Today's Lecture

- ✓Announcements
- ✓Stoichiometry
  - –Limiting Reactants
- ✓Quizzes

Announcements

- Office hours
  - Mon, Wed, 11:30-12:30 am
  - Sun,Tue,Thu 11:00-12:00 pm
- Reading
  - Chapter 3, Sections (3.4),(3.6) and **(3.7)**
- Suggested Problems
- 3.27,3.293.31,3.33, 3.35, 3.37,3.39,3.41,3.573.59, 3.61, 3.63,3.67,3.69, 3.71,3.73,3.77

Limiting Reactants

Matter And Measurement

How Many Cookies Can I Make?

- You can make cookies until you run out of one of the ingredients.
- Once this family runs out of sugar, they will stop making cookies (at least any cookies you would want to eat).

Matter And Measurement

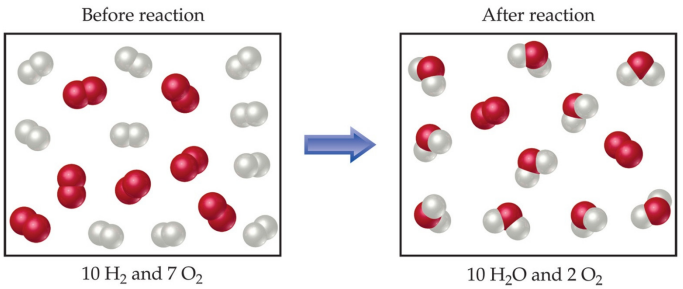
How Many Cookies Can I Make?

- In this example the sugar would be the limiting reactant, because it will limit the amount of cookies you can make.

Matter And Measurement

Limiting Reactants

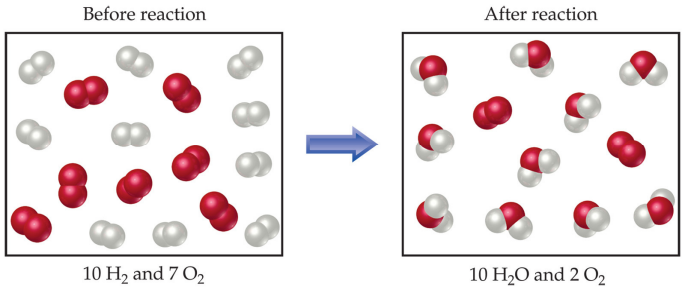
- The limiting reactant is the reactant present in the smallest stoichiometric amount.
  - In other words, it's the reactant you'll run out of first (in this case, the H_2).



Matter And Measurement

Limiting Reactants

In the example below, the O_2 would be the excess reagent.



Matter And Measurement

Theoretical Yield

- The theoretical yield is the maximum amount of product that can be made.
  - In other words it's the amount of product possible as calculated through the stoichiometry problem.
- This is different from the actual yield, which is the amount one actually produces and measures.

Matter And Measurement

Percent Yield

One finds the percent yield by comparing the amount actually obtained (actual yield) to the amount it was possible to make (theoretical yield).

$$\text{Percent Yield} = \frac{\text{Actual Yield}}{\text{Theoretical Yield}} \times 100$$

Sample Exercise 3.18 Calculating the Amount of Product Formed from a Limiting Reactant

The most important commercial process for converting N_2 from the air into nitrogen-containing compounds is based on the reaction of N_2 and H_2 to form ammonia (NH_3):

$$N_2(g) + 3\ H_2(g) \rightarrow 2\ NH_3(g)$$

How many moles of NH_3 can be formed from 3.0 mol of N_2 and 6.0 mol of H_2?

Practice Exercise

Consider the reaction $2\ Al(s) + 3\ Cl_2(g) \rightarrow 2\ AlCl_3(s)$. A mixture of 1.50 mol of Al and 3.00 mol of Cl_2 is allowed to react.

(a) Which is the limiting reactant?
(b) How many moles of $AlCl_3$ are formed?
(c) How many moles of the excess reactant remain at the end of the reaction?

