

If Sally has  $4.56 \times 10^{34}$  atoms of oxygen in a sample of aluminum oxide, how many kilograms of aluminum does she have?

$$\frac{4.56 \times 10^{34} \text{ atoms O}}{6.022 \times 10^{23} \text{ atoms O}} \times \frac{1 \text{ mol O}}{3 \text{ mol O}} \times \frac{2 \text{ mol Al}}{1 \text{ mol Al}} \times \frac{26.98 \text{ g}}{1000 \text{ g}} \times \frac{1 \text{ kg}}{1000 \text{ g}}$$



Bertha has .025 milligrams of sodium that she got from a sample of Sodium phosphate, How many atoms of oxygen does she have?

$$\frac{.025 \text{ mg Na}}{1000 \text{ mg Na}} \times \frac{1 \text{ g Na}}{22.99 \text{ g Na}} \times \frac{1 \text{ mol Na}}{3 \text{ mol Na}} \times \frac{4 \text{ mol O}}{1 \text{ mol O}} \times 6.022 \times 10^{23} \text{ atoms O}$$



Feb 25-9:32 AM

Hubert found that a sample of ammonium nitrate has 23 grams of nitrogen in it. What is the mass of hydrogen in the sample?

Clara-bell has a chemical analysis of a sample containing 72.1% Strontium, 26.3 % oxygen and 1.65% hydrogen. If she found that there were  $3.4 \times 10^{12}$  grams of hydrogen, how many grams of oxygen was there?

Feb 25-9:57 AM

# Stoichiometry

The quantitative relationships between the amounts of reactants used and the amounts of products formed by a chemical reaction

Based on the law of conservation of matter

Mar 1-11:30 AM

# Stoichiometry

What you need to know:

- How to balance chemical equations
- How to convert Moles to Grams using Molar Mass
- How to use Mole Ratios

Mar 2-1:03 PM

## Mole Ratios

Ratio--A relationship between two numbers of the same kind

We can determine the ratio for elements in a compound by using the subscripts in the compound



Ratios:

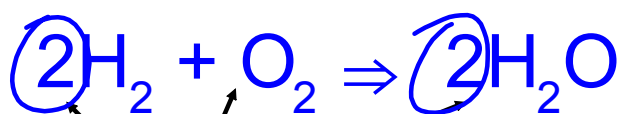
- 2 Irons for 3 Carbons
- 2 Irons for 9 oxygen
- 3 carbon for 9 oxygen

Mar 2-1:16 PM

## Mole Ratios

coefficients = moles

Let's looking at the following reaction:



Use the coefficients of the balanced chemical reaction to determine the mole ratios

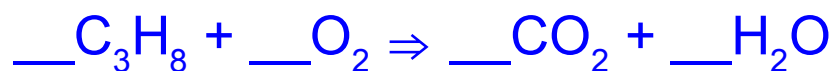
Ratios:

- 2 Hydrogen for 1 Oxygen
- 2 Hydrogen for 2 Water
- 1 Oxygen for 2 Water

Mar 2-1:06 PM

## Mole Ratios

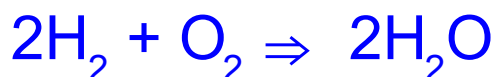
Determine the mole ratio for each of substance in the following reactions



Mar 2-1:12 PM

## Mole Ratios

Knowing the mole ratios in reactions will allow us to do some basic stoichiometry calculations



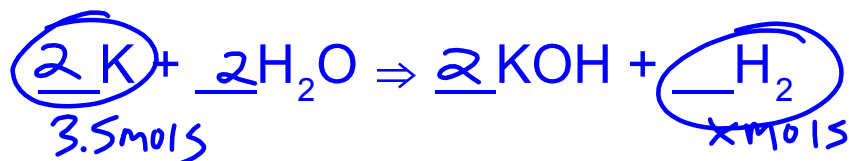
If we have 5 moles of hydrogen reacting, how many moles of water are formed?

