The Mole & Stoichiometry Unit 4

The mole is a chemistry counting term.

Complete these sentences with counting terms:

1. I went to the bakery and asked for a _____ cookies; they gave me twelve.
2. This morning I put on a _____ of socks.
3. A _____ is a hundred years.
4. A _____ is 10^{100}.
5. A _____ is ten years.
6. I listened to four musicians playing on the street; they were a _____.

A _____ is **6.02×10^{23}** atoms of an element or particles of a compound. That is a lot. We call this Avogadro's number.

The name "Avogadro's Number" is the number of atoms, particles, molecules, elephants, anything that we need to say that we have a mole of something.

If we had 12 giraffes I could say we have a dozen giraffes here.

If I had 602 213 700 000 000 000 000 000 giraffes I could say I had a mole of giraffes.

What is a mole?
Although most people think a mole is a small brown furry mammal that lives in tunnels in the ground, it also has an important meaning in chemistry.

How much is a mole?
A mole is an incredibly large collection of stuff. It is a set of $6.022\ 137 \times 10^{23}$ things.
That's 602 sextillion, 213 quintillion, 700 quadrillion items.
Or... 602 213 700 000 000 000 000 000

Why is the mole important to chemistry?
You may have wondered why scientists chose the number 6.02×10^{23}. It was conveniently picked so that if we had a mole of an element or compound the weight of the element or compound in grams would equal its atomic mass.

For example, the atomic mass of selenium (Se) is 78.96 amu. This means that one mole, or 6.02×10^{23} atoms of selenium has a mass of 78.96 grams.

Some interesting facts:
Here are some facts about the mole and Avogadro's number that show just how large it really is.

a. Avogadro's number of inches would take us across our galaxy and back 8 times.
b. Avogadro's number of seconds is about 19 quadrillion years, 4,240,666 times the age of the earth, or 954,150 times the age of the universe itself.
c. Avogadro's number of cents could repay the United States National Debt 86 million times.
d. Avogadro's number of kilograms is just over 20 times the mass of the earth.

Something to think about?

1. What would take up more space, A dozen eggs or a dozen people? _____
2. What would weigh more, a pair of dice of a pair of rhinoceros? _____
3. What would take up more space, a mole of pennies or a mole of loonies? _____
4. What would weigh more, a mole of elephants or a mole of feathers? _____
5. What would weigh more, a mole of hydrogen or a mole of gold? _____

Check out our mole box.

Why are the sizes of the samples of the elements all different if they are all one mole?

Think about it if I had a dozen geckos and a dozen polar bears would they take up the same space or have the same weight?

Calculations

- **Set up this ratio (1 mole / 6.02 x 10^{23}).**
- **Remember: 6.02 x 10^{23} can refer to atoms, formula units or molecules**
- **Flip it to cancel out your units.**

1. If I have 144 balloons how many dozen balloons do I have? Show your work.

2. If I have 1.204 x 10^{24} balloons how many dozen do I have? How many moles?

3. If I have 2.408 x 10^{24} molecules of water how many moles of water do I have?

4. If I have 8 moles of sugar how many particles of sugar do I have?

5. If I have 22 moles of Cu how many atoms of copper do I have?

Always set up this ratio with what you are looking for on top:

Example:

1. You have 2.6 mol of aluminum oxide ($Al_2O_{3\,(s)}$).
    a. How many formula units are in the sample?

    b. How many atoms, in total are in the sample:

    c. How many aluminum atoms are in the sample:

Do page 1-5 on page 226

Read p. 226-230
Do p. 232 #1, 2, 6-13

Day 2

Moving From the **Mole** to **Molar Mass**

What did we do yesterday?
If I have a dozen koala bears, how many koala bears do I have? _____
If I have a mole of koala bears, how many koala bears do I have? _____
If I have a mole of koala bears and a mole of pennies which would weigh more? _____
If I have a mole of Helium and a mole of Silver which would weigh more? _____

1. How many moles of Silver do you have if you have 1.204×10^{24} atoms?
   (Set up a ratio with what you are looking for on top.)

2. How many molecules of water do you have if you have 3.5 moles?
   (Set up a ratio.)

Remember…
If we have a mole of an element or compound the weight of the element or compound in grams would equal its atomic mass. For example, the atomic mass of selenium (Se) is 78.96 amu. This means that one mole, or 6.02×10^{23} atoms, of selenium has a mass of 78.96 grams.

Therefore, the atomic mass of an element or compound is also its Molar Mass (M).

Let's practice calculating _____. This is the exact same as calculating atomic mass (which you can already do). _____

Examples:

a. Copper (II) Sulfate

b. Sodium Chloride

c. Aluminum Nitrate

Ok let's do this now with our Stoichiometry - Steps:

1. Write the chemical formula for the element or compound.
2. Determine the average atomic mass of the element, or each element in the compound. This number can be found on your periodic table.
3. If you are dealing with an element the atomic mass equals the molar mass.
4. If you are dealing with a compound add up the atomic masses of each element in the compound. Make sure to watch for subscripts.

Here is the BIG deal…

Before we used a ratio, with what we are looking for on top, to convert between atoms or particles and moles. Now we want to _____ _____, with what we want on top. We will either be solving for mass or moles.

