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Unit 9: The Mole- Guided Notes

What is a Mole?

- A mole is a name for a specific _____________ of things
  - Similar to a ____________________ or a _____________________
- One mole is equal to…
  - 602 ___________________________________
  - 602,000,000,000,000,000,000,000
    - That's 602 with ____________________ zeros
  - ____
- A mole is NOT an abbreviation for molecule
- A mole is also called ____
- How many donuts are in one dozen donuts? ______________________
- How many donuts are in one mole of donuts? ______________________
- How many jelly beans are in one dozen jelly beans? ______________________
- How many jelly beans are in one mole of jelly beans? ______________________
- How many of anything are in one dozen anything? ______________________
- How many of anything are in one mole of anything? ______________________

Definition of the Mole:

- The number of ______________________________ equal to the number of atoms in exactly ______________________________ of Carbon-12
- The quantity of ____
- Why are the moles of water molecules and sugar molecules so much smaller than the moles of jelly beans and donuts?
- Why do you think scientists use the mole?
- Think of the mole as a bridge…..It connects the microscopic world (of atoms and molecules) that we cannot see to the macroscopic world we live in
- The mole will be the bridge connecting moles, ____________________________, ____________________________________, and ________________________________

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Moles and Mass

- What is the desired unit in a lab for mass? ___________________________
- We need to relate the atomic mass (___________) of an element to an amount of the element in _________________________________
  - The MOLE relates these two!
- The ______________________________ of a substance is equal in magnitude to the ____ of a substance
  - For example the atomic mass of hydrogen is _____________________________ and the molar mass of hydrogen is _______________________________________

Molar Mass

- Mass of ___________________________________ (or 6.02×10^{23}) of a substance.
- Equal to the magnitude of the atomic mass of an element.
- Measured in ____
- The molar mass of each individual element is listed on the periodic table
- Practice:
  - What is the molar mass of Sodium?
  - What is the mass of a mole of Nitrogen?
  - What is the mass of 6.02×10^{23} atoms of fluorine?
  - What do you call the mass of a mole?
- Calculating Molar Mass
  - To calculate molar mass you _____________________ the mass of each atom in a compound
  - Example: Determine the molar mass of $CaCl_2$
    - How many calcium atoms are in $CaCl_2$? ___________________
    - How many chlorine atoms are in $CaCl_2$? __________________
  - Add the mass of 1 calcium atom plus the mass of 2 chlorine atoms

- Practice: 1) What is the molar mass of magnesium nitrate, $Mg(NO_3)_2$?

  2) What is the mass of one mole of $Al(OH)_3$?

  3) What is the mass of 6.02×10^{23} molecules of water?

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Percent Composition:

- What is a percentage?
- What does it mean if you made an 88% on a test?
- A percentage is simply ____
- How would you calculate the percentage of people in this class wearing glasses?

- Percent composition is another type of percentage.
- Percent composition is the percentage by _________________ of each element in a compound

- % composition=

- Round your answer to __________ decimal places
- The total % composition of a compound should add up to _______________________________
- Fine the percent composition of Carbon in the following:
    - C_3H_7OH
    - CO_2

- Practice: Determine the percent composition of all of the elements in the following compounds (remember you already did Carbon).

    1) C_3H_7OH

    2) CO_2

    3) If you add the percent composition for each element in a compound what will your answer be?

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Mass ←→ Moles

- When converting between mass (_____________) and moles, you MUST determine the ____
- ____ will be used as a conversion factor to convert between units of _____________________ and units of __________________
    - Because molar mass is the mass of _____________ mole of substance the conversion factor can be written as
- When converting between mass (g) and moles, look at the units to determine if you need to multiply or divide
    1) What is the mass of 0.045 moles of NaCl? (remember to find molar mass)
    2) If a student measured 0.25g of NaCl in lab, how many moles does the student have?
- Practice: Convert the following to grams:
    3) 1.70 mole of $KMnO_4$
    4) 2.5 mole CO_2
    5) 1.98 x 10^5 moles of $AlBr_3$
- Practice: Convert the following to moles:
    6) 74g of KCl
    7) 125g of H_2SO_4
    8) 0.00745g of $(NH_4)_2S$

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Types of Particles (Review)

Type of Particles	Explanation	Examples
Atoms	• Smallest component of an element that retains its chemical properties • Made up of protons, neutrons, and electrons	
Molecules	• Two or more atoms are chemically bonded together • Types of molecules include: Diatomic molecules, compounds, formula units, etc	

Mole ←→ Particles

- 1 mole of a substance is equivalent to _____________________________ particles of substance
- To convert between moles and particles use the conversion factor

  _____________________________=_____________________________
- Example 1: How many compounds are in 2.34 moles of sodium chloride?
- Example 2: How many moles are in 8.23×10^{32} molecules of water?
- Practice:
  1. How many moles are in 9.21×10^{44} molecules of Hydrofluoric acid?
  2. How many atoms of sodium are in 13.2 moles of sodium?
  3. How many atoms of oxygen are in one molecule of Phosphoric acid?
  4. How many atoms of oxygen are in 18.9 moles of phosphoric acid (hint convert to molecules first then convert to atoms)?

