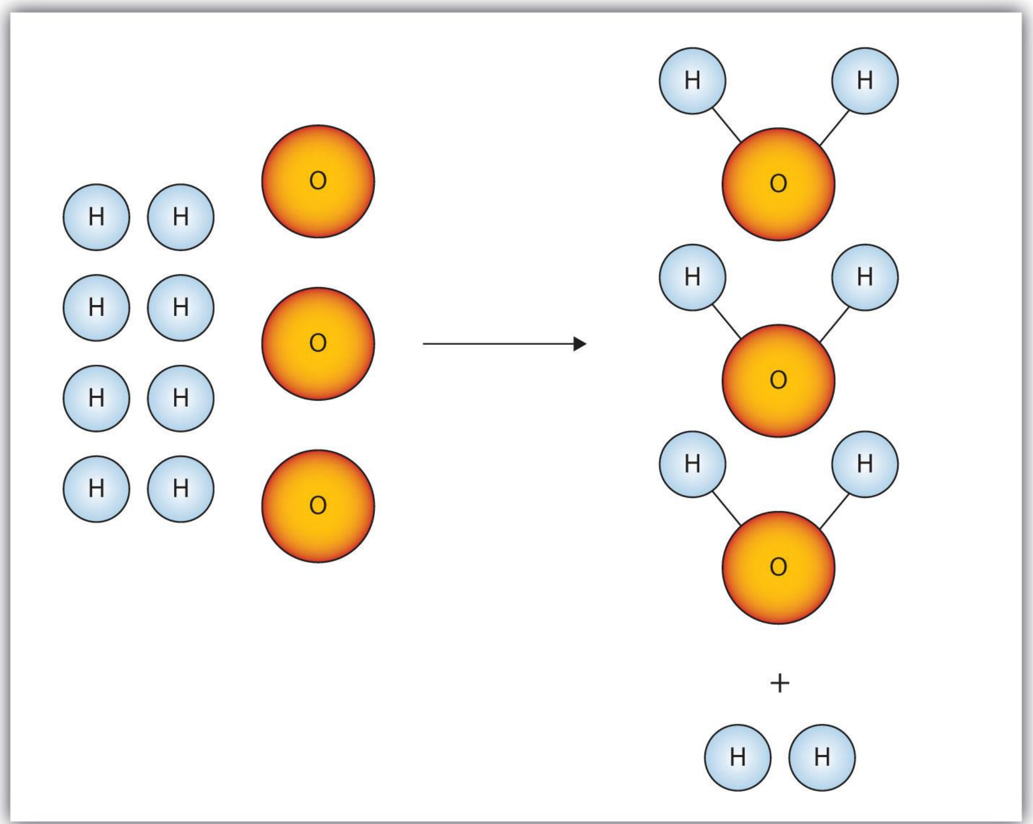
[7.3] Limiting and Excess Quantities



Beginning Activity

16 P + 8W + 1C →1 Ho

With you and your partner, in your bags you have the materials to make a marshmallow house.

Each house requires:

☐16 toothpicks ☐ 8 white marshmallows ☐1 colored marshmallow

- How many marshmallow houses can you make?
- Answer the questions on your handout

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Beginning Activity

Each house requires:

12 toothpicks **8 white marshmallows** **1 colored marshmallow**

Beginning Activity

How many houses could you make?

Were there any materials left over?

Why could you not use those materials to make another house?

What materials prevented you from making another house?

Limiting and Excess Quantities

- Today we will be applying stoichiometry to **excess** and **limiting quantities.**

Definitions:

- **Excess Reactant:** The reactant that will have some extra after the reaction because it is not fully used
- **Limiting Reactant:** The reactant that determines how much product is made

How to Calculate Limiting and Excess Reactant

1. Use stoichiometry to calculate the amount of product created by each reactant
2. The reactant that produces the **smaller** product is the amount of product theoretically made. That reactant is the **limiting** reactant.
3. The reactant the produces the **larger** product is known as the **excess** reactant.