Our ratio will be:  **or** 

Steps:

1. Underline what we are looking for.
2. Calculate the molar mass of your element or compound.
3. Set up your ratio.
4. Multiply by what we are given.
5. Cancel your units. What units are you left with?
6. This is your answer. Leave to two decimal places

Examples:

1. How many moles do you have if you have 64 grams of Sulfur?

2. How many moles do you have if you have 36 g of water?

3. How much does 4 moles of helium weigh?

4. How many grams of NaCl would I have if I had 3.2 moles of salt?

Okay you are now able to try this mole stations lab.

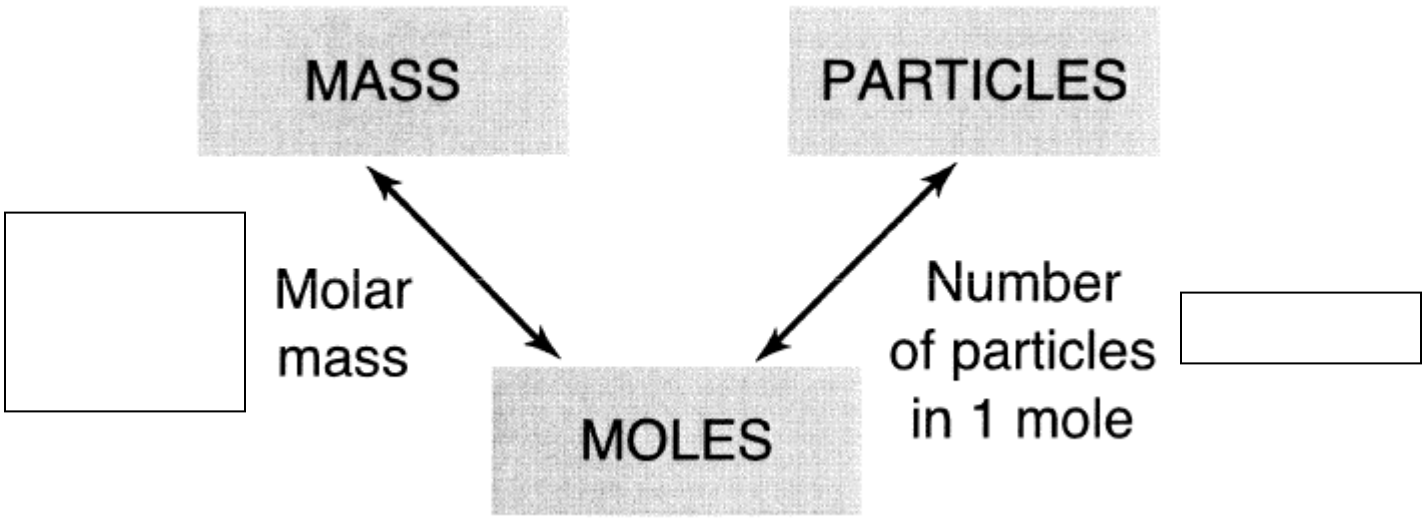
Name	Formula	Molar Mass (g/mol)	Mass (g)	Moles	Atoms or Molecules
Iron					
Zinc					
Copper					
Aluminum					
Tin					
Lead (sheet)					
Lead (balls)					
Water					
Copper (II) Chloride					
Nickel (II) Sulphate					
Sugar	$C_6H_{12}O_6$				

***** A Ziploc bag weighs 2.5g**

Do p. 237 #41- 48 and p. 239 #51-59

Day 3

Two Step Mole Problems
"The Mole Bridge"



Imagine you are flying to Winnipeg from Thompson. You can't get on the plane without a ticket!

Now imagine the ticket is like moles. You cannot get on the plane to go from Thompson to Winnipeg without a ticket, and you cannot get from mass to particles (or atoms) without moles.

You always need a ticket first! You always need moles first!

Steps:

1. What are you given?
2. What are you looking for?
3. What do you need to get there? (HINT- the answer to this is always moles.)
4. Calculate the molar mass of the compound you are using.
5. Set up your **first ratio** with moles on top because that is what we need first. (Like the ice cream.)
6. Solve for moles.
7. Set up your **second ratio** with what you are looking for on top. (Hint – moles will now be on the bottom.)
8. Solve the problem by multiplying your ratio by the number of moles you solved for in the first ratio.
9. Double check your units.
10. You did it!

Examples:

1. You have a 150g bottle of water. How many molecules of water are in your bottle?

2. You have a 3.5g silver chain. How many atoms of silver are you wearing?

3. A test tube contains 6.2×10^{24} particles of cobalt. What is the mass of cobalt in the sample?

4. You have 3.8×10^{23} atoms of lithium fluoride. What is the mass of the sample of lithium fluoride?

Do page 242 #61-67 in your textbook

Challenge

Choose a chemical from the lab trolley at the front and take it to your bench. I will give you a Chemical Card (cue card). Your task is to get a Ziploc bag and fill it with 0.1 moles of your chemical.

Chemicals:

a. **Glucose**
b. **Sodium bicarbonate**
c. **Sodium sulfate**
d. **Sodium chloride**

Before we begin:

1. What will be different about every group's sample?

2. What will be the same?

3. Can we see atoms or molecules? Are you sure?

Materials:

- Your chemical
- Scoopula
- Paper weighing cup
- Ziploc bag

Procedure:

Come up with a plan as to how you can determine how much of your chemical needs to be in the Ziploc bag.

