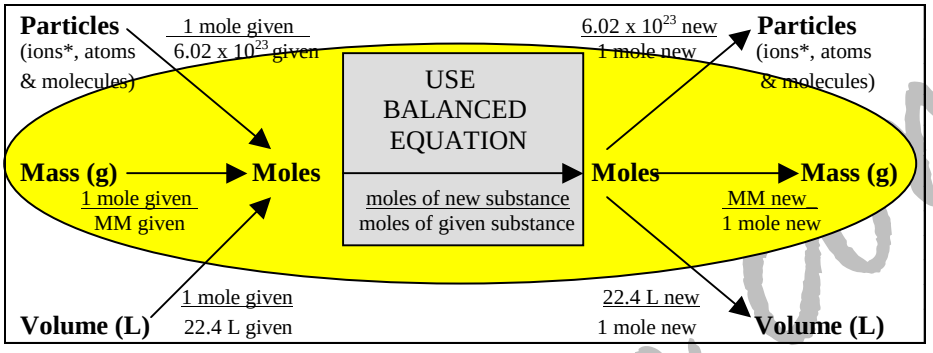
NAME CHEMISTRY ___/___/___

MASS-TO-MASS PROBLEMS

Since moles are not a practical unit of measurement in the lab, we must be able to convert our mole values to mass, something we can easily measure in a lab. Today we will branch out in both directions and look at mass-to-mass problems.

Look at the chart below and find the word **Mass** on the left side of the chart. This will be our starting point for all problems in which you are **GIVEN Mass**. Now, find the word Mass on the right side of the chart. This will be the ending point for all problems in which you are asked to **FIND Mass**. Now if we trace our path from the Mass on the left to the Mass on the right, you will see we will have to go Mass → Moles → Moles → Mass. And, since there are 4 bold terms as we go from Mass → Mass, our problems will have 4 steps



Lets use the example below to understand the steps in a mass → mass problem.

Example #1: Ammonia, NH_3, is produced through the synthesis of nitrogen and hydrogen. If Michelle is given 8.35 grams of hydrogen and excess nitrogen, how many grams of ammonia can she produce?

Step 1: **Write the balanced equation.**
$N_2 + 3H_2 \rightarrow 2NH_3$

Note: Although ammonia was mentioned first in the example, it is still our product because the sentence says it is *produced* through the *synthesis* of nitrogen and hydrogen. Synthesis problems are element + element → compound.

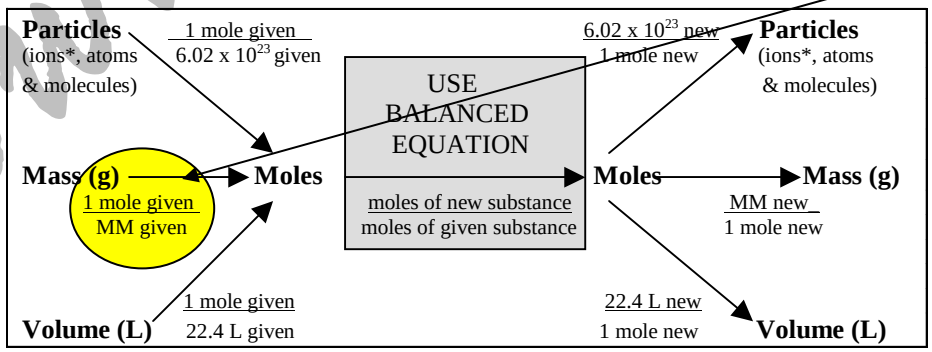
Step 2: **Determine what is given.**
GIVEN: 8.35 grams of H_2

Step 3: **Determine what you are asked to find.**
FIND: grams of NH_3

Step 4: **Write the GIVEN value over 1. ALL STOICHIOMETRY PROBLEMS BEGIN BY PUTTING THE GIVEN OVER 1.**

$$\frac{8.35 \text{ grams of } H_2}{1}$$

Step 5: **Note that when going from Mass to Moles on our chart the following is written:** $\left(\frac{\textbf{1mole given}}{\textbf{MM given}}\right)$



That tells us that when going from Mass to Moles we must multiply our ratio by 1 mole of the given substance and divide by its Molar Mass. So, lets calculate the Molar Mass of 1 mole of H_2

Molar Mass of 1 mole of H_2:
H: 2 x 1.0 = **2.0 grams**

Now lets add this step to our problem.

$$\frac{8.35 \text{ grams of } H_2}{1} \times \frac{1 \text{mole } H_2}{2.0 \text{ grams of } H_2}$$

Note: I added the H_2 to the end because we must identify which molecule we are using. Just as before, we can cancel words. So lets cross out "**grams of H_2**" on the top and bottom. This is an important step that not only tells you that you are setting up the problem correctly but also means your answer will have the correct units.