How to Calculate Excess Quantity

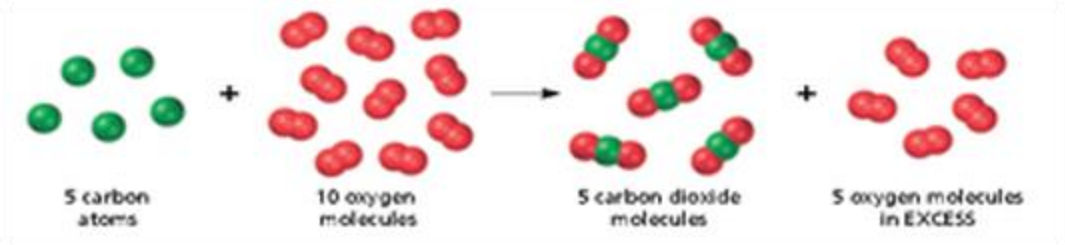
How do you calculate the amount of reactant that is left over after the reaction is complete?

You can calculate that amount by:

1. Start with the limiting reactant and calculate the amount of excess reactant used in the reaction
2. Excess quantity = beginning amount of excess reactant – amount **consumed**

Calculating Limiting and Excess Quantities

$$5C + 10O_2 \longrightarrow 5CO_2 + 5O_2$$



Using the equation above, if 4.50 grams of carbon (C) and 1.80 grams of oxygen (O_2) is reacted together, how much CO_2 will be produced?

Calculating Limiting and Excess Quantities

$5C + 10O_2 \longrightarrow 5CO_2 + 5O_2$

Using the equation above, if 4.50 grams of carbon (C) and 1.80 grams of oxygen (O_2) is reacted together, how much CO_2 will be produced?

- C: $4.5 \text{ g C} \times \dfrac{1 \text{ mol C}}{12.00 \text{ g C}} \times \dfrac{5 \text{ mol } CO_2}{5 \text{ mol C}} \times \dfrac{44.0 \text{ g CO2}}{1 \text{ mol } CO_2} = 16.5 \text{ g } CO_2$
- O2: $1.8 \text{ g O2} \times \dfrac{\text{I mol } O_2}{32.0 \text{ g } O_2} \times \dfrac{5 \text{ mol } CO_2}{10 \text{ mol } O_2} \times \dfrac{44.0 \text{ g } CO_2}{1 \text{ mol } CO_2} = 1.24 \text{ g } CO_2$

This is the smaller product, thus **oxygen is the limiting reactant**.

Calculating Limiting and Excess Quantities

$$5C + 10O_2 \longrightarrow 5CO_2 + 5O_2$$

Using the equation above, if 4.5 grams of carbon (C) and 1.8 grams of oxygen (O_2) is reacted together, how much CO_2 will be produced?

How much carbon(C) is left over in the reaction?

Remember: Excess quantity = **beginning amount of excess reactant** – **amount consumed**

Amount of C consumed: 1.80 g O2 x $\frac{1 \text{ mol } O_2}{32.0 \text{ g } CO_2}$ x $\frac{5\text{mol C}}{10 \text{ mol } O_2}$ x $\frac{12.0 \text{ g C}}{1 \text{ mol C}}$

= 0.34 g

Excess quantity: 4.50 g – 0.338 g = 4.16 g

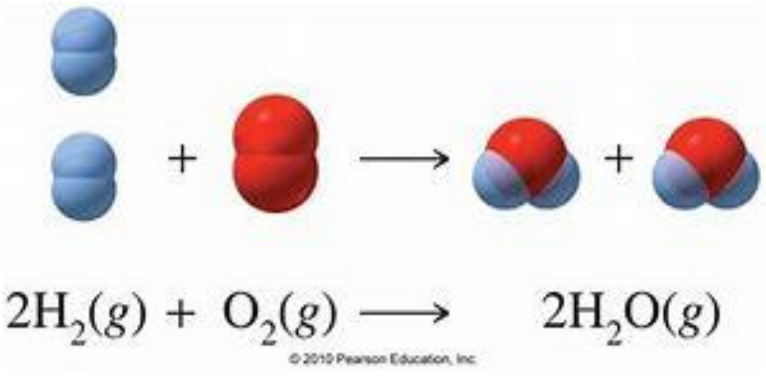
Practice Problem #1:

$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$

- Using the reaction above, if 30.0 g of $H_2(g)$ react with 150.0 g of $O_2(g)$:

A) Which reactant is in excess reactant and which one is the limiting reactant?