On your card please tell me:

- Your names.
- The name and formula for your compound.
- The molar mass of your compound.
- The mass of your sample
- The number of atoms or molecules in your sample.
- Hand in your card and your Ziploc bag. Please put your chemical formula on the Ziploc bags in case they get mixed up.

10–2 Practice Problems (continued)

17. If you burned 6.10×10^{24} molecules of ethane (C_2H_6), what mass of ethane did you burn?

18. How many formula units are in 5.1 g of TiO_2?

19. What is the mass of 3.62×10^{24} molecules of methanol (CH_3OH)?

20. How many formula units are in 1.4 g of $PbCl_2$?

21. Determine the mass of 2.94×10^{24} molecules of decane ($C_{10}H_{22}$).

22. How many formula units are in 5.6 g of H_2S?

Do review: p. 243 #1, 4-12
Do more review questions: p. 251 #1-25, 34-36

Day 4

Volumes of Gases at STP

The mole is important to all phases of matter. The difference between the gas and other matter is that gas will expand until it fills a container. Therefore, it is important to impose a few rules on gas in order to predict its molar mass and volume.

Remember STP - Standard Temperature and Pressure

Temperature (^{0}C) 25°C (K) _____

Pressure _____ or _____

Under these conditions (STP) it has been experimentally proven that all gases occupy 22.4L of space. They have the same number of particles and therefore will have the same amount of space between them. Remember - the size of the particle itself does not effect how much space the gas will take up. It does effect how much the gas will weigh.

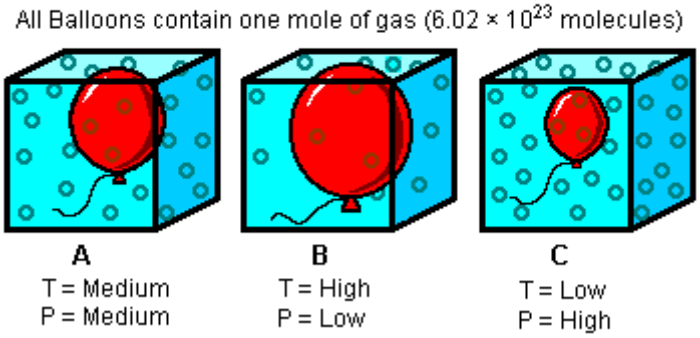
Let's quickly review our gas laws from last unit.

Boyle's Law – Pressure and volume are _____ related; which means that _____.

Charles Law – Volume and temperature are _____ related; which means that _____.

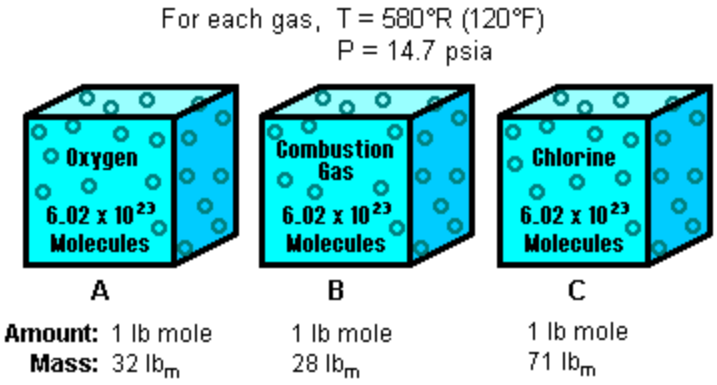
Gay- Lussac's Law – Pressure and temperature are _____ related; which means that _____.

Figure 2. Volume of One Mole of Gas Under Different Conditions



If each cube below contains 1 mole of particles, how many particles are in the cube?
_____

Why does the Cl_2 gas weigh more than the O_2 gas? _____



Converting between gas volumes and moles; what do we do? **Set up a Ratio!!!!!!**

Ratios –

- 1 mole contains 6.02 x 10^{23} particles or atoms. This number is called *Avogadro's number* or *Avogadro's constant*.
- 1 mole of a pure substance has a mass in grams equal to its molar mass. Also known as formula mass or formula weight.
- **1 mole of an ideal gas has a volume of: 22.4 litres (22.4L) at S.T.P.**

Practice Questions:

1. If I have a 2.0L Helium balloon at STP, how many moles of helium do I have?

2. In my balloon form question 1 how many atoms of helium do I have?

3. If I have 6 moles of F_2 gas, how much volume would it occupy at STP?

4. If I have a 3.6 L balloon of carbon dioxide what would the gas inside of the balloon weigh?

Day 5

Mixing it Up

Identifying Types of Questions

For each of the following statements, identify the **specific type** of question you are being asked to solve, e.g., gas volume and density, volume-mole conversion, mass-mass problem. **Then please solve the question.**

1. What is the mass of $7.8x10^{30}$ atoms of Na?

2. How many molecules are there in 3.0 moles of NO?

3. 11.5×10^{25} molecules of N_2 take up how much volume at STP?

4. What is the mass of H_20 in 3.9 L of water vapor at STP?

5. How many moles are there in 4.7 L of CH_4 at STP?

6. How many moles are there in 25.0 grams of H_2?

10–2 Review and Reinforcement

Mole Conversions

Answer each of the following questions in the space provided.

