

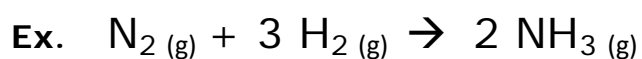
## ***Stoichiometry***

Stoichiometry (greek): **Stoicheion** – element, **metry** – to measure

Balanced Chemical equation:

Skills            –formula writing  
                      –balancing equations

Tells             –substances involved in the chemical rxn  
                      –relationship between the # of particles of each substance



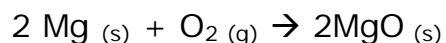
1 molecule  $\text{N}_2$  + 3 molecules of  $\text{H}_2 \rightarrow$  2 molecules of  $\text{NH}_3$

Or... 1 mole  $\text{N}_2$  + 3 moles of  $\text{H}_2 \rightarrow$  2 moles of  $\text{NH}_3$

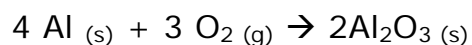
If we use 2 moles of  $\text{N}_2$  we could make 4 moles of  $\text{NH}_3$

Equation:  $2 \text{ mol N}_2 \left( \frac{2 \text{ mol NH}_3}{1 \text{ mol N}_2} \right) = 4 \text{ mol NH}_3$

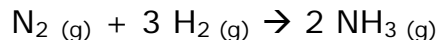
**Ex.** How many moles of oxygen gas are required to produce 5.0 moles of  $\text{MgO}$  when  $\text{Mg}_{(\text{s})}$  undergoes combustion?



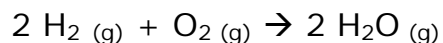
**Ex.** Aluminum metal will undergo combustion in  $\text{O}_2(\text{g})$  How many moles of aluminum oxide would be produced from 3.70 moles of aluminum?



**Ex.** How many moles of ammonia are produced when you react 12 grams of hydrogen gas with an excess of nitrogen gas?



**Ex.** How many grams of hydrogen gas are required to burn with 24.0 grams of oxygen when making water by combustion?



## **Reactions involving a Limiting Reactant**

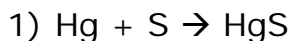
When chemicals are mixed together in reactions there are two possibilities:

- a) Stoichiometric quantities: exactly correct amounts used, so each reactant runs out at the same time (not too likely)
- b) One or more reactants are in excess: more of one reactant than is required, the reaction will proceed until the limiting reactant is all used up

## Steps to Follow

- 1) Write and balance the equation for the reaction
- 2) Convert known masses of substances into moles
- 3) Calculate the theoretical number of moles of a product that each of the reactants could form
- 4) Take the smaller amount to be your limiting reactant
- 5) Solve for final units (grams, concentration, etc...)

**Ex.** If 75.0g of mercury react with 50.0g of sulphur, how much HgS will be produced?



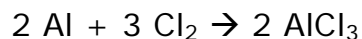
2)

3)

4) So mercury only gives 0.374 mol of product, to sulphur 1.56 mol of product, and therefore mercury is the limiting reagent. Now you know that 0.374 mol of HgS will be produced

5) So just calculate the amount of HgS produced.

**Ex.** If 15.5g of aluminum react with 46.7g of chlorine how much aluminum chloride will be produced?



So because  $\text{Cl}_2$  produces less aluminum chloride it's the limiting reactant! And only 0.439 moles of  $\text{AlCl}_3$  can be produced.

**Ex.** How many grams of solid aluminum oxide are produced if 270g of aluminum are combined with 256g of oxygen gas?

Aluminum is limiting so...

### **Amount of excess**

How many liters of Oxygen are left over from the above question?

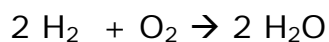
*Moles of reactant – moles required for reaction = moles remaining (excess)*

## Percent Yield

Actual experimental results rarely follow theory (due to side reactions, and impurities, and experimental error etc...) percent yield is a measure of how efficient a particular chemical reaction is in practice.

$$\% \text{ Yield} = \frac{\text{actual yield (usually given in question)}}{\text{theoretical yield (calculated)}} \times 100\%$$

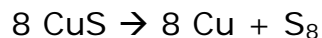
**Ex.** If 4.0g of hydrogen gas are burned in excess oxygen and 32.0g of water are produced, what is the yield?



## Percent Composition

Very similar to % yield, but is concerned with percentage of active ingredient in a sample; such as the % acetic acid in vinegar, or % of Al in bauxite ore.

**Ex.** Calculate the % composition of copper metal in covellite (CuS) if 37.0kg sample of covellite yields 22.2kg of copper?

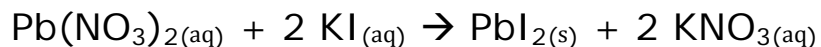


## Stoich problems with Solutions

Recall:  $M = n/V$  and  $n = M \times V$

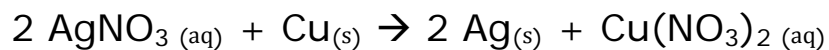
Where  $M$  = molarity,  $n$  = number of moles,  $V$  = volume

**Ex.** 100.0 mL of 0.50 M  $\text{Pb}(\text{NO}_3)_2$  are mixed with 100.0 mL of 0.50 M KI. How much  $\text{PbI}_2$  is precipitated? (assume  $\text{PbI}_2$  is totally insoluble)



Since KI produces less it's the limiting reactant...

**Ex.** How many grams of copper will react to completely replace the silver from 208 mL of a 0.100M solution of silver nitrate?

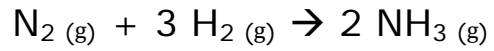


Here, we can assume that silver is the limiting reactant because it asks how much copper is needed

## Stoich problems with Gases

Recall: 1 mole of any gas at STP has a volume of 22.4L

**Ex.** 33.6 L of N<sub>2</sub> gas reacts with 44.8 L of H<sub>2</sub> gas. What volume of NH<sub>3</sub> will be produced at STP?



Since H<sub>2</sub> produces less it's the limiting reactant...