

Chapter 11 Part 2

Warm Up!

- Write and balance the reaction:

Ammonium nitrate decomposes to form dinitrogen monoxide and water.

- Write the mole ratio and calculate:

How many moles of water form from the decomposition of 3.2 moles of ammonium nitrate?

How many grams of water are produced?

Today's Agenda

- Question of the day: How do you determine which reagent is limiting the amount of product?
- Welcome back!
- Review stoichiometry problems
- Intro to limiting reagents
- Practice!
- Homework due WEDNESDAY: Ch 11 – 74, 75, 76, 78, 80, 81, 82 and finish worksheet.

Stoich Review!



How many grams of CH_4 are required to produce 30 g of HCl ? (list what's given and what you want)

- What do we do first? Convert to moles!

$$30 \text{ g HCl} \times \frac{1 \text{ mol}}{36.4 \text{ g HCl}} = 0.824 \text{ mol HCl}$$

- What's next? Mole ratio – use the coefficients (just big #'s)

$$0.824 \text{ mol HCl} \times \frac{1 \text{ mol CH}_4}{3 \text{ mol HCl}} = 0.275 \text{ mol CH}_4$$

Stoich Review!

- Okay last step: Convert moles of CH₄ to grams!

$$0.275 \text{ mol CH}_4 \times \frac{16 \text{ g CH}_4}{1 \text{ mol}} = 4.4 \text{ g CH}_4$$

Because of the coefficients of the balanced reaction we know that we
Only need 4.4 g of CH₄ to create 30 g of HCl product!

- How many grams of chloroform (CHCl₃) are produced? (list what's given and what you want)

Your Turn! Write balanced chem eqn 1st !

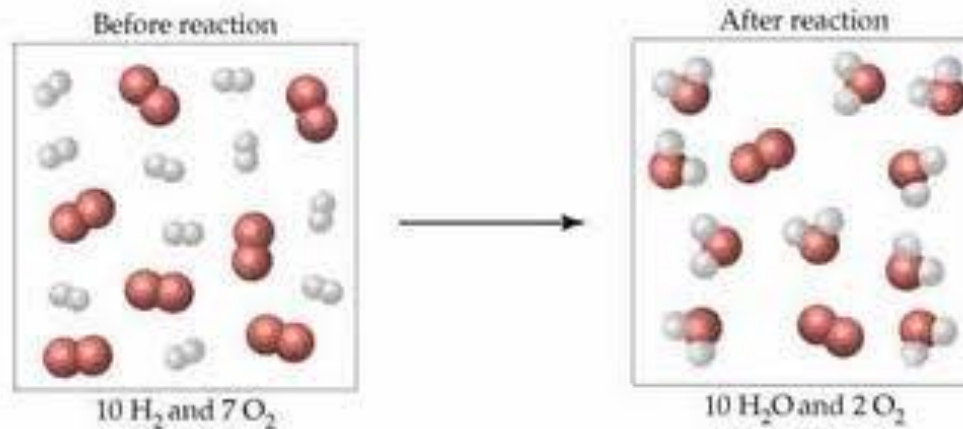
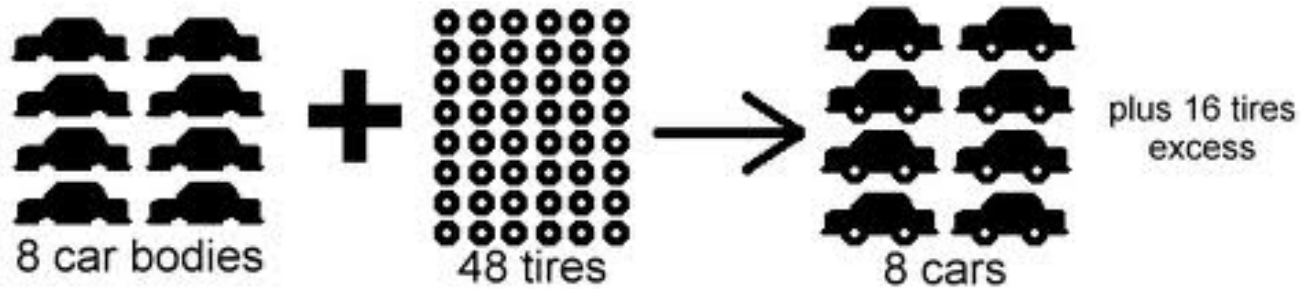
WRITE OUT STEPS!

- If 31 grams of water are produced when hydrochloric acid reacts with calcium hydroxide, how many grams of calcium hydroxide were used?

Limiting Reagents

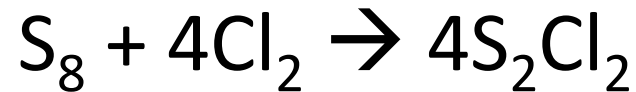
- The **limiting reagent** (reactant) limits the extent of the reaction, and determines the amount of product formed.
- Whichever reagent is supplied in the **least amount**. The trick is to remember the mole ratios!
- Any reactant left over is an **excess reagent**.