1. How would you calculate the number of moles present in a given mass of a substance?

2. How would you calculate the number of particles present in a given number of moles of a substance?

3. How would you calculate the number of particles present in a given mass of a substance?

Complete each of the following conversions as directed. Show all your work.

4. 3.5 mol C = _____ g C

5. 1.6×10^{24} molecules $FeCl_3$ = _____ mol $FeCl_3$

6. 27.6 g Ar = _____ mol Ar

7. 4.10 mol $BaSO_4$ = _____ formula units $BaSO_4$

8. 16.5×10^{23} atoms Zn = _____ mol Zn

10–2 *Review and Reinforcement (continued)*

9. 0.0621 mol K_2S = _____ g K_2S

10. 65.8 g Mg = _____ atoms Mg

Solve each of the following problems as directed. Show all your work.

11. Calculate the number of atoms in 0.40 mol of sulfur.

12. Calculate the number of atoms in 2.30 mol of silver.

13. You have a tank of NO_2 gas. If the tank contains 5 mol of the gas, how many atoms are in it?

14. A recipe for chili calls for 3 g of sodium chloride. How many formula units of NaCl is that?

15. If you used 30.6 g of methanol (CH_3OH) to start a fire, how many molecules did you use?

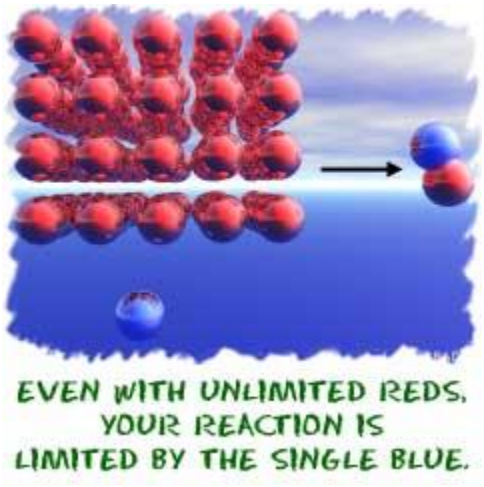
16. A storage tank with a volume of 500. L contains how many moles of He at STP?

17. A chemical reaction between acetic acid and calcium carbonate produces 0.76 mol of CO_2 at STP. How many liters of gas were produced?

18. In an experiment, 12.1 g of dry ice (solid CO_2) were converted into gaseous CO_2 at STP. How many moles were in the sample? What was the volume of gaseous CO_2?

STOICHIOMETRY

Let's start with how to say this word.
Five syllables. STOY-KEE-AHM-EH-TREE.
It's a big word that describes a simple idea.



Stoichiometry is the study of the quantitative aspects of Chemical reactions.

$NaCl + H_2O \rightarrow NaOH + HCl$

This is a balanced equation with coefficients of 1.
The ratio would be 1:1:1:1

Balance these equations and write their ratios.

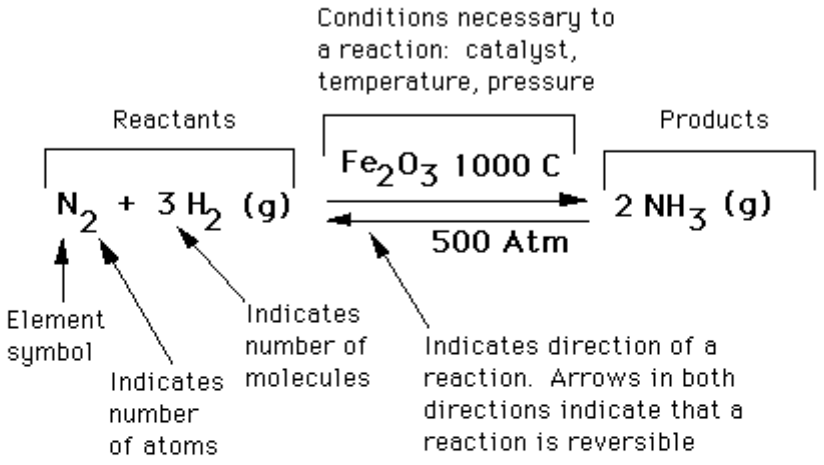
$KCl + MgO \rightarrow K_2O + MgCl_2$ ratio _____

$Cu(NO_3)_2 + CaSO_4 \rightarrow CuSO_4 + Ca(NO_3)_2$ ratio _____

$AlCl_3 + KBr \rightarrow AlBr_3 + KCl$ ratio _____

STOICHIOMETRY ↔ The Chemical Reaction

THE CHEMICAL EQUATION



The coefficient values in an equation do not indicate amounts in any particular system of measure. The coefficients in an equation indicate a *proportion* of one reactant to another. For example, if the following values were assigned to the above equation, differing amounts of the same product would result.

1 molecule N2 + 3 molecules H3 <-----> 2 molecules NH3
1 mole N2 + 2 moles H3 <----> 2 moles NH3
28 metric tons N2 + 6 metric tons H3 <----> 34 metric tons NH3

Source: The Volume Library, Volume One, The SouthWestern Company, Nashville, Tennesse, 1995

In words explain what the following reaction means. Be sure to complete and balance it first.

$Ag + Al_2O_3 \rightarrow$

_____

_____

Molar Ratios

Practice:

Balance the following reactions and answer the questions after them.