Sample Exercise 3.19 Calculating the Amount of Product Formed from a Limiting Reactant

Consider the following reaction that occurs in a fuel cell:

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

This reaction, properly done, produces energy in the form of electricity and water. Suppose a fuel cell is set up with 150 g of hydrogen gas and 1500 grams of oxygen gas (each measurement is given with two significant figures). How many grams of water can be formed?

Practice Exercise

A strip of zinc metal with a mass of 2.00 g is placed in an aqueous solution containing 2.50 g of silver nitrate, causing the following reaction to occur:

$$Zn(s) + 2\ AgNO_3(aq) \rightarrow 2\ Ag(s) + Zn(NO_3)_2(aq)$$

a) Which reactant is limiting?
b) How many grams of Ag will form?
c) How many grams of Zn(NO3)2 will form?
d) How many grams of the excess reactant will be left at the end of the reaction?

Sample Exercise 3.20 Calculating the Theoretical Yield and the Percent Yield for a Reaction

Adipic acid, $H_2C_6H_8O_4$, is used to produce nylon. The acid is made commercially by a controlled reaction between cyclohexane (C_6H_{12}) and O_2:

$$2\ C_6H_{12}(l) + 5\ O_2(g) \rightarrow 2\ H_2C_6H_8O_4(l) + 2\ H_2O(g)$$

(a) Assume that you carry out this reaction starting with 25.0 g of cyclohexane and that cyclohexane is the limiting reactant. What is the theoretical yield of adipic acid?
(b) If you obtain 33.5 g of adipic acid from your reaction, what is the percent yield of adipic acid?

Practice Exercise

Imagine that you are working on ways to improve the process by which iron ore containing Fe_2O_3 is converted into iron. In your tests you carry out the following reaction on a small scale:

$$Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$$

(a) If you start with 150 g of Fe_2O_3 as the limiting reagent, what is the theoretical yield of Fe?

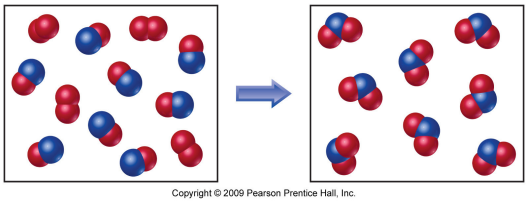
(b) If the actual yield of Fe in your test was 87.9 g, what was the percent yield?

Matter And Measurement

How many moles of oxygen gas are required to react completely with 1.0 mole NO?

2 NO (*g*) + O_2 (*g*) ⟶ 2 NO_2 (*g*)

1. 0.5 mol O_2
2. 1.0 mol O_2
3. 1.5 mol O_2
4. 2.0 mol O_2
5. 2.5 mol O_2

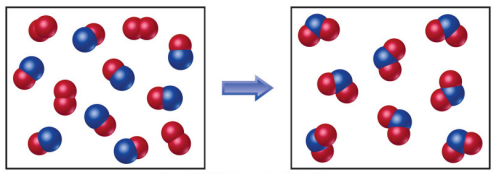


Matter And Measurement

If 10.0 moles of NO are reacted with 6.0 moles O_2, how many moles NO_2 are produced?

2 NO (*g*) + O_2 (*g*) ⟶ 2 NO_2 (*g*)

1. 2.0 mol NO_2
2. 6.0 mol NO_2
3. 10.0 mol NO_2
4. 16.0 mol NO_2
5. 32.0 mol NO_2

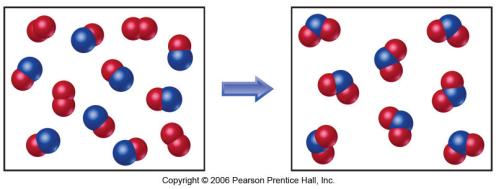


Matter And Measurement

If 10.0 moles of NO are reacted with 6.0 moles O_2, how many moles of the excess reagent remain?

2 NO (*g*) + O_2 (*g*) ⟶ 2 NO_2 (*g*)

1. 1.0 mol O_2
2. 5.0 mol O_2
3. 4.0 mol NO
4. 8.0 mol NO
5. None of the above



Matter And Measurement

Next Lecture

- Aqueous Reactions and Solution Stoichiometry
  - Chapter 4
    - focus on Sections 4.5, and 3.6