ g Br}_2 & 6 \text{ mol Br}_2 & 1 \text{ mol C}_2\text{H}_3\text{Br}_3
 \end{array} = 63.9 \text{ g C}_2\text{H}_3\text{Br}_3 \text{ in excess}$$

ANOTHER PROBLEM

- Consider the following chemical reaction:
 - $4 \text{CoO} + \text{O}_2 \rightarrow 2 \text{Co}_2\text{O}_3$
- What mass of Co_2O_3 is created if 24.5 g of CoO is reacted with 2.58 g of O_2 ? Which compound is the limiting reactant? How much excess reactant is left over?

ANOTHER PROBLEM SOLUTION

- Consider the following chemical reaction:
 - $4 \text{CoO} + \text{O}_2 \rightarrow 2 \text{Co}_2\text{O}_3$
- What mass of Co_2O_3 is created if 24.5 g of CoO is reacted with 2.58 g of O_2 ? Which compound is the limiting reactant? How much excess reactant is left over?

| | |
|--|---|
| Limiting Reactant: | Oxygen |
| Amount of Co_2O_3 Created: | 26.74 g Co_2O_3 |
| Amount of Excess: | 0.338 g CoO |