$$\frac{5 \text{ moles H}_2}{\text{The Amount Given}} \left| \frac{2 \text{ moles H}_2\text{O}}{2 \text{ moles H}_2} \right. = 5 \text{ moles H}_2\text{O}$$

Mole ratio between the two compounds in the problem

Mar 2-1:16 PM

## Stoichiometry



If there are 3.5 moles of Potassium reacting, how many moles of hydrogen are formed?

$$\frac{3.5 \text{ moles K} \mid 1 \text{ mol H}_2}{2 \text{ mol K}} = 1.8 \text{ mol H}_2$$

Mar 2-1:30 PM

## Practice Problems

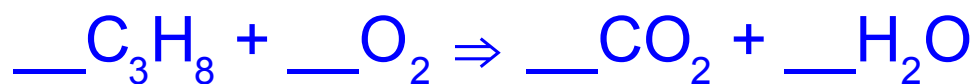


If you only had 0.45 moles of Fe how many moles of  $\text{Fe}_2\text{O}_3$  would you produce?

form the above amount of Fe, how many moles of  $\text{O}_2$  were used?

Mar 2-1:43 PM

## Practice Problems



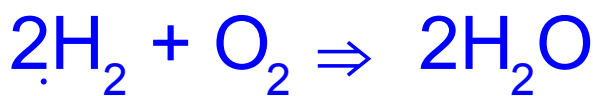
If 7.8 moles of  $\text{O}_2$  are used how much  $\text{C}_3\text{H}_8$  was also used?

How many moles of  $\text{CO}_2$  were produced for this amount of oxygen?

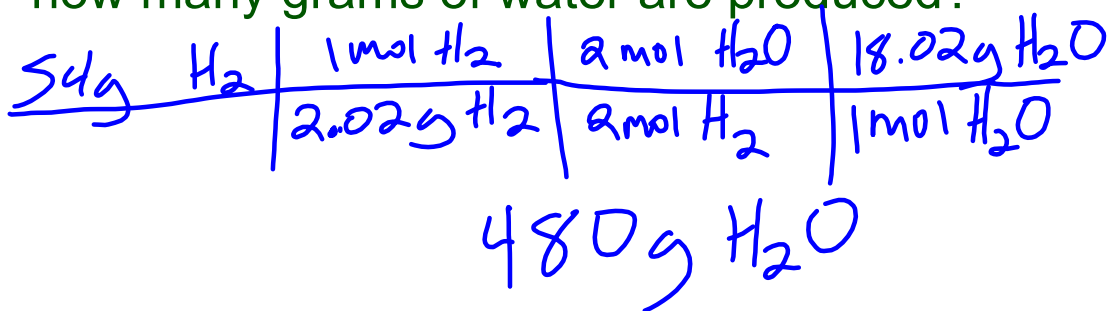
Mar 2-1:45 PM

## Stoichiometry

-We will take this further by adding in calculations from moles to grams



If we start with 54 grams of Hydrogen gas, how many grams of water are produced?



Mar 2-2:03 PM

$$2\text{H}_2 + \text{O}_2 \Rightarrow 2\text{H}_2\text{O}$$

54g H <sub>2</sub>	1 Mole H <sub>2</sub>	2 Moles H <sub>2</sub> O	18g H <sub>2</sub> O
	2g H <sub>2</sub>	2 moles H <sub>2</sub>	1 Mole H <sub>2</sub> O

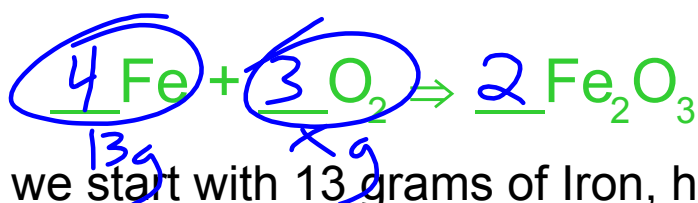
"What you want"

