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UNIT 7
QUANTITY RELATIONSHIPS IN
CHEMICAL REACTIONS
TOPICS FOR UNIT 7

- Stoichiometry
- Percent Yield
- Limiting Reactant Problems

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REVIEW: CHEMICAL
REACTIONS/EQUATIONS

Reactants: $\text{Zn} + \text{I}_2$ \longrightarrow Product: Zn I_2

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Chemical Equations

stoichiometric coefficients
 $2 \text{Al}(s) + 3 \text{Br}_2(l) \longrightarrow \text{Al}_2\text{Br}_6(s)$
This equation means

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Hold Onto Your Hat!

As fascinating as it was to find out we could measure out 27.0 grams of aluminum and know it was exactly 6.02×10^{23} atoms of aluminum, we can go a lot farther!


Before we even let those fascinating elements and compounds meet, we can predict how they are going to react! **WOW!**

- We can determine how many elements and compounds will be produced in a chemical reaction! **WOW!**
- We can determine how many elements and compounds we need, based upon the amount of product produced. **WOW!**
- How **WONDERFUL!!** This is **STOICHIOMETRY!!**

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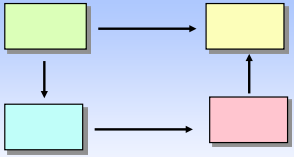
STOICHIOMETRY

STOICHIOMETRY is a term to describe calculations based upon a balanced equation involving quantities of substances entering into a chemical reaction.



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GENERAL PLAN FOR STOICHIOMETRY CALCULATIONS

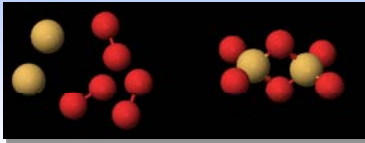


Note: The stoichiometric coefficients in a balanced equation give the relative numbers of atoms, or molecules, or the number of moles of each substance reacting.

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STOICHIOMETRY

It rests on the principle of the **conservation of matter**.



$2 \text{Al}(s) + 3 \text{Br}_2(l) \rightarrow \text{Al}_2\text{Br}_6(s)$


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**STOICHIOMETRY
MOLES TO MOLES**

A reaction with iron oxide:

$\text{Fe}_2\text{O}_3(s) + 3 \text{H}_2(g) \rightarrow 2 \text{Fe}(s) + 3 \text{H}_2\text{O}(l)$

- The chemical equation indicates:




How many moles of hydrogen are needed to react to produce 15.65 moles of iron?

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**STOICHIOMETRY
MASS TO MASS**

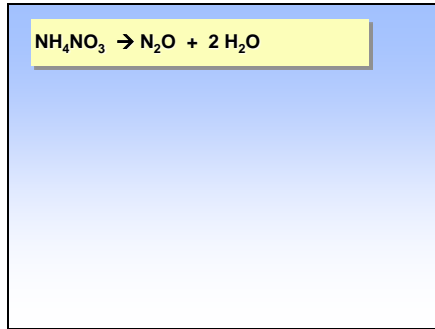
PROBLEM: If 454 g of NH_4NO_3 decomposes into N_2O and H_2O . What is the mass of H_2O produced?



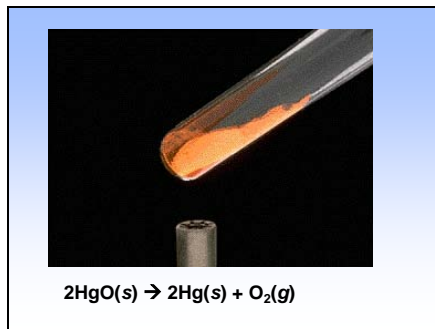
Write the balanced chemical equation

$\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} + 2 \text{H}_2\text{O}$

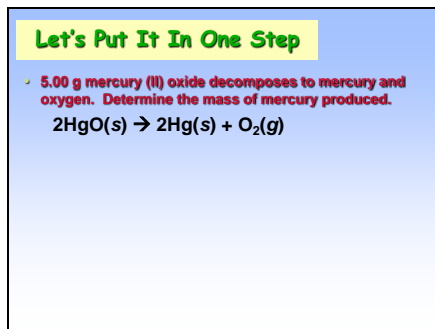
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Theoretical and Percent Yield