$Na_2O + MgF_2 \rightarrow NaF + MgO$

1. If I fully react 2 moles of Na_2O how many moles of NaF will I make?

2. If we produce 3 moles of MgO how many moles of MgF_2 did we start with?

This is a little tougher; lets set up ratios to make sure we get the right answers.

$AlCl_3 + MgCO_3 \rightarrow Al_2(CO_3)_3 + MgCl_2$

1. If we begin with 2 moles of $MgCO_3$ how many moles of $MgCl_2$ can we make?

2. If 0.36 moles of $Al_2(CO_3)_3$ are produced how many moles of $AlCl_3$ did we begin with?

3. If we began with 0.5 moles of $AlCl_3$ how many moles of $MgCl_2$ can we produce?

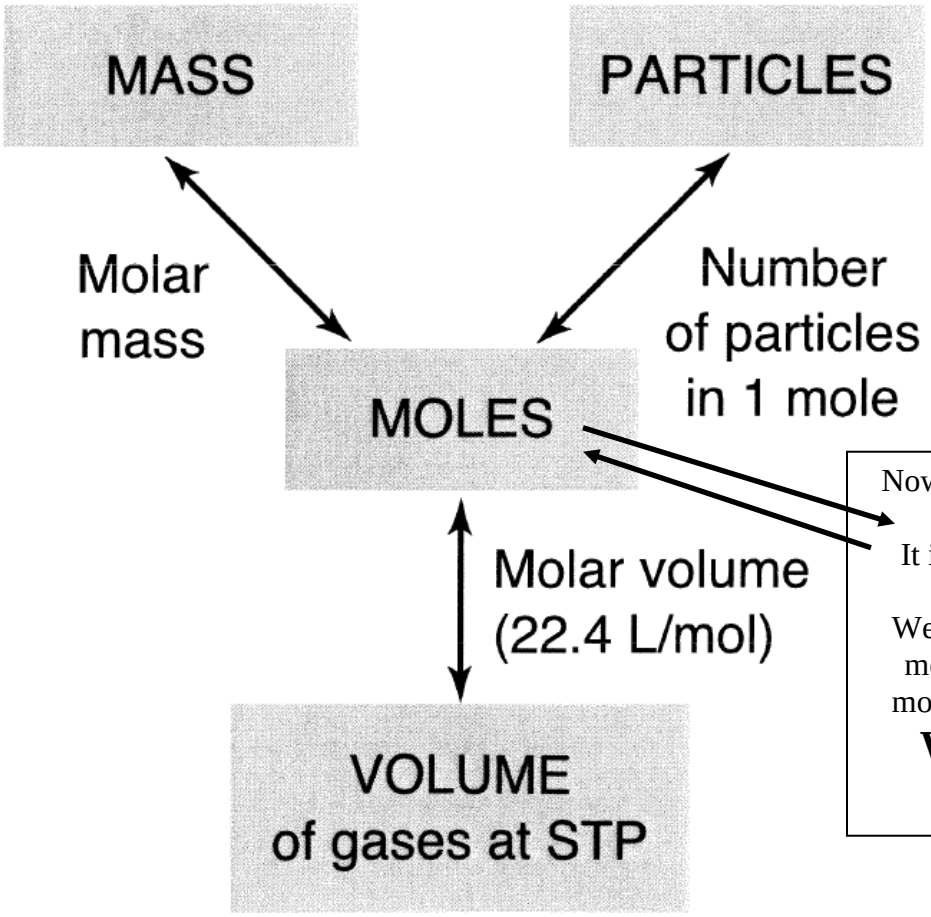
Ok on your own! Hint – always write the equation first.

Lithium sulfide reacts with oxygen gas to create two new products. If we started with 2.2 moles of lithium sulfide how many moles of lithium oxide are produced?

Do pg. 298 #1-10 and pg. 300 #11-18

Day 7

Stepping Up the Mole Bridge



Now we have a middle step to do on the mole bridge.
It is like we are stopping to change our shoes.
We have to convert form the moles of one compound to moles of another compound.
We set up a mole ratio.

Steps:

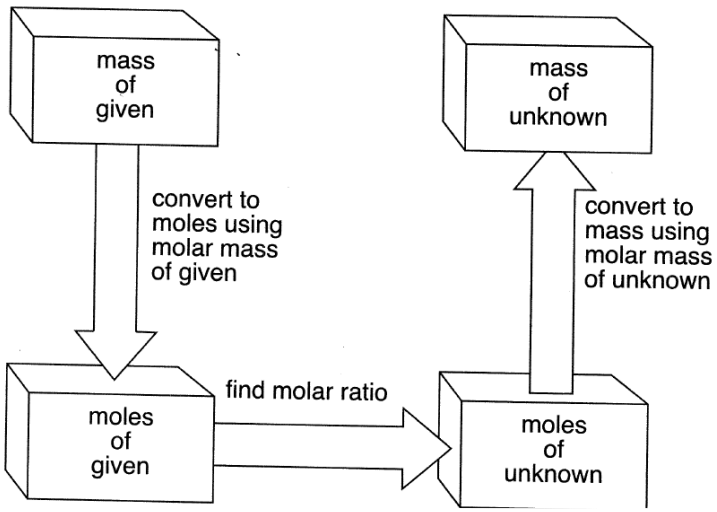
11. Write the balanced chemical equation for the reaction.
12. What are you given?
13. What are you looking for?
14. What do you need to get there? (HINT- the answer to this is always moles.)
15. Set up your **first ration** and solve for moles.
16. _____
    _____
    _____.
17. Set up your **third ratio** with what you are looking for on top. (Hint – moles of your second compound will now be on the bottom.)
18. Double check your units.
19. You did it – a three ratio problem!