1. Given      2. Molar mass of H<sub>2</sub>      3. Mole ratio      4. Molar Mass of H<sub>2</sub>O

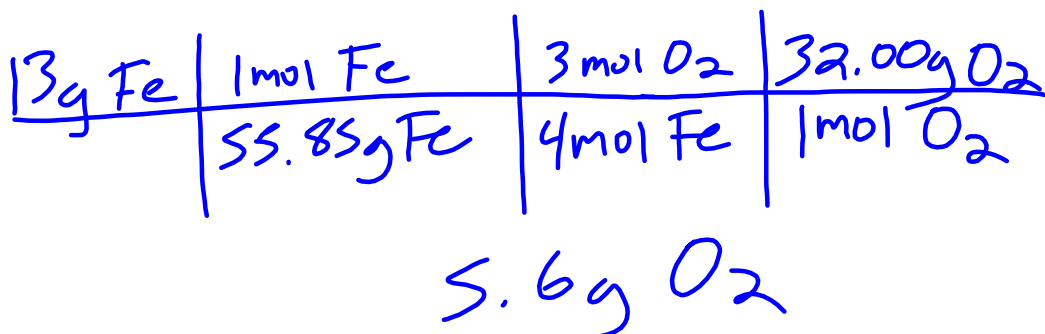
1. Write your given.
2. Write the molar mass of what you are given.
3. Write the mole ratio of what you are given to what you want.
4. Write the molar mass of what you want.
5. Cross out, multiply and divide!

Mar 8-7:59 AM

## Practice Problems



If we start with 13 grams of Iron, how many grams of Oxygen are needed to react?



Mar 2-2:11 PM

## Practice Problems



If 456 grams of calcium chloride are produced, how many grams of hydrochloric acid reacted?

Mar 2-2:13 PM

## Challenge Problems

Zinc metal is refined from Zinc (II) Sulfide. When Zinc (II) sulfide is heated it will react with oxygen to form Zinc (II) oxide and Sulfur Dioxide. The Zinc (II) Oxide is then reacted with carbon to form zinc vapor and carbon monoxide gas. The zinc vapor is then collected and cooled into solid zinc. If a company produces 225 grams of Zinc daily, how many grams of Zinc (II) sulfide do they start with each day?

Mar 2-1:48 PM



**Warm-up:**

**A.** Write and balance the following equation:

Titanium (II) oxide reacts with lithium to produce lithium oxide and titanium.

**B.** What are all the mole ratios?

**C.** If I have 2.50 moles of lithium, how many moles of lithium oxide would be produced?

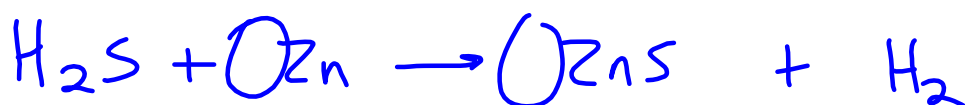
**D.** If  $2.5 \times 10^4$  mg of titanium was produced, how many grams of titanium (II) oxide was used?

Mar 6-10:15 AM

If 3.67 kg of lithium chlorate are produced from the reaction of lithium oxide and aluminum chlorate, how many grams of lithium oxide did the reaction start with?

Mar 5-2:07 PM

Hydrosulfuric acid reacts with zinc to produce zinc sulfide and hydrogen gas



How many grams zinc sulfide would be produced with 56 grams of zinc

<u>56g Zn</u>	1 mol Zn	1 mol ZnS	97.47g ZnS
	65.40g Zn	1 mol Zn	1 mol ZnS
83g ZnS			

Mar 8-9:21 AM

## Warm up

Calcium hydroxide reacts with hydrochloric acid to form water and calcium chloride.



-If there are 5.00 grams of calcium hydroxide, how many grams of H<sub>2</sub>O will be formed?

