Chemistry

Unit 3: Atoms, Elements, and Molecules

Workbook 3

Name: _____ Period: _____

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

_____ is a convenient way to write numbers that have lots of zeros, either because they are very large or very small.
This is helpful when looking at atoms because a very small amount of substance contains an enormously large number of atoms.

However, keeping track of all those atoms, even using scientific notation is cumbersome so chemists use a unit called the mole.
The mole is simply a counting unit. Just as one dozen is always equal to 12 objects, regardless of what they are, 1 mole is always equal to 6.02×10^{23} objects.

1 mole =
=
=
=

The mass of 1 mole of a substance is called the molar mass.
The molar mass of each element can be found on the periodic table

6.02×10^{23} was picked because it is the number of atoms needed so that the average atomic mass of one atom in amu is the same number as the mass in grams found in a mole.
For example the molar mass of bromine (79.9 g/mol) is the same number as the average atomic mass of bromine (79.9 amu).

Response:

14 Holey Moley
The Mole

The Mole

Video on **moles:**

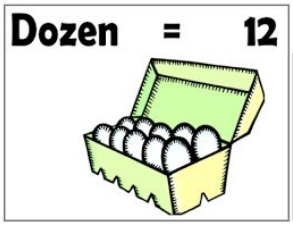
1. What is a "mole" used for in chemistry?

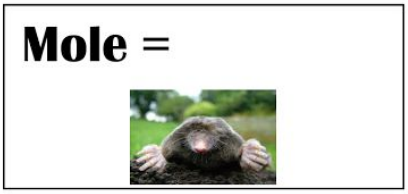
2. What is **Avogadro's number?** _____

3. What is another name for Avogadro's number? _____

4. Why are moles useful in science? What's the purpose of a mole?

5. How is a "mole" similar to a "dozen"?





Questions

1. How many candies are in a mole of candies?
2. How many molecules are in a mole of water, H_2O?
3. How many atoms are there in a mole of sodium?
4. Why do scientists use moles?

5. One mole of hydrogen atoms has a mass of 1.01 grams. How many *atoms* would be in 3.03 grams of hydrogen? How do you know?

6. One mole of oxygen atoms has a mass of 16.00grams. How many atoms would be in 32.00 grams of oxygen? How do you know?

Molar Mass

So, now we know that moles come in handy when we are talking about mass. Who wants to talk about the mass of one individual thing when you can talk about the mass of 602,000,000,000,000,000,000,000 of them?! We saw that a mole of hydrogen atoms had a mass of 1.01 g. **The mass of a mole of something is called the *molar mass* (see the word "mole" in "molar"?).**

Let's make up a word for a moment = "dozenar mass". This term would refer to the mass of a dozen of something. A dozen golf balls would have a mass of 62 grams, meaning the dozenar mass of golf balls is 62 g/dozen. A dozen cotton balls, however, would have a mass of 10 grams, meaning the dozenar mass of cotton is 10 g/dozen. See, we can use *molar* mass to talk about anything—hot dogs, H_2O compounds, lone gold atoms, whatever, as we are just talking about the *mass* of 6.02×10^{23} of those things.

7. What is **molar mass** (in your own words)?

8. How is it possible that a mole of hydrogen has a different molar mass than a mole of carbon atoms – even though both moles have 6.02×10^{23} atoms?

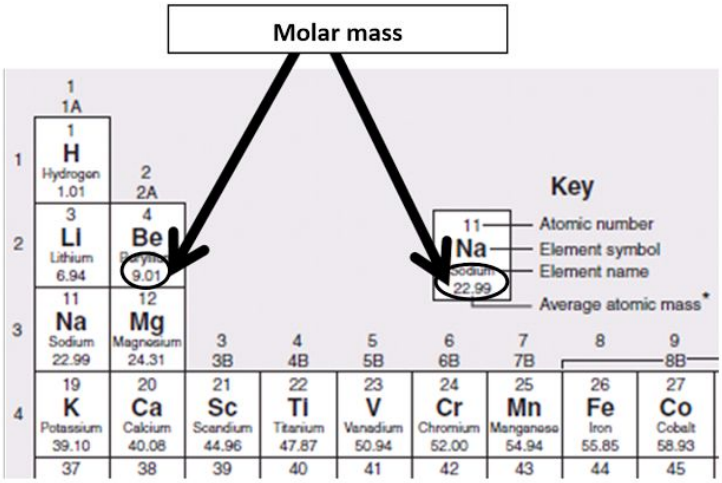
9. Which would have a larger mass: a mole of baseballs or one bowling ball? Why do you think this?

Workbook 3.3 Date:

How do we calculate the molar mass??

One of the *most important* skills in chemistry is to be able to calculate the molar mass of an element or compound. First, let's take a look at the periodic table (YAYYY!!!! WE GET TO USE PERIODIC TABLES AGAIN!!! I know it is quiet reading time, but I understand if you cheer with excitement at this point). The **molar mass** of an element is located at the bottom of the periodic table. For example, Hydrogen has a **molar mass** of 1.01 gram/mol (pronounced "grams per mole"). This means that 1 mole of hydrogen atoms (6.02 x 10^{23} Hydrogen atoms) has a mass of 1.01 grams. The label for molar mass is "*grams per mole"* and is written g/mol. This label helps us remember that the molar mass is the # of grams in each mole of the substance.