There are 3 common Stoichiometry problems:

a. Mass – Mass
b. Mass – Volume
c. Volume - Volume

Mass – Mass Stoichiometry Problems

Process of Solving Mass-Mass Problems



Questions

7. What mass of K_2S is produced if 8.47 grams of potassium reacts with plenty of sulfur?

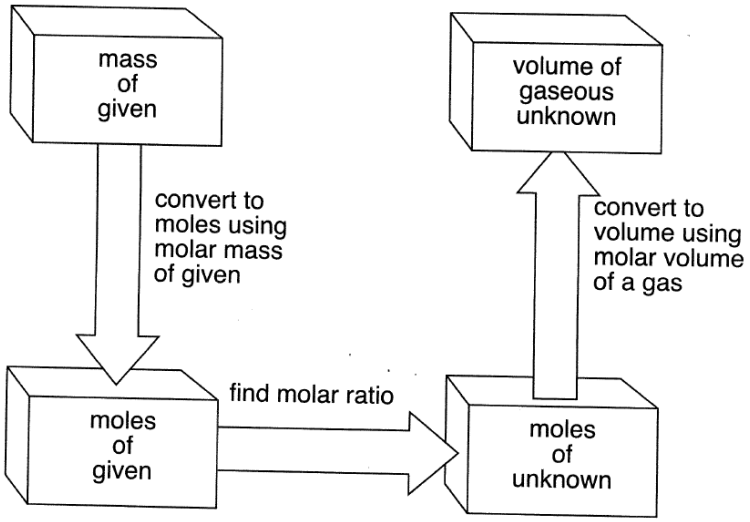
8. What mass of sodium chloride is produced when chlorine gas reacts with 0.29 grams of sodium iodide?

9. Iron will react with oxygen to produce Fe_2O_3. What is the mass of Fe_2O_3 produced if 3 g of oxygen gas is used?

Do page 304 #21-30
p. 305 #1-7, 9, 10

Mass – Volume Stoichiometry Problems

Process of Solving Mass-Volume Problems



Questions

1. How many liters of oxygen are necessary for the combustion of 134 grams of methane (CH_4), assuming that the reaction occurs at STP?

2. In the reaction where hydrogen iodide decomposes to form hydrogen gas and iodine gas, how many liters of hydrogen gas are produced if 22 g of HI decompose?

3. If 8L of CO_2 react with lots of CuO to form $CuCO_3$, what is the weight of the product?

10. Find the mass of sugar ($C_6H_{12}O_6$) required to produce 1.82 L of carbon dioxide gas at STP from the reaction described by the following equation:

$$C_6H_{12}O_6 \rightarrow 2C_2H_6O + 2CO_2$$

11. How many liters of oxygen are necessary for the combustion of 425 g of sulfur, assuming that the reaction occurs at STP? The balanced equation is $S + O_2 \rightarrow SO_2$.

12. Find the mass of benzene (C_6H_6) required to produce 2.66 L of carbon dioxide gas at STP from the reaction described by the following equation:

$$2C_6H_6 + 15O_2 \rightarrow 6H_2O + 12CO_2$$

13. Find the mass of sodium required to produce 5.68 L of hydrogen gas at STP from the reaction described by the following equation:

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

14. How many liters of oxygen are necessary for the combustion of 277 g of carbon monoxide, assuming that the reaction occurs at STP? The balanced equation is

$$2CO + O_2 \rightarrow 2CO_2$$

15. How many liters of oxygen are necessary for the combustion of 134 g of magnesium, assuming that the reaction occurs at STP? The balanced equation is

$$2Mg + O_2 \rightarrow 2MgO$$

16. Find the mass of aluminum required to produce 4.72 L of hydrogen gas at STP from the reaction described by the following equation:

$$2Al + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$$

17. How many liters of hydrogen are produced if 225 g of iron reacts with hydrochloric acid, assuming that the reaction occurs at STP? The balanced equation is

$$Fe + 2HCl \rightarrow FeCl_2 + H_2$$

18. Find the mass of S_8 required to produce 2.47 L of sulfur dioxide gas at STP from the reaction described by the following equation:

$$S_8 + 8O_2 \rightarrow 8SO_2$$

Day 9

Volume – Volume Stoichiometry Problems

Questions

1. What volume of hydrogen disulfide gas is necessary to produce 8.4 L of sulfur gas?
   $SO_2 + 2H_2S \rightarrow 3S + 2H_2O$

Notice a short cut??????

2. $N_{2(g)} + H_{2(g)} \rightarrow NH_{3(g)}$ Balance this equation and then determine the volume of NH_3 produced if we react 22.8L of H_2 with plenty of N_2.

Do Practice Problems 11-2 Questions 20-25

20. What volumes of H_2S gas and oxygen are necessary to produce 14.2 L of sulfur dioxide gas? The balanced equation is

$$2H_2S + 3O_2 \rightarrow 2SO_2 + 2H_2O$$

21. What volumes of sulfur dioxide and dihydrogen sulfide gases are necessary to produce 11.4 L of water vapor? The balanced equation is

$$SO_2 + 2H_2S \rightarrow 3S + 2H_2O$$

22. Glucose ($C_6H_{12}O_6$) burns in oxygen to produce carbon dioxide and water vapor as described in the following equation: $C_6H_{12}O_6 + 6O_2 \rightarrow 6H_2O + 6CO_2$. What volume of carbon dioxide is produced when 3.7 L of oxygen are consumed?