<u>5.00g Ca(OH)<sub>2</sub></u>	1 mol Ca(OH) <sub>2</sub>	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O
	74.08g Ca(OH) <sub>2</sub>	1 mol Ca(OH) <sub>2</sub>	1 mol H <sub>2</sub> O
2.43g H <sub>2</sub> O			

-If there are 10.00 grams of HCl, how many grams of H<sub>2</sub>O will be formed?

<u>10.00g HCl</u>	1 mol HCl	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O
	36.45g HCl	2 mol HCl	1 mol H <sub>2</sub> O
4.94g H <sub>2</sub> O			

Mar 2-2:19 PM

## Limiting Reactants

Limits the extent of the reaction, determining the amount of product that will be formed

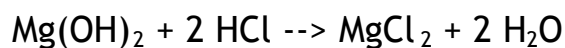
- Excess reactants are reactants that are left over when a reaction stops (when all the limiting reactant is used up)

Mar 2-2:21 PM

The first step in solving a limiting reactant problem is being able to recognize that you have a limiting reactant problem.

Suppose you were given the following problem:

A 50.6 g sample of magnesium hydroxide is reacted with 45.0 g of hydrochloric acid according to the reaction:



What is the theoretical yield of  $\text{MgCl}_2$ ?

Mar 20-9:40 AM

Notice in this problem that there are only amounts of reactants given and Two values are given. **This is a limiting reactant problem.**

In order to find out which reactant is the limiting reactant, you have to compare the amount of ONE product produced by EACH reactant.

2. This comparison can be done in moles or grams of the PRODUCT

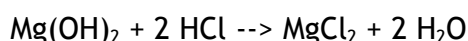
3. Therefore, the next step will be to convert the grams of each reactants to moles

4. The convert the moles of each reactant to the SAME PRODUCT

5. Compare the amounts. Whichever REACTANT produced the LEAST amount of product is the LIMITING REACTANT and the other is the EXCESS REACTANT. The smallest amount of product formed is the THEORETICAL YIELD for that product.

Mar 20-10:33 AM

A 50.6 g sample of magnesium hydroxide is reacted with 45.0 g of hydrochloric acid according to the reaction:



	convert to moles	mole ratio of product	
50.6 g Mg(OH) <sub>2</sub>	1 mol Mg(OH) <sub>2</sub>	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O
	58 g Mg(OH) <sub>2</sub>	1 mol Mg(OH) <sub>2</sub>	1 mol H <sub>2</sub> O

31.4 g H<sub>2</sub>O

45.0 g HCl	1 mol HCl	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O
	36 g HCl	2 mol HCl	1 mol H <sub>2</sub> O

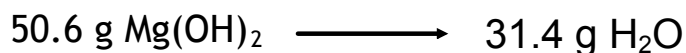
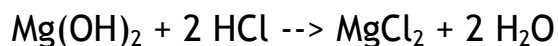
22.5 g H<sub>2</sub>O

Whichever number is **greater** is the **excess** (Magnesium hydroxide); the **lesser** is the **limiting reactant** (Hydrochloric acid).

**Water** is NOT the limiting reactant (It is not even a reactant!!!)

Mar 20-10:41 AM

A 50.6 g sample of magnesium hydroxide is reacted with 45.0 g of hydrochloric acid according to the reaction:



How much of the Excess Reactant was left over?

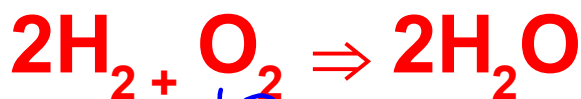
45.0 g HCl	1 mol HCl	1 mol Mg(OH) <sub>2</sub>	58g Mg(OH) <sub>2</sub>
	36 g HCl	2 mol HCl	1 mol H <sub>2</sub> O

36.3g Mg(OH)<sub>2</sub> was USED

$$50.6 - 36.3 = 14.3 \text{ grams } \underline{\text{LEFT OVER}}$$

Mar 20-10:41 AM

## Stoichiometry



Determine the limiting reactant. How much water is formed? How much of the excess was left over?