Finding the molar mass of individual elements:



10. What is the molar mass of magnesium (include the units)?

11. What is the molar mass of chlorine atoms (include the units)?

12. What is the molar mass of lithium atoms (include the units)?

Ok, that was pretty easy. But how do we calculate the molar mass of a compound?

We need to know how to use the molar masses of individual elements to determine the molar masses of whole compounds. We calculate the molar mass *of a compound* by adding the masses *of the atoms that make it up*. For example, the molar mass of H_2O would be the molar mass of 2 hydrogen atoms and 1 oxygen atom added together. Each hydrogen atom has a molar mass of 1.01 g/mol. Oxygen has a molar mass of 16.00 g/mol.

EXAMPLE: Find the molar mass of 1 mole of H_2O

STEP 1: Use the periodic table to find the molar mass of each element in the compound (you may round)

Molar mass of Hydrogen = 1.01 g/mol

Molar mass of Oxygen = 16.0 g/mol

STEP 2: Use the coefficients to figure out how many of each atom is in 1 molecule. Then multiply the molar mass of each element by how many of each element you have

H_2O = has 2 hydrogen atoms and 1 oxygen atoms

For the 2 hydrogen atoms…

2 x 1.01 g/mol H = ***2.02 g/mol***

For the 1 oxygen atom…

1 x 16.00 g/mol O = ***16.00 g/mol***

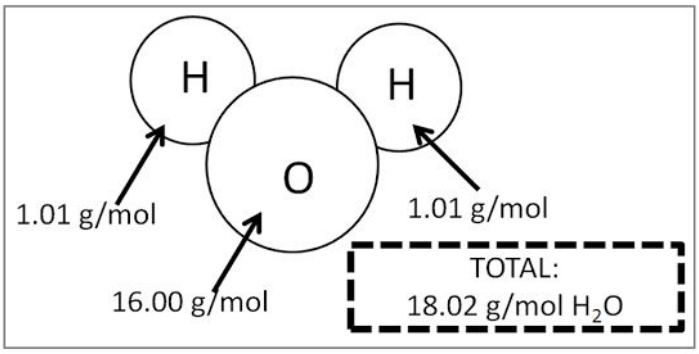
STEP 3: Add together the masses from each element to get the molar mass of the compound

Adding these together to make H_2O….

2.02 g/mol + 16.00 g/mol = ***18.02 g/mol H_2O***

Molar mass of H_2O = 18.02 g/mol

In picture form:



This, of course, means that 6.02 x 10^{23} little molecules of water have a mass of 18.02 grams.

13. Describe in words how you calculate the molar mass of a **<u>compound</u>**?

14. What is the molar mass of $CaCl_2$?

<u>STEP 1</u>: Count the atoms of each element in $CaCl_2$

A) There are _____ Ca atoms

B) There are _____ Cl atoms

<u>STEP 2:</u> Find the molar mass of each element from the periodic table

A) The molar mass of Ca is _____ g/mol

B) The molar mass of Cl is _____ g/mol

CHECK!! WHY is the label for molar mass "g/mol" _____

Multiply the molar mass of each element by how many there are in the compound below:
(Need help?? Step 1 (A) x Step 2 (A) = …)

<u>STEP 3:</u> Add together the masses from each element to find the molar mass

FINAL ANSWER (include units) = _____

Practice

15. What is the molar mass of C_2HF_3? (Show your work below. Include units.)

16. What is the molar mass of $Mg(OH)_2$? (Show your work below. Include units)

17. What is the molar mass of $Na(PO_4)_2$? (Show your work below. Include units)

18. What is the molar mass of $(NH_4)_2O$? (Show your work below. Include units)

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

You can figure out the mass of 1 mole of any element or compound by using the periodic table.

•For a compound, you must sum the molar mass of all the atoms in the molecule

Example:

A mole of atoms or molecules of a solid or liquid is usually an amount you can hold in your hand.

A mole of any gas, if it is at standard temperature and pressure, always has a volume of 22.4 L

Response:

15 What's in a Mole?
Molar Mass

Purpose

To compare what one mole of various substances looks like

Part 1: Molar Mass

1. Use a periodic table to complete the second column in the table. You will complete the last column in Part 2.

Chemical formula	Molar mass g/mol	Mole of what?	Equivalent to:
$Cu(s)$	63.55 g	Cu atoms	50 ft of 20-gauge copper wire
$O_2(g)$	32.00 g	O_2 molecules	22.4 L oxygen gas at STP
$Ni(s)$		Ni atoms	
$Al(s)$		Al atoms	
$H_2O(l)$		H_2O molecules	
$He(g)$		He atoms	22.4 L helium gas at STP
$NaCl(s)$		NaCl units	
$Hg(l)$		Hg atoms	14.7 mL mercury
$Fe(s)$		Fe atoms	
$C_{12}H_{22}O_{11}(s)$		sugar molecules	0.75 lb sugar