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{mole } H_2}{2.0 \text{ ~~grams of } H_2~~}$$

Step 6: Since we are now going from Moles to Moles, refer to your chart and note that you must USE YOUR BALANCED EQUATION and put the moles of the new substance over moles of the given substance.

$N_2 + 3H_2 \rightarrow 2NH_3$

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{mole } H_2}{2.0 \text{ ~~grams of } H_2~~} \times \frac{2 \text{ moles of } NH_3}{3 \text{ moles of } H_2}$$

Again, notice I can cancel out the words "**mole of H_2**". So I'm going to do just that. See below.

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{~~mole } H_2~~}{2.0 \text{ ~~grams of } H_2~~} \times \frac{2 \text{ moles of } NH_3}{3 \text{ ~~moles of } H_2~~}$$

Step 7: Now we are going from Moles to Mass. In this step the chart tells us we must multiply by the following: $\left(\frac{\text{MM new}}{\text{1 mole new}}\right)$

This time we must find the Molar Mass of NH_3, since that is the molecule we are currently using.
NH_3 Molar Mass:
N: 1 x 14.0 = 14.0
H: 3 x 1.0 = 3.0
17.0 grams

Lets add this step to the problem.

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{~~mole } H_2~~}{2.0 \text{ ~~grams of } H_2~~} \times \frac{2 \text{ moles of } NH_3}{3 \text{ ~~moles of } H_2~~} \times \frac{17.0 \text{ grams of } NH_3}{1 \text{ mole of } NH_3}$$

Once again we can cancel out terms. This time we will cross out "**moles of NH_3**". See below.

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{~~mole } H_2~~}{2.0 \text{ ~~grams of } H_2~~} \times \frac{2 \text{ ~~moles of } NH_3~~}{3 \text{ ~~moles of } H_2~~} \times \frac{17.0 \text{ grams of } NH_3}{1 \text{ ~~mole of } NH_3~~}$$

Earlier, we predicted 4 steps. Note that we have done 4 steps. We made it from mass-to-mass!!! On to step 8.

Step 8: Multiply across the top, multiply across the bottom. Divide and write your answer with the proper units.

$$\frac{8.35 \text{ ~~grams of } H_2~~}{1} \times \frac{1 \text{~~mole } H_2~~}{2.0 \text{ ~~grams of } H_2~~} \times \frac{2 \text{ ~~moles of } NH_3~~}{3 \text{ ~~moles of } H_2~~} \times \frac{17.0 \text{ grams of } NH_3}{1 \text{ ~~mole of } NH_3~~} = \frac{283.9}{6.0} = \boxed{\textbf{47.3 grams of } NH_3}$$

Summary of how to do a mass-to-mass problem:

$$\frac{\text{GIVEN}}{1} \times \frac{\text{1 mole of given substance}}{\text{Molar Mass of given substance}} \times \frac{\text{moles of new substance from equation}}{\text{moles of given substance from equation}} \times \frac{\text{Molar Mass of new substance}}{\text{1 mole of new substance}} =$$

Homework: Do these on a separate sheet of paper…obviously.

1. Potassium chlorate decomposes to form potassium chloride and oxygen. Calculate the amount of potassium chloride that Marisol can produce if she decomposes 74.1 grams of potassium chlorate.

2. Aluminum is reacted with hydrogen chloride in a single displacement reaction. Determine the product of this reaction. How many grams of hydrogen gas can Kerry produce if she is given 45.6 grams of aluminum and excess hydrogen chloride?

3. Cuprous chloride reacts with hydrogen sulfide. Determine the product of this reaction. How many grams of cuprous sulfide can Kristen produce if she is given 9.90 grams of cuprous chloride and an unlimited supply of hydrogen sulfide?

4. Calcium hydroxide reacts with hydrogen phosphate. Determine the product of this reaction. Calculate the mass of calcium phosphate Florence can produce if she is given 18.3 grams of hydrogen phosphate and an excess of calcium hydroxide.

5. Lithium is reacted with water. Determine the product of this single displacement reaction. If Judy wants to produce 780.0 grams of lithium hydroxide, how many grams of lithium would she need?

6. Lead(II) nitrate reacts with sodium chromate. Determine the product of this reaction. How many grams of plumbous chromate can Evelyn produce if she has 83 grams of lead(II) nitrate and an excess of sodium chromate.

7. Sodium reacts with chlorine. Predict the product of this reaction. If Mary wants to make 737.0 grams of sodium chloride (that's how much salt is in a container of salt), how many grams of each reactant does she need?