- The **percent yield** tells the efficiency of the reaction.
- The **actual yield** is the amount of product really obtained (by experiment).
- The **theoretical** is the amount of product that should be obtained (by calculation).


$$\% \text{Yield} = \frac{\text{actual yield}}{\text{theoretical yield}} \times 100\%$$

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A Little History to illustrate a reaction of incandescent light bulbs.



It's a little known fact that if Lewis Latimer hadn't been on Thomas Edison's team (the only African American) that the light bulb might have been too impractical for most people to use. You see, Edison's light bulb used bamboo as the filament and the light bulb burned out after only 30 hours. Carbon lasted much longer and made the light bulb practical. Latimer, with Joseph V. Nichols, came up with both idea to use carbon filaments and the process for manufacturing the carbon filaments.



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**Incandescent Bulb Filaments
A Limiting Reactant Problem**

At present, tungsten metal, W is used to make incandescent bulb filaments. The metal is separated out of yellow tungsten(VI) oxide, WO_3 , by reacting with hydrogen according to the following reaction:

$$\text{WO}_3 + 3 \text{H}_2 \rightarrow \text{W} + 3 \text{H}_2\text{O}$$

If 2.76 grams of W is experimentally obtained from the reaction between 15.8 grams of WO_3 and excess of H_2 , calculate the percent yield obtained from the reaction.


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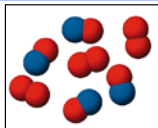
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**Reactions Involving a
LIMITING REACTANT** 

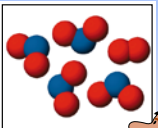
In our age of environmental awareness, we try to minimize our waste production. The same is true in chemical processes. We learned with stoichiometry that we could determine the exact amount of product that will be produced when using a known amount of reactant. Well, we've seen in many chemical reactions, that often more than one reactant is used. How can we minimize using too much of our reactants to produce a certain amount of product?

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LIMITING REACTANTS




Reactants



Products

$2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$

Limiting reactant = _____
Excess reactant = _____



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$2 \text{NO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2 \text{NO}_2(\text{g})$

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Steps for Calculating Limiting Reactant

The steps involved:
 $A + B \rightarrow C$

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Remember the Following for Limiting Reactant

- The reaction will stop when the reactants are used up.
- If one reactant is used up before the other, the reaction will stop.
- The first reactant used up is the **LIMITING REACTANT**, use it for the calculation.
- The other reactant is the **EXCESS REACTANT**.

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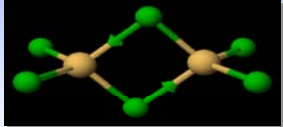
LIMITING REACTANTS

0.100 mol solid Zn react with
0.100 mol HCl (aq)
 $Zn + 2 HCl \rightarrow ZnCl_2 + H_2$
Determine the L.R. and E.R.



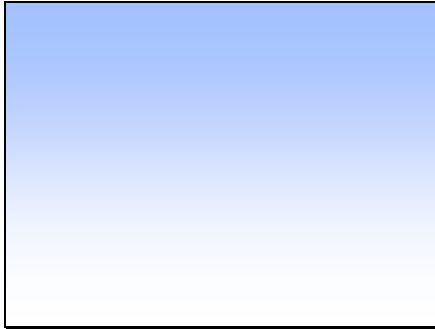
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Reaction to be Studied

$$2 Al + 3 Cl_2 \rightarrow Al_2Cl_6$$


PROBLEM: Mix 5.40 g of Al with 8.10 g of Cl_2 . What mass of Al_2Cl_6 can form?


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How much of excess reactant will remain when reaction is complete?

- Cl_2 was the limiting reactant. Therefore, Al was present in excess. But how much?
- First find how much Al was required.
- Then find how much Al is in excess.



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