2. How many copper atoms are there in 63.55 g of copper?

3. Copper has a larger molar mass than aluminum. Explain what this means.

4. Which contains more moles, 1.0 g of Al(s) or 1.0 g of Hg(l)? Explain your thinking.

5. Explain how you determined the molar mass of sugar. Show your work.

6. What do you think the volume of one mole of carbon dioxide gas would be? Explain your reasoning.

Part 2: Mole Challenge

Procedure

1. There are weighing stations around the room. With your group, visit the stations and create 1-mole samples of the items found at each station. These samples must be close to 1 mole, but they do not have to be exact.

2. Enter the amounts that you determined in the table on page 11

Questions

1. How many moles of aluminum do you need to make a six-pack of cans?

2. How many iron nails do you need in order to have 223.40 g of iron atoms?

3. What volume of water do you need in order to have 25 moles of H_2O molecules?

4. Suppose that you have 1 g of sugar and 1 g of water. Which one has more molecules? Explain how you arrived at your answer.

5. The average teenager drinks 868 cans of soda per year. Determine how many aluminum cans per year this represents for your school by estimating the number of students. How many moles of aluminum does this represent?

Guiding Question:

Do Now:

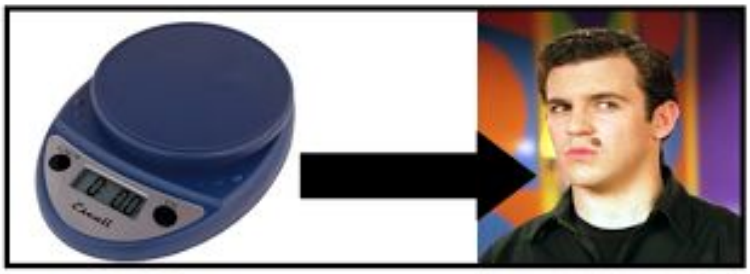
Important Definitions and Equations:	**Notes:**

Response:

16 Mountains into Molehills

Gram and mole conversions

Converting Between Grams and Moles POGIL



For the next two weeks we are going to be working on **stoichiometry**, which pretty much means math in chemistry. The big objective for the next two weeks is "WWBAT calculate the grams of one substance when given the grams of another substance." This objective is the hardest—but the best!—objective in chemistry. One of these problems looks like this:

If you have 20 grams of water (H_2O). How many grams of O_2 could you make, according to the following reaction?

$$2H_2O \rightarrow 2H_2 + O_2$$

To solve this problem, we have to break it down into three steps. Today you will practice step one, *first* we must be able to convert between moles and grams. I am completely confident that if you work hard today you will master this! Don't fear, CheMasters – you *will* master this objective!

So let's try this…

STEP 1: Prepare your battlefield – set up a chart. Set up something called a "t-chart" or "railroad tracks" like you learned in math. A t-chart is tool that will help us decide when to divide and when to multiply in a stoichiometry problem.

A t-chart looks like this:

Here is how you use a t-chart: *The letters (A-D) are there just to show you when you multiply and divide.* In a t-chart, you multiply across the top and bottom to get a simplified fraction. Then, you divide the fraction to get your final answer

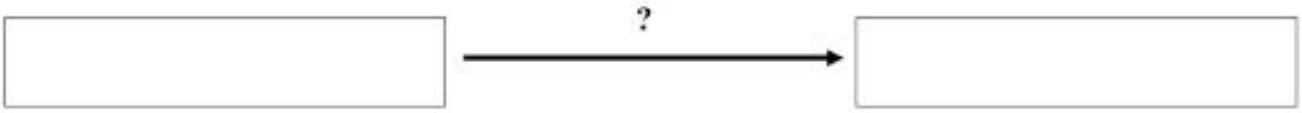
"THINK: Multiply across the top"

$$\frac{A \overset{\times}{|} B}{C \underset{\times}{|} D} = \frac{A \times B}{C \times D} = \boxed{\frac{(A \times B) \div (C \times D)}{\text{Final Answer}}}$$

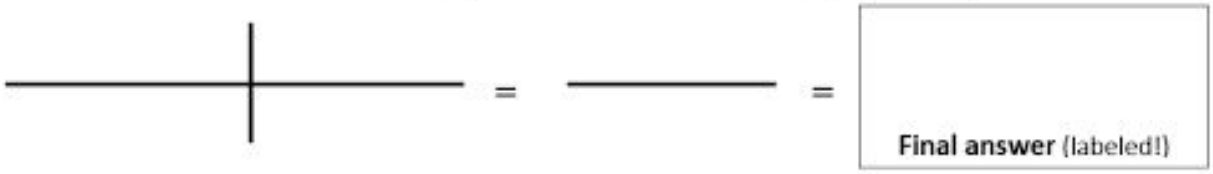
"THINK: Multiply across the bottom" *"THINK: Divide top by bottom"*

Let's see if we can set up a t-chart with a problem that we already know how to answer!