23. The compound TNT (trinitrotoluene) decomposes explosively into carbon, carbon monoxide, hydrogen, and nitrogen. What volumes of hydrogen and nitrogen are produced if 5.8 L of CO is produced? The balanced equation is

$$2C_7H_5(NO_2)_3 \rightarrow 2C + 12CO + 5H_2 + 3N_2$$

24. Nitroglycerin decomposes explosively to produce carbon dioxide, water, nitrogen, and oxygen. What volumes of nitrogen and oxygen are produced if 4.3 L of carbon dioxide is produced? The balanced equation is

$$4C_3H_5(NO_3)_3 \rightarrow 12CO_2 + 10H_2O + O_2 + 6N_2$$

25. Acetylene (C_2H_2) burns in oxygen to produce carbon dioxide and water. The balanced equation for this reaction is $2C_2H_2 + 5O_2 \rightarrow 2H_2O + 4CO_2$. What volume of carbon dioxide is produced when 1.6 L of oxygen are consumed?

You are now ready to do Review with a mixture of Stoichiometry Questions #10-15

10. 20.0 g of potassium react with water to produce potassium hydroxide and hydrogen gas. How many liters would the hydrogen gas occupy at STP?

11. If 30.2 g of aluminum react with HCl to produce aluminum chloride and hydrogen gas, how many liters of hydrogen are produced at STP?

12. How many liters of HCl are produced by the reaction of 5.7 L of hydrogen with an equal amount of chlorine?

13. How many liters of hydrogen are required to react with 0.45 mol of oxygen to produce water?

14. How many liters of SO_2 are produced from the reaction of sulfur with 26.9 L of oxygen?

15. How many grams of zinc chloride will be produced if zinc is allowed to react with 16.8 L of chlorine at STP?

Day 10

Limiting Reactant

Before –
"How much water can be produced when 2.9 L of H_2 gas reacts with lots of oxygen?"

Now –
"How much water can be produced when 2.9 L of H_2 gas reacts with 4.1 L of oxygen?"

Highlight the difference above.

So what is the big deal?!?!?!

What is a limiting reactant?

1.

2.

3. But not necessarily….

For the question above how can we figure out what the limiting reactant is?

Step 1:

Step 2:

Step 3:

Ok do it – "What is the limiting reactant when 2.9 L of H_2 gas reacts with 4.1 L of O_2?"

Limiting Reactant Practice

1. Write the balanced chemical reaction.
2. Calculate the moles of product produced from each reactant. Use molar ratios.
3. Determine your limiting reactant.
4. What is the theoretical yield of product? (How much stuff did we make?)

Example Question 1:
If 2 moles of hydrogen gas, 6 moles of nitrogen gas, and 3 moles of oxygen gas are combined to form HNO_3, which of the reactants is my limiting reactant, and how many moles of HNO_3 can we make?

Example Question 2:
If 0.70 moles of aluminum chloride reacts with 0.45 moles of copper (II) nitrate what is the maximum amount of copper (II) chloride that we can produce?

Practice:

1. What is the LR when 1.2 moles of CuO reacts with 2.1 moles of CO_2 to form $CuCO_3$?

2. What is the limiting reactant when .5 moles of chlorine gas reacts with 0.75 moles of sodium to produce sodium chloride?

1. Identify the limiting reactant when 1.22 g of O_2 reacts with 1.05 g of H_2 to produce water.

2. Identify the limiting reactant when 4.68 g of Fe reacts with 2.88 g of S to produce FeS.

3. Identify the limiting reactant when 5.87 g of $Mg(OH)_2$ reacts with 12.84 g of HCl to form $MgCl_2$ and water.

4. Identify the limiting reactant when 6.25 g of $AgNO_3$ reacts with 4.12 g of NaCl to form $NaNO_3$ and AgCl.

5. Identify the limiting reactant when 7.81 g of HCl reacts with 5.24 g of NaOH to produce NaCl and H_2O.

6. Identify the limiting reactant when 6.33 g of H_2SO_4 reacts with 5.92 g of NaOH to produce Na_2SO_4 and water.

Day 11

More Limiting Reactant Practice

Next step – solve for both products

1. When 2 moles of LiCl react with 4 moles of Na_2O how much of each product can be made?

On your own….

2. When 0.5 moles of CaF_2 reacts with 0.3 moles of K_3N how much of each product can be made?

Next step – solve for mass of product

1. What is the limiting reactant, and the mass of product made when 3 moles of hydrogen gas, 3 moles of sulphur gas, and 4 moles of oxygen gas react to form H_2SO_4?

Do page 309 #31-34, 37, 38

Day 12

Next step – solve for leftover reactant

Introducing the Stoichiometry table (if you want)

How many moles of oxygen gas are left over after 10 moles of oxygen gas reacts with 4 moles of $CuCl_2$ to make copper oxide?

nb		
LR?		
nd		
na		

For the following practice questions you only need to do a number of steps or complete the entire Stoichiometry table:

1. How many moles of excess reactant are there when 5 moles of oxygen gas reacts with 3 moles of hydrogen gas to form water?