Limiting and Excess



Limiting Reagent Calculations

- Problem: Sulfur reacts with chlorine gas to produce disulfur dichloride according to the reaction:



If 200 g of sulfur reacts with 100 g of chlorine, which reagent is limiting?

What mass of disulfur dichloride is produced?

Pick out important info

- Chem eqn: $S_8 + 4Cl_2 \rightarrow 4S_2Cl_2$
- Given : 200 g S_8
100 g Cl_2
- Want : Limiting reagent?
 S_2Cl_2 g = ?

Find limiting reagent

- What do we always do first?! **Convert to moles!**

$$200 \text{ g S}_8 \times \frac{1 \text{ mol}}{256.5 \text{ g S}_8} = 0.7797 \text{ mol S}_8$$

$$100 \text{ g Cl}_2 \times \frac{1 \text{ mol}}{70.91 \text{ g Cl}_2} = 1.410 \text{ mol Cl}_2$$

- In the chemical eqn the ratio of Cl₂ to S₈ is 4:1

Determine the ratio given (divide by smallest moles)

$$1.410 \text{ mol Cl}_2 / 0.7797 \text{ mol S}_8 = 1.808 \text{ mol Cl}_2$$

$$0.7797 \text{ mol S}_8 / 0.7797 \text{ mol S}_8 = 1 \text{ mol S}_8$$

1.808 : 1 is less than 4 : 1 that we need so Cl₂ is limiting!

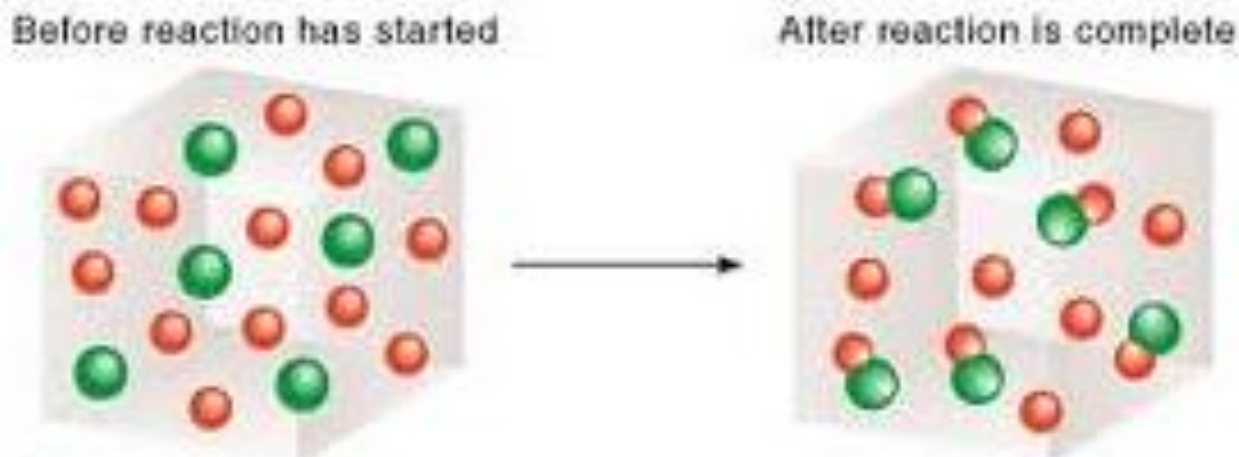
Now we need g of S₂Cl₂

- Use moles we found before : 1.410 mol Cl₂

$$1.410 \text{ mol Cl}_2 \times \frac{4 \text{ mol S}_2\text{Cl}_2}{4 \text{ mol Cl}_2} = 1.410 \text{ mol S}_2\text{Cl}_2$$

$$1.410 \text{ mol S}_2\text{Cl}_2 \times \frac{135 \text{ g S}_2\text{Cl}_2}{1 \text{ mol}} = 190.4 \text{ g S}_2\text{Cl}_2$$

Warm Up



- You have green molecules and red molecules, which is the limiting reactant? which is excess?
- If each circle = 1 mole...

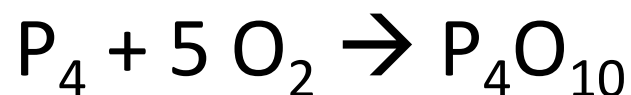
How many moles of product is made?

How many moles of the excess do you have?

Today's Agenda

- QOTD: How do you calculate the excess in a reaction and what is the percent yield?
- Limiting reagent problems
- Percent yield calculations
- Practice

Find limiting reagent



What is limiting if 25 g of P_4 reacts with 50 g of O_2 ?

How much of the excess is left over?