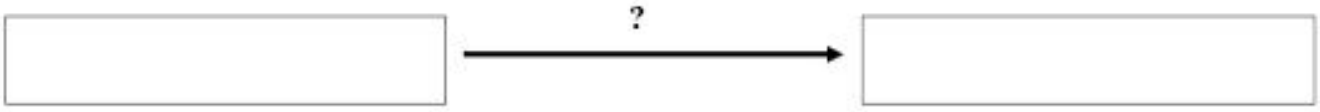
PROBLEM #1 – There are 2 dozen pencils in the pencil case. How many pencils do you have in total?
Roadmap to success: *"THINK: What can I use to move from centimeters to meters? What is your conversion factor?"*



DO THE DISCO!!!! *"THINK: The units you want to cancel out must go diagonal from each other"*



PROBLEM #2 – You have 36 inches of string, but you need to know how many feet of string you have. (Remember, you know there are 12 inches in 1 foot)
Roadmap to success: *"THINK: What can I use to move from inches to feet? What is your conversion factor?"*



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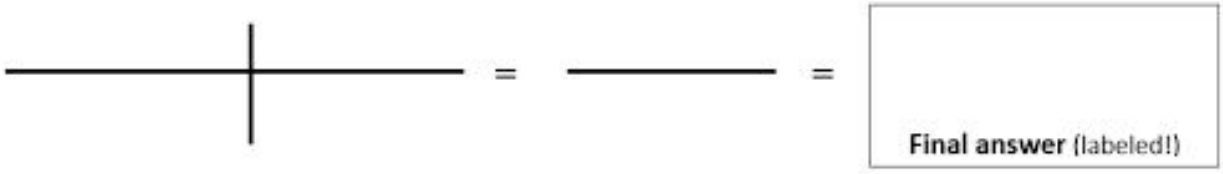
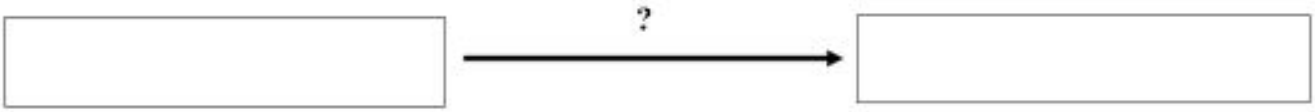


PROBLEM #3 – A carpenter measures a window to have a length of 750 centimeters. How many meters is the window? (There are 100 centimeters in 1 meter)
Roadmap to success: *"THINK: What can I use to move from centimeters to meters? What is your conversion factor?"*



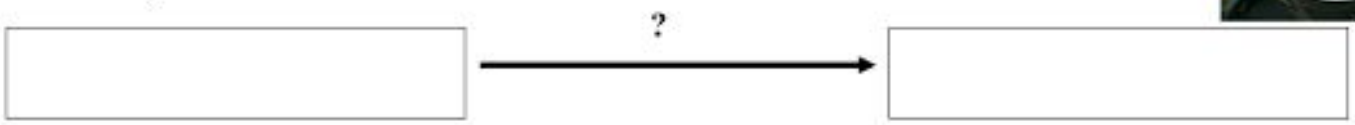
DO THE DISCO!!!! *"THINK: The units you want to cancel out must go diagonal from each other"*

Check In Stamp

Now with a chemistry problem…

PROBLEM #3 – You have 10 **grams** of water and you want to know how many **moles** of water that is.

Roadmap to success: *"THINK: What can I use to move from grams to moles? What is your conversion factor?"*



STEP 1: The first step is to set up our t-chart. Remember to write the given information in the upper left hand box. **DO THE DISCO!!!!** *"THINK: The units you want to cancel out must go diagonal from each other"*

But what do we do now? Where is our conversion factor?
Calm down! The conversion factor comes from the molar mass which we calculate from the periodic table. This
is what we did during yesterday's lesson and today's catalyst.

★ **Check yourself: Why does it make sense that we can use molar mass to convert from grams to moles of a substance?** HINT: think about the units!!

STEP 2: Calculate the molar mass of water:

The molar mass of water is (include your units!):

The molar mass is our conversion factor; this is what goes in the second box on our t-chart.

STEP 3: Fill in the rest of the t-chart and solve. Cross off units as you go through to get the units of your final answer.

Phew! There we go! We just completed step 1! We found that 10 grams H_2O = 0.56 moles H_2O

PAUSE AND THINK: Recap the "swing" from moles to grams in words. What did we just do? How did we do it?