2. How much bromine gas is produced when .067 moles of aluminum bromide react with 0.039 moles of oxygen gas? Also how many moles of reactant are left over?

Last two….these are as hard as it gets…lots of steps! You can do it!!!!!

If 4 grams of iron (III) chloride reacts with 8 grams of potassium oxide in a double replacement reaction what is the mass of each product formed?

I am going to get you to hand this question in so make sure your answers are clearly written.

We are going to react 26 litres of hydrogen gas with, 16 grams of carbon and 18 litres of oxygen gas to form H_2CO_3 a solid. What is the mass of product formed and the mass of reactants left over?

Day 13

Percent Yield

Equation:

*****Hint – make sure your two yields are in the same units.

Definitions:

Theoretical yield –

Experimental yield -

Sources of Error

Why do we not always have 100% yield?

Practice Questions

1. In a lab experiment where we combined hydrogen gas and oxygen gas with energy to form water, we expected to create 40 g of water. When the experiment was complete we had only formed 32g of water. What was our percent yield?

2. In the laboratory we were able to successful form 18 g of gold. The theoretical yield for the experiment was 0.5 moles of gold. What was our percent yield?

3. Calculate the theoretical yield of NaCl when 5 g of sodium oxide is combined with 6 g of aluminum chloride. The percent yield we got when we did the double replacement reaction was only 75%. How much NaCl did we make in the lab?

Day 14

Stoichiometry Review

The outcomes listed below describe what you should be able to do for this test. Read each over carefully and decide if you know how to do it. Work first on those outcomes you find most difficult. Make sure you can do what each outcome says.

Here are some suggestions for studying.

1. Complete your worksheet booklet. There is lots of practice in it to help you review.

2. Review the notes, worksheets, labs and quizzes for the unit.

- Solve mole - mole problems given enough information to write a balanced equation
- Solve mass - mass problems given enough information to write a balanced equation
- Solve mass - volume problems given enough information to write a balanced equation
- Solve volume - volume problems given enough information to write a balanced equation
- Identify limiting reactant given the amounts of reactants. These are our Stoichiometry box questions.
- Determine theoretical yield and percent yield from experimental data
- Calculate the mass of product formed given amounts of reactants and enough information to write a balanced equation

On the next page are two **extra BIG Stoichiometry** questions. There will be one just like these on the test.

1. If 2.0 g of Nitrogen gas reacts with 4L of oxygen and 1 g of hydrogen to form HNO_3. IN the lab the percent yield was 46%, calculate the experimental yield (so you need to find the theoretical yield) of product.

2. If 6 L of hydrogen, 12 g of sulfur, and 14 L of oxygen react together to form H_2SO_4, which reactant is the limiting reactant, what is the mass of reactant left over and the mass of product formed.

REVIEW PRACTICE QUESTIONS
ALL MIXED UP KNIDS

Solve the following problems on a separate sheet of paper. Show all your work.

16. Use the chemical reaction $2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$ to answer the following questions.

a. How many moles of CO_2 are produced for every mole of C_6H_6 reacted?

b. How many liters would this amount of CO_2 occupy at STP?

c. What volume of CO_2 will be produced when 128.0 g of C_6H_6 reacts at STP?

17. When propane (C_3H_8) reacts with oxygen, carbon dioxide and water are produced.

a. When 7.51 g of propane reacts with excess oxygen, how many grams of carbon dioxide are formed?

b. If 18.6 g of carbon dioxide are actually formed, what is the percent yield of this reaction?

18. Aluminum reacts spontaneously with bromine to produce $AlBr_3$.

a. If 15.0 g of aluminum react with 46.0 g of bromine, which is the limiting reactant?

b. What is the percent yield of this reaction if 31.0 g of $AlBr_3$ are produced?

19. The commercial production of nitric acid (HNO_3) involves the reaction of nitrogen dioxide gas (NO_2) with water. An additional byproduct is NO.

a. How many kilograms of NO_2 are needed to produce 500. kg of nitric acid?

b. If this process has a percent yield of 88%, calculate the actual yield in this reaction.

22. Aluminum chloride is made by reacting scrap aluminum with chlorine gas.

a. Which is the limiting reactant when 3.5 g of Al and 5.6 g of Cl_2 react?

b. How many grams of aluminum chloride are produced?

c. What is the mass of the remaining excess reactant when the reaction is complete?

23. Acetylene gas (C_2H_2) is used by welders.

a. If acetylene and oxygen are supplied in tanks of equal size, at STP, how many tanks of oxygen would be needed to burn one tank of acetylene?

b. Why do you think welders often carry a large tank of oxygen and a small tank of acetylene on welding carts?

24. Phosphorus and bromine react vigorously together to form PBr_3.

a. If 5 g of phosphorus and 35 g of bromine react, which is the limiting reactant?

b. How many grams of PBr_3 will be produced?

c. If the actual yield of PBr_3 is 30 g, what is the percent yield?

15. If 21.4 g of aluminum is reacted with 91.3 g of Fe_2O_3, the products will be Al_2O_3 and iron. What mass of iron will be produced?

22. Determine the percent yield for the reaction between 46.1 g of Cs and 13.4 g of O_2 if 28.3 g of Cs_2O is produced.