B) How much H_2O (g) will be formed?



Practice Problem #1:

$$2H_2(g) + O_2(g) \longrightarrow 2H_2O(g)$$

A)Which reactant is in excess reactant and which one is the limiting reactant?

$$30.0 \text{ g } H_2 \times \frac{1 \text{ mole } H_2}{2.0 \text{ g } H_2} \times \frac{2 \text{ mole } H_2O}{2 \text{ mole } H_2} \times \frac{18.0 \text{ g } H_2O}{1 \text{ mole } H_2O} = 2.70 \times 10^2 \text{ g } H_2O$$

$$150.0 \text{ g } O_2 \times \frac{1 \text{ mole } O_2}{32.0 \text{ g } O_2} \times \frac{2 \text{ mole } H_2O}{1 \text{ mole } O_2} \times \frac{18.0 \text{ g } H_2O}{1 \text{ mole } H_2O} = 1.69 \times 10^2 \text{ g } H_2O$$

Oxygen made the smaller product, so it is the limiting reactant

B) How much H_2O (g) will be formed?

1.69×10^2 g H_2O will be formed

Practice Problem #2

$$5C + 2\,SO_2 \longrightarrow CS_2 + 4CO$$

A) What mass of **CS_2** is produced when 18.0 g of **C** are reacted with 74.0 g of **SO_2** ?

B) What mass of the excess reactant will be left over after the reaction?

Practice Problem #2:

$$5C + 2\ SO_2 \longrightarrow CS_2 + 4CO$$

A) What mass of $\mathbf{CS_2}$ is produced when 18.0 g of **C** are reacted with 74.0 g of $\mathbf{SO_2}$?

Practice Problem #2:

$$5C + 2\,SO_2 \rightarrow CS_2 + 4CO$$

A) What mass of **CS_2** is produced when 18.0 g of **C** are reacted with 74.0 g of **SO_2** ?

$$18.0\text{ g C} \times \frac{1\text{ mole C}}{12.0\text{ g C}} \times \frac{1\text{ mole }CS_2}{5\text{ mole C}} \times \frac{76.14\text{ g }H_2O}{1\text{ mole }CS_2} = 22.8\text{ g }CS_2$$

$$74.0\text{ g }SO_2 \times \frac{1\text{ mole }SO_2}{64.07\text{ g }SO_2} \times \frac{1\text{ mole }CS_2}{2\text{ mole }SO_2} \times \frac{76.14\text{ g }H_2O}{1\text{ mole }CS_2} = 44.0\text{ g }CS_2$$

22.8 g CS_2 is the mass produced

Practice Problem #2:

$$5C + 2\,SO_2 \longrightarrow CS_2 + 4CO$$

B) What mass of the excess reactant will be left over after the reaction?

Since Carbon was the limiting reactant, SO_2 is the excess reactant.

Amount of SO_2 consumed:

Practice Problem #2:

$$5C + 2\,SO_2 \rightarrow CS_2 + 4CO$$

B) What mass of the excess reactant will be left over after the reaction?

Since Carbon was the limiting reactant, SO_2 is the excess reactant.

Amount of SO_2 consumed:

$$18.0\text{g C} \times \frac{1\text{ mole C}}{12.0\text{ g C}} \times \frac{2\text{ mole }SO_2}{5\text{ mole C}} \times \frac{64.1\text{g }SO_2}{1\text{ mole }SO_2} = 38.5\text{ g }SO_2$$

Mass of excess reactant: 74.0 g – 38.5 g = 35.5 g

Exit Ticket: Practice Problem #3

$$2\ AlBr_3 + 3\ CaS \rightarrow Al_2S_3 + 3\ CaBr_2$$

17.8 g of Aluminum bromide is reacted with 6.67 g of Calcium sulfide according to the reaction above,

A) Which is the limiting reactant?

B) How much aluminum sulfide is produced?

C) How much excess reactant will be left over after the reaction is complete?

HOMEWORK

Textbook:

Pg. 133-137

#'s 28 - 32