_____

_____

_____

_____

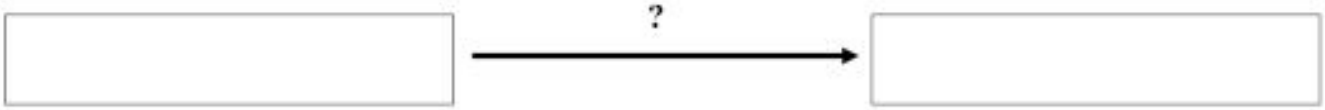
Check In Stamp

Try one on your own now:

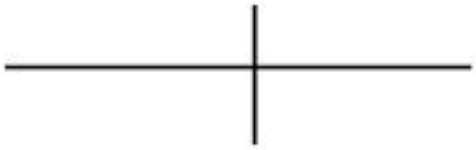
PROBLEM #4 – *Let's say that you have 4.5 grams of NaF and you want to know how many moles of NaF that is.*

STEP 1: Make a plan and set up your t-chart

Roadmap to success: *"THINK: What can I use to move from grams to moles? What is your conversion factor?"*



DO THE DISCO!!!! Remember to write the given information in the upper left hand box. *"THINK: The units you want to cancel out must go diagonal from each other"*

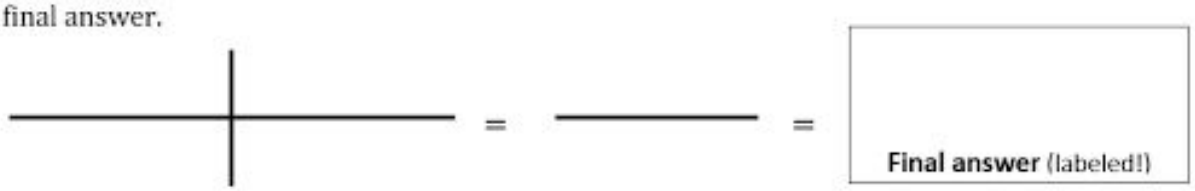


Step 2: Calculate the molar mass of NaF:

The molar mass of NaF is (include your units!) = _____

★ **Check yo'self!! WHY did you need to do step 2? What does finding the molar mass of NaF help you do?**

Step 3: Fill in the rest of the t-chart and solve: Cross off units as you go through to get the units of your final answer.



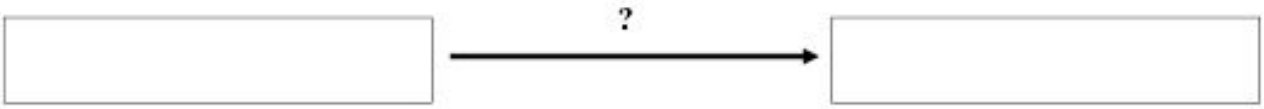
Check In Stamp

REVERSE IT: Going from moles to grams

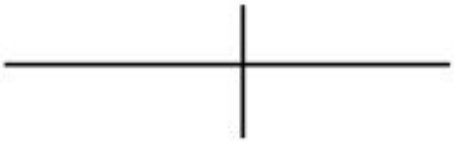
PROBLEM #5 – How many grams are in 0.02 moles of BeI_2?

STEP 1: Make a plan and set up your t-chart

Roadmap to success: *"THINK: What can I use to move from moles to grams? What is your conversion factor?"*



DO THE DISCO!!!! Remember to write the given information in the upper left hand box. *"THINK: The units you want to cancel out must go diagonal from each other"*



Step 2: Calculate the molar mass of BeI_2

The molar mass of BeI_2 is (include your units!) = _____

Check yo'self!! WHY did you need to do step 2? What does finding the molar mass of BeI_2 help you do?

Step 3: Fill in the rest of the t-chart and solve: Cross off units as you go through to get the units of your final answer.

Whew – you did it! Make sure you understand the KEY POINTS below!

Re-Cap: Overview of conversions between grams and moles

Molar mass (g/mol)

mass (g) **moles (mol)**

MOST IMPORTANT thing is to check what units you WANT to end up with and do the disco!!

$$\frac{\text{Given Info} \mid \text{Units we } \mathbf{Want}}{\text{Units to Cancel}} =$$

Check In Stamp

Practice Time – grams to moles problems

Example 1: How man moles are in 30 grams of H_3PO_4?

_____ = _____ =

Final answer (labeled!)

Example 2: You have 110 grams of $NaHCO_3$, how many moles of $NaHCO_3$ do you have?

_____ = _____ =

Final answer (labeled!)

Example 3: How man moles are in 1.1 grams of $FeCl_3$?

_____ = _____ =

Final answer (labeled!)

Example 4: How many moles are in 987 grams of $Ra(OH)_2$?

_____ = _____ =

Final answer (labeled!)

Check In Stamp

Guiding Question:

Do Now:

Important Definitions and Equations:

Notes:

Mole Ratio: The ratio in which reactants have to combine to form the maximum amount of products.

You determine the mole ratio by looking at the coefficients in the balanced chemical equation.

Example:

$$2CH_4O + 3O_2 \rightarrow 2CO_2 + 4H_2O$$

How many moles of carbon dioxide will you make if you react 4 moles of O_2?

Response:

17 Step up to the line
Mole Ratios

Why?