3.00 grams of H<sub>2</sub> and 5.00 grams of O<sub>2</sub>

3.00g H <sub>2</sub>	1 mol H <sub>2</sub>	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O	= 26.8g H <sub>2</sub> O
	2.02g H <sub>2</sub>	2 mol H <sub>2</sub>	1 mol H <sub>2</sub> O	
5.00g O <sub>2</sub>	1 mol O <sub>2</sub>	2 mol H <sub>2</sub> O	18.02g H <sub>2</sub> O	= 5.63g H <sub>2</sub> O
	32.00g O <sub>2</sub>	1 mol O <sub>2</sub>	1 mol H <sub>2</sub> O	

LR → O<sub>2</sub>

Mar 2-2:28 PM

## Practice Problems

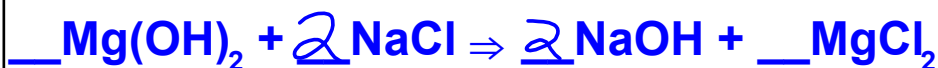


Determine the limiting reactant. How much Disulfur dichloride is formed? How much of the excess was left over?

If you have 2.5 grams of  $\text{S}_8$  and 1.2 grams of  $\text{Cl}_2$

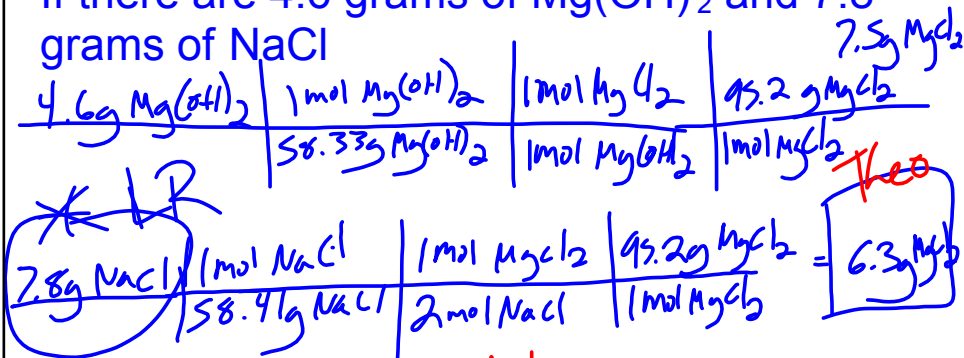
Mar 2-2:22 PM

## Practice Problems



Determine the limiting reactant. How much magnesium chloride is formed? How much of the excess was left over?

If there are 4.6 grams of  $\text{Mg(OH)}_2$  and 7.8 grams of  $\text{NaCl}$



Sally measure <sup>Act</sup> 5.2g  $\text{MgCl}_2$

$$\frac{5.2}{6.3} \times 100 = 83\%$$

Mar 2-2:27 PM

21.5 grams of lithium oxide is added to 31.6 grams of copper (III) nitrate.

-Balanced chemical equation



-what is the limiting reactant

-how much of copper (III) oxide is formed

-How much of the excess reactant used

-How much of the excess reactant is left over

-if 10.2 grams of copper (II) oxide is formed, what is the % yield

Mar 6-8:30 AM

## Percent Yield

-this is a measurement of the efficiency of a chemical reaction

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

**Actual Yield** is how much product is actually measured at the end of the reaction

**Theoretical Yield** is how much product was calculated to be formed from the beginning amounts of the reactants

Mar 2-2:29 PM

## Practice Problems



Determine which reactant is the limiting reactant and how many grams of  $\text{MgCl}_2$  will be formed from it.

If there are 4.6 grams of  $\text{Mg(OH)}_2$  and 7.8 grams of  $\text{NaCl}$

What is the percent yield if only 5.78 grams of  $\text{MgCl}_2$  was collected at the end of the experiment?

$$\frac{5.78}{6.3} \times 100 = 92\%$$

Mar 2-2:30 PM

### Warm-up:



Determine which reactant is the limiting reactant and how many grams of  $\text{LiCl}$  will be formed from it.