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Volume ←→ Moles

- __________________________ stands for standard temperature and pressure
    - Because gases ________________________________ differently at different temperatures and pressures, we have to be specific about the temperature and pressure of a gas we are discussing
    - Standard temperature= ___________________
    - Standard pressure= _______________________
    - All problems in this are at STP unless otherwise stated
- The volume (_____________) occupied by one mole of ___________________ at STP is always _________________________________
    - ____________________________ = ___________________________
    - We can use this as a conversion factor when converting between volume and moles
- Example 1: What volume will 5.99 moles of oxygen gas occupy at STP?
- Example 2: If a gas occupies 0.176 L of space at STP, how many moles of gas are present?
- Practice:
    1. If a sample of carbon dioxide occupies 457 L of space at STP, how many moles of carbon dioxide gas are present?
    2. A sample of gas was measure to contain 4.23 moles of gas at STP. What is the volume of this gas?

Mole Math Practice

1. What is the mass of 1.23 x 10^{25} atoms of potassium metal?
2. What volume would 75 g of oxygen gas (O_2) occupy at STP?
3. How many compounds of carbon dioxide are present in 15 L of carbon dioxide at STP?

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4. What volume would 6.5 x 10^{20} molecules of hydrogen gas (H_2) occupy at STP?

5. How many atoms of aluminum are in a 0.50gram sample of aluminum metal?

6. What would the mass of a 32L sample of Neon be at STP?

Molecular and Empirical Formula

- ______________________________ is a group of element symbols with subscripts which represent the actual composition of a molecule. Shows the actual # of each atom found in a specific molecule (not simplified)
- _______________________ shows the simplest whole number ratio for the elements in the compound. (i.e. simplified molecular formula)
    - To find the EF, determine the largest common denominator of the subscripts of the MF.
        - Sometimes the EF = MF (especially with _____________________________)
- Example: Determine the empirical formula for the following:

Molecular Formula	Empirical Formula
1. H_2O	
2. H_2O_2	
3. $C_6H_{12}O_6$	
4. CH_4	
5. C_2H_6	
6. C_8H_{18}	

- Determining the **Molecular Formula**
    - You are given: EF and Molar Mass of the MF

1. Determine the ________________________ of the EF.
2. ___________________ the molar mass of the MF (given) by the molar mass of the EF
3. mm MF ÷ mm EF = a multiple
4. _______________________ the subscripts of the EF by the answer the step 2.

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- Molecular Formula Practice:

  1. What is the molecular formula of a compound that has a molar mass of 98.21 g/mol and an empirical formula of CH_2?

  2. What is the molecular formula of a compound that has a molar mass of 120.02 g/mol and an empirical formula of CO_3?

- Determining the Empirical Formula
  - Given: percent composition of each element in the compound
  - Steps to determine EF:
    1. Use the mass given, or if no mass given assume there is exactly _______________________ of the substance (aka change percent sign to grams).
    2. Convert mass into __________________ of each element (by dividing the mass by the molar mass of the atom). This will give you moles of the atom. Keep _____ decimal places.
    3. Compare the mole quantities by dividing all moles by the smallest number of moles (*this step should produce a whole number)
    4. Use the ratios from step 3 as _________________________________.
- Problem: Determine the empirical Formula for a compound with the following composition:

40.00% C 6.72% H 53.28% O

- Now using the EF to calculate the MF. Suppose the molar mass of the MF is 180 g/mol. What is the molecular formula?

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- Empirical Formulas: If you do not get _______________ numbers when you divide by smallest number of moles, and you get a number that ends in .5, multiply ALL ELEMENTS by ________ (because .5 is really ½)
    - If you don't get whole numbers and you get a decimal other than .5, you messed up
- Why do we want whole numbers?

- Example #2: Calculate the empirical formula of a compound containing 38.67% C, 16.22% H, and 45.11% N.

- Example 2 Continued: After determining the EF, suppose the molar mass of this compound is 93.21 g/mol and determine the MF.

- Example 3: A substance is 41.87% C, 2.35% H, and 55.78% O. What is the empirical formula?

- Example 4: Caffeine is 49.48% C, 5.15% H, 28.87%N, and 16.49% O. What is the empirical formula?