A balanced chemical equation can tell us the number of reactant and product particles (ions, atoms, molecules or formula units) that are necessary to conserve mass during a chemical reaction. Typically when we balance the chemical equation we think in terms of individual particles. However, in real life the reaction represented by an equation occurs an unimaginable number of times. Short of writing very large numbers (10^{23} or larger) in front of each chemical in the equation, how can we interpret chemical equations so that they more realistically represent what is happening in real life? In this activity you will explore the different ways a chemical reaction can be interpreted.

Model 1 – A Chemical Reaction

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

1. Consider the reaction in Model 1.
   a. What are the coefficients for each of the following substances in the reaction?

   N_2 H_2 NH_3

   b. Draw particle models below to illustrate the reaction in Model 1.

2. Consider each situation below as it relates to the reaction in Model 1.
   a. Calculate the amount of reactants consumed and products made.
   b. Record the ratio of N_2 to H_2 to NH_3. Reduce the ratio to the lowest whole numbers possible.

	N_2 Consumed	H_2 Consumed	NH_3 Produced	Ratio N_2:H_2:NH_3 (reduced)
For a single reaction, how many molecules of each substance would be consumed or produced?				
If the reaction occurred one hundred times, how many molecules would be consumed or produced?				
If the reaction occurred 538 times, how many molecules would be consumed or produced?				

3. Refer to the data table in Question 2.

   a. How do the reduced ratios in the last column compare to the coefficients in the reaction shown in Model 1?

   b. Use mathematical concepts to explain how your answer in part *a* is possible.

4. Even 538 is a small number of molecules to use in a reaction. Typically chemists use much larger numbers of molecules. (Recall that one mole is equal to 6.02×10^{23} particles.) Consider each situation below as it relates to the reaction in Model 1: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$.

   a. Calculate the amount of reactants consumed and products made.

   b. Record the ratio of N_2 to H_2 to NH_3. Reduce the ratio to the lowest whole number possible.

	N_2 Consumed	**H_2 Consumed**	**NH_3 Produced**	**Ratio N_2:H_2:NH_3**
If the reaction occurred 6.02×10^{23} times, how many molecules would be consumed or produced?				
How many ***moles*** of each substance would be consumed or produced in the previous situation?				

5. Refer to the data table in Question 4.

   a. How do the reduced ratios in the last column compare to the coefficients in the reaction in Model 1?

   b. Use mathematical concepts to explain how your answer in part *a* is possible.

6. The ratio obtained from the coefficients in a balanced chemical equation is called the **mole ratio**.

   a. What is the mole ratio for the reaction in Model 1?

   b. Explain why this ratio is called the mole ratio?

7. Use the mole ratio from the balanced chemical equation in Model 1, $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, to solve the following problems. *Hint:* Set up proportions.

   a. How many moles of nitrogen would be needed to make 10.0 moles of ammonia?

   b. How many moles of ammonia could be made by completely reacting 9.00 moles of hydrogen?

   c. How many moles of hydrogen would be needed to react completely with 7.41 moles of nitrogen?

8. Consider this situation as it relates to the reaction in Model 1, $N_2(g) + 3H_2(g) \rightarrow 2\ NH_3(g)$.

   a. Calculate the amounts of reactants consumed and the amount of product made.

   b. Record the mass ratio of N_2 to H_2 to NH_3. Reduce the ratio to the lowest whole numbers possible.

	N_2 Consumed	**H_2 Consumed**	**NH_3 Produced**	**Mass Ratio N_2:H_2:NH_3**
How many grams of each substance would be consumed or produced in the situation in Question 4?				

9. Refer to the data table in Question 8.

   a. Can the mole ratio from a balanced chemical equation be interpreted as a ratio of masses?

   b. Use mathematical concepts to explain how your answer in part *a* is possible.

10. As a group, develop a plan to solve the following problem. Remember that the mole ratio cannot be used directly in this situation. *Note:* You do not need to do the actual calculation here.

    "What mass of nitrogen is needed to produce 30.0 g of ammonia?"

Model 2 – Proposed Calculations for Mass of NH_3 to Mass of N_2

Toby's Method

$$\frac{x \text{ grams}}{30.0 \text{ g}} = \frac{1 \text{ mole } N_2}{2 \text{ moles } NH_3} \rightarrow x = \_\_\_\_\_ \text{ g } N_2$$

Rachel's Method

$$30.0 \text{ g } NH_3 \times \frac{1 \text{ mole } NH_3}{17.0 \text{ g } NH_3} = \_\_\_\_\_ \text{ moles } NH_3$$

$$\frac{x \text{ mole } N_2}{\_\_\_\_\_ \text{ mole } NH_3} = \frac{1 \text{ mole } N_2}{2 \text{ moles } NH_3} \rightarrow x = \_\_\_\_\_ \text{ moles } N_2$$

$$\_\_\_\_\_ \text{ mole } N_2 \times \frac{28.0 \text{ g } N_2}{1 \text{ mole } N_2} = \_\_\_\_\_ \text{ g } N_2$$