If there are 4.6 grams of  $\text{LiOH}$  and 7.8 grams of  $\text{NaCl}$

What is the percent yield if only 5.78 grams of  $\text{LiCl}$  was collected at the end of the experiment?

Mar 14-11:30 AM



**Warm-up:**

**A.** Write and balance the following equation:  
ammonium carbonate reacts with beryllium chloride to produce ammonium chloride and beryllium carbonate.

**B.** What are all the mole ratios?

**C.** If I have 2.50 moles of beryllium chloride, how many moles of ammonium chloride would be produced?

**D.** If 17 moles of beryllium carbonate was produced, how many moles of ammonium carbonate were used?

Mar 6-10:15 AM

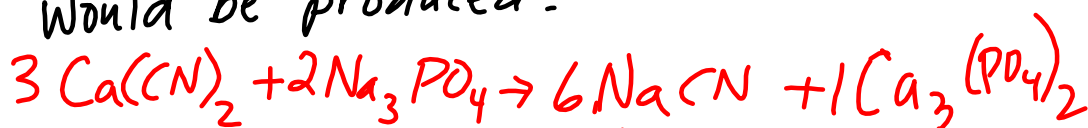
**Warm-up:**

**A.** Write and balance the following equation:  
ammonium carbonate reacts with beryllium chloride to produce ammonium chloride and beryllium carbonate.

**B.** If I have 3.705 grams of beryllium chloride, how much mass of ammonium chloride would be produced?

Mar 6-10:15 AM

If 3.6 g of  $\text{Ca}(\text{CN})_2$  reacted with 3.6 g of  $\text{Na}_3\text{PO}_4$  how much product would be produced?



3.6 g $\text{Ca}(\text{CN})_2$	1 $\text{Ca}(\text{CN})_2$ mol	6 $\text{NaCN}$ mol	49 $\text{NaCN}$ g = 3.8 g
	92 $\text{Ca}(\text{CN})_2$ g	310 $\text{Ca}(\text{CN})_2$ mol	1 $\text{NaCN}$ mol
3.6 $\text{Na}_3\text{PO}_4$	1 mol	1 $\text{Ca}_3(\text{PO}_4)_2$ mol	
	164 $\text{Na}_3\text{PO}_4$ g	2	

3.4 g  $\text{Ca}_3(\text{PO}_4)_2$ 
NaCN 3.2 g

Feb 26-9:15 AM

obtained  
 3.00 g  $\text{Ca}_3(\text{PO}_4)_2$  ← actual yield

What is my percent yield?

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

Mar 1-11:55 AM

35.6g NaCl is add to .358L  
of H<sub>2</sub>O. What is the M

$$\frac{35.6 \text{ g NaCl} \left| \begin{array}{l} 1 \text{ mol} \\ 58.5 \text{ g} \end{array} \right.}{58.5 \text{ g}} = \frac{0.609 \text{ mol}}{.358 \text{ L}}$$

1.70 M NaCl

Mar 12-1:45 PM

You want to Make 50.0mL of a  
0.25M solution of NaCl,  
How Much NaCl do you Need?

$$\frac{\text{mols}}{\text{L}} \times \text{L} \rightarrow \frac{.25 \text{ mols}}{\text{L}} \times .05 \text{ L}$$

↓

.0125 mols NaCl

$$\frac{.0125 \text{ mols NaCl} \left| \begin{array}{l} 58.5 \text{ g} \\ 1 \text{ mol NaCl} \end{array} \right.}{1 \text{ mol NaCl}} = 0.731 \text{ g NaCl}$$

Mar 12-2:18 PM

$$M_1 V_1 = M_2 V_2$$



$$(0.125M)(500mL) = (18M)(V_2)$$

$$V_2 = 3.47mL \ HNO_3$$

Mar 12-2:23 PM

Mar 10-7:44 AM