Find moles

Divide by least moles

Compare to balanced eqn

Limiting Reagent

- $25 \text{ g P}_4 \times \frac{1 \text{ mol}}{123.9 \text{ g P}_4} = 0.202 \text{ mol P}_4$
- $50 \text{ g O}_2 \times \frac{1 \text{ mol}}{32 \text{ g O}_2} = 1.56 \text{ mol O}_2$

$$0.202 \text{ mol P}_4 / 0.202 \text{ mol P}_4 = 1 \text{ mol P}_4$$

$$1.56 \text{ mol O}_2 / 0.202 \text{ mol O}_2 = 7.72 \text{ mol O}_2$$

7.72 : 1 is MORE than 5 : 1 that we need so P₄ is limiting!

How much O₂ left over?

- Since P₄ is limiting only 0.202 mol react with O₂.
- Do the mol conversion

$$0.202 \text{ mol P}_4 \times \frac{5 \text{ mol O}_2}{1 \text{ mol P}_4} = 1.01 \text{ mol O}_2$$

$$1.56 \text{ mol O}_2 - 1.01 \text{ mol O}_2 = 0.55 \text{ mol O}_2$$

What we started with what was used

Your Turn

- The reaction between solid sodium and iron (III) oxide is one of many involved in inflation of airbags.
- Balanced eqn: $6 \text{ Na} + \text{Fe}_2\text{O}_3 \rightarrow 3 \text{ Na}_2\text{O} + 2 \text{ Fe}$
- 100 grams of Na react with 100 grams of Fe_2O_3 .
- Which is limiting?
- Which is in excess? How much is left over?

Percent Yield

- You need to figure out how much product you can make with a certain amount of reactants.
- Theoretical yield – the maximum amount of product possible from a given amount of reactant.
- Actual yield – the amount of product produced in the experiment.

Percent Yield Calculations

- **Percent Yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$**

In these problems **you need to calculate theoretical yield**. You will be **given actual yield**.

Theoretical yield = amount of product formed
(which we already know how to find!)

Sample Problem

- Excess potassium chromate is added to a solution containing 0.50 g of silver nitrate.
- Determine the theoretical yield.
- Calculate the percent yield if the experiment is done and produces 0.455 g of silver chromate.

- We know the limiting reactant is silver nitrate so this will determine the amount of product!

Sample Problem

- Balanced chemical equation:



- How many g of Ag_2CrO_4 are produced from 0.5 g of AgNO_3 ?

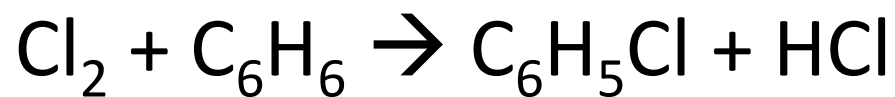
$$0.50 \text{ g AgNO}_3 \times \frac{1 \text{ mol AgNO}_3}{169.9 \text{ g AgNO}_3} \times \frac{1 \text{ mol Ag}_2\text{CrO}_4}{2 \text{ mol AgNO}_3} \times \frac{331.7 \text{ g Ag}_2\text{CrO}_4}{1 \text{ mol Ag}_2\text{CrO}_4} =$$

0.488 g Ag_2CrO_4 ← Theoretical yield!!

Sample Problem

- **Percent Yield = $\frac{\text{actual yield}}{\text{theoretical yield}} \times 100$**
- **% yield = $\frac{0.455 \text{ g Ag}_2\text{CrO}_4}{0.488 \text{ g Ag}_2\text{CrO}_4} \times 100 = 93.2 \%$ yield**

Warm Up!

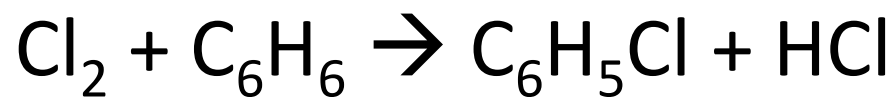


Which is limiting if 45 g of C_6H_6 reacts with 45 g of chlorine?

Today's Agenda

- QOTD: How do we put it all together to use the limiting reagent to find % yield
- Review of limiting reagents
- Review of % yield calculations
- Practice
- Homework Ch 11 - 83, 84, 90-94, 96, 97 and problems 6-10 of worksheet **DUE FRIDAY**
- **Quiz Friday – limiting reactants & % yield!**

Continuation of Warm Up!



Use answer to warm up!

What is the theoretical yield of $\text{C}_6\text{H}_5\text{Cl}$?

What is the percent yield if 55 g were actually collected?

Warm Up

Zinc reacts with iodine in a synthesis reaction to form zinc iodide.

- 1. Write the chemical equation
- 2. Determine the theoretical yield of zinc iodide if 1.912 mol of zinc is used and 10 mol of iodine is used.
- 3. Determine the % yield if 515.6 g of product is recovered.