Jerry's Method

$$30.0 \text{ g } NH_3 \times \frac{1 \text{ mole } NH_3}{17.0 \text{ g } NH_3} \times \frac{1 \text{ mole } N_2}{2 \text{ moles } NH_3} \times \frac{28.0 \text{ g } N_2}{1 \text{ mole } N_2} = \_\_\_\_\_ \text{ g } N_2$$

11. Model 2 shows three proposed calculations to solve the problem in Question 10. Complete the calculations in Model 2 by filling in the underlined values.
12. Which method does not use the mole ratio in an appropriate manner? Explain.
13. Two of the methods in Model 2 give the same answer. Show that they are mathematically equivalent methods.
14. Use either Rachel or Jerry's method from Model 2 to calculate the mass of hydrogen needed to make 30.0 g of ammonia. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

Extension Questions

15. One mole of any gas will occupy 22.4 L of volume at standard temperature and pressure (STP).

    Consider this situation as it relates to the reaction in Model 1: $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$

    a. Calculate the volumes of reactants consumed and the volume of product made.

    b. Record the ratio of N_2 to H_2 to NH_3. Reduce the ratio to the lowest whole numbers possible.

	N_2 Consumed	**H_2 Consumed**	**NH_3 Produced**	**Volume Ratio N_2:H_2:NH_3**
How many liters of each substance would be consumed or produced if the reaction occurred 6.02×10^{23} times at STP?				

16. Refer to the data table in Question 15.

    a. Can the mole ratio from a balanced chemical equation be interpreted as a ratio of volumes for gases?

    b. Use mathematical concepts to explain how your answer in part *a* is possible.

17. Explain why the ratio of volumes is NOT followed in the following reactions.

$2H_2(g)$	+	$O_2(g)$	→	$2H_2O(l)$	$NH_3(g)$	+	$HCl(g)$	→	$NH_4Cl(s)$
44.8 L		22.4 L		0.036 L	22.4 L		22.4 L		0.035 L

18. Which of the following quantities are **conserved** (total amount in reactants = total amount in products) in a chemical reaction? Find an example or counter example from this activity to support your answer for each.

    a. Molecules

    b. Moles

    c. Mass

    d. Volume

    e. Atoms of an element

Guiding Question:

Do Now:

Important Definitions and Equations:	**Notes:**

Response:

18 Run the Race

3 Step Stoichiometry Conversions

2 Step Stoichiometry - Moles of one Compound into Grams of another compound

Catalyst CHALLENGE!!

Based on what you know so far about stoichiometry and the chart below – try to figure out the problem below! Work together with your table to get it ☺

Example problem #1) According to the following chemical equation, how many moles of CO_2 are produced when 250 grams of C_3H_8 are used in the reaction?

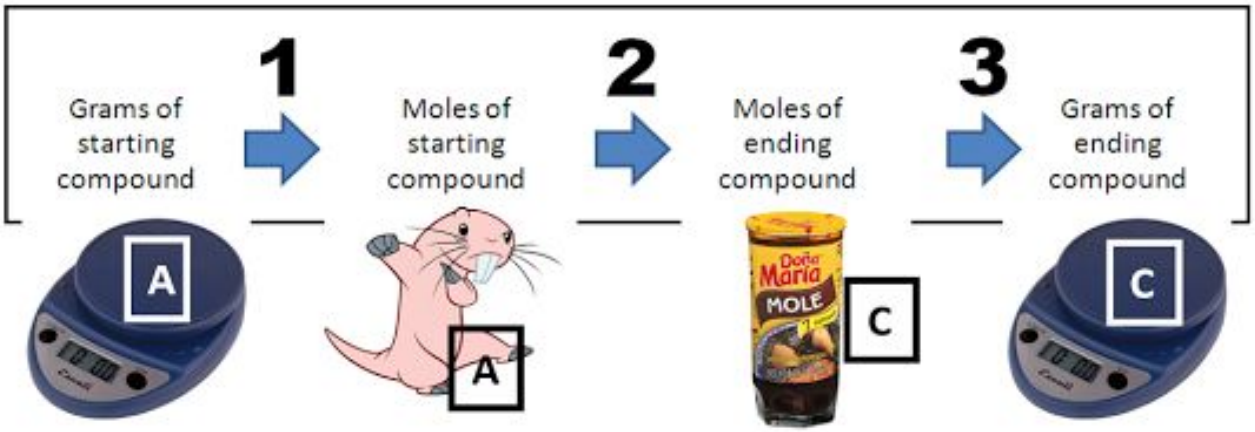
$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Make your roadmap!

Make your t-chart (s):

Our goal is to be able to convert from grams of one substance to grams of another. We have learned steps 1 and 2 below. Now – we must put both steps together to make a 2 step stoichiometry problem. We will start by keeping it as 2 steps – then we will put it together for a giant t-chart!! Look at the flow chart below to see the big picture…

In the reaction… **A + B → C + D**



Check yo'self! What step(s) are we learning today? What units will we start AND end with?

_____

_____

Let's look at how we use these 2 steps in 1 problem…

Example problem #1) According to the following chemical equation, how many moles of H_2O are created when 480 grams of O_2 are used in the reaction?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

Roadmap:

WHY must you turn grams into moles in the first step? Why not just convert from grams to grams?_____

_____

How do you convert moles of 1 substance into moles of another substance? What do you need to use?

_____

Ok…LET'S DO THIS!!!

Example problem #1) According to the following chemical equation, how many moles of H_2O are created when 480 grams of O_2 are used in the reaction?

$$C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$$

STEP 1: Convert *grams of C_3H_8* to *moles of C_3H_8* by using the molar mass of C_3H_8

STEP 2: Convert *moles of C_3H_8* to *moles of CO_2* by using the mole ratio of C_3H_8 to CO_2

What does this mean? If you used _____ of _____ you would make _____ of _____

Check In Stamp

Try it with your partner!!

Example 2: According to the equation below, how many moles of H_2O are produced when 200 grams of H_2 is used?

$$4H_2 + O_2 \rightarrow 2H_2O$$

Roadmap:

STEP 1

STEP 2

What does this mean? If you started with _____ of _____, then you could produce _____ of _____

Gram to Moles Stoichiometry –TWO STEPS!

DIRECTIONS: For the first problems – use both steps to find the correct answer. You should use a t-chart for each step!

Example 3: How many moles of oxygen (O_2) gas are produced in the decomposition of 10g of sulfur trioxide (SO_3)?

$$2\,SO_3 \rightarrow 2\,S + 3\,O_2$$

Roadmap!

STEP 1

STEP 2

What does this mean? If you took _____ of _____, then you could make _____ of _____.

Check In Stamp

Example 4: How many moles of sodium chloride (NaCl) are produced by the reaction of 40.3 g of chlorine (Cl_2) gas with sodium (Na) metal?

$$2\ Na + Cl_2 \rightarrow 2\ NaCl$$

Roadmap! [ ] → [ ] → [ ]

STEP 1

STEP 2

What does this mean? If you took _____ of _____, then you could make _____ of _____.

Example 5: How many moles of copper oxide (CuO) would be needed to make 19.2 g of copper (Cu)?

$$4CuO + CH_4 \rightarrow 4Cu + CO_2 + 2H_2O$$

Roadmap! [ ] → [ ] → [ ]

STEP 1

STEP 2

What does this mean? If you took _____ of _____, then you could make _____ of _____.

STOP!!! Now, let's step it up to *college level*!! You can do these in 1 giant t-chart! Look at how I set up the example below:

QUESTION: You found 10g of Cl_2 on the shelf. How many moles of $CHCl_3$ could you make?

$$2\ CH_4 + 3Cl_2 \rightarrow 2\ CHCl_3 + 6\ HCl$$

$$\frac{10\ \text{grams } Cl_2}{1} \left| \frac{1\ \text{mole } Cl_2}{71\ \text{grams } Cl_2} \right| \frac{2\ \text{moles } CHCl_3}{3\ \text{moles } Cl_2} = 0.0939\ \text{moles } CHCl_3$$

Try it!! Do the following problem with **1 giant t-chart**

Example 4: You found 50g of CH_4 on the shelf. How many moles of HCl could you make?

$$2\ CH_4 + 3Cl_2 \rightarrow 2\ CHCl_3 + 6\ HCl$$

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DIRECTIONS – Try to complete the following problems using 1 t-chart only!!! Show your work and label, label, label!!

1. Your boss needs 25g of SO_2 for a customer. How many moles of PbS do you need to get off the shelf to make this reaction work?

$$PbS + O_2 \rightarrow PbO + SO_2$$

2. Consider the combustion of ethane

$$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

   a. If 13.5 g of ethane (C_2H_6) is burned, how many moles of water are formed?

   b. You need to produce 15 moles of carbon dioxide (CO_2) gas. How many grams of ethane (C_2H_6) should you use in your reaction?

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3. Consider the following equation:

$$2AgNO_3 + BaCl_2 \rightarrow 2AgCl + Ba(NO_3)_2$$

   a. How many moles of silver chloride (AgCl) are produced when 5.0 grams of silver nitrate ($AgNO_3$) react?

   b. How many moles of barium nitrate ($Ba(NO_3)_2$) are produced if 18.4 g of silver chloride (AgCl) are also produced?

4. Consider the reaction of calcium sulfide (CaS) with silver nitrate ($AgNO_3$):

$$CaS + 2AgNO_3 \rightarrow Ca(NO_3)_2 + Ag_2S$$

   a. If 14.8 grams of calcium sulfide (CaS) react, how moles of silver nitrate ($AgNO_3$) will react?

   b. If you react 5 moles of CaS, how many grams of Ag_2S will you produce?

5. Aluminum metal (Al) reacts with sulfur (S) to produce aluminum sulfide (Al_2S_3) according to this balanced chemical equation:

$$2Al(s) + 3S(s) \rightarrow Al_2S_3(s)$$

   a. How many moles of aluminum will react completely with 90 grams of sulfur?

   b. How many grams of sulfur must react to produce 5.5 moles of Al_2S_3?

Check In Stamp