

Chapter 10: Molar Relationships

(PreIB)

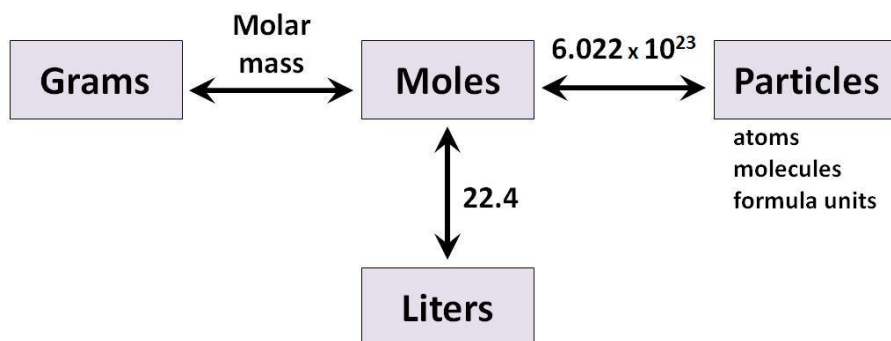
Name: _____

Chemistry, Mrs. Cook

Chapter 10 Notes of Concepts

- Atoms and molecules are too small to count by usual means!!
- Avogadro's number = 6.022×10^{23} particles = 1 mole
- Types of particles in chemistry:
 - atoms
 - molecules (covalent bonds)
 - formula units (ionic bonds)
- molar mass = mass of one mole of a substance
 - found using the periodic table
 - also referred to as *formula mass* or *molecular mass*
- 1 mole of a gas at STP = 22.4 L
 - STP = "standard temperature & pressure"
 - 0°C or 273 K
 - 1 atmosphere of pressure

Flow chart for molar conversions:

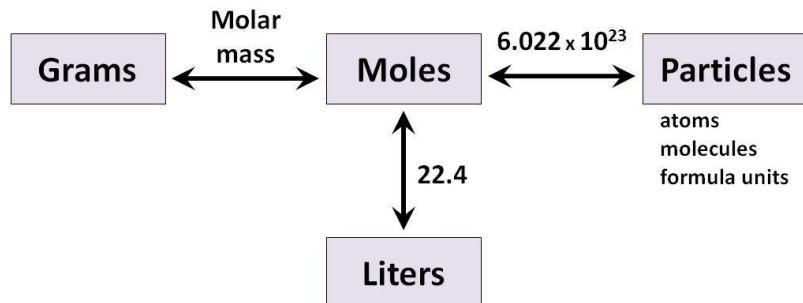


Assignment 1 - Understanding "The Mole"

- 1) Answer in your own words, using an example: "What is a mole?"
Avogadro's number, which is 6.022×10^{23} particles of anything. Chemists specifically use atoms, molecules, and formula units. BUT a mole could represent anything. For example, a mole of manatees would be 6.022×10^{23} manatees.
- 2) How many atoms are in a mole of anything? 6.022×10^{23}
 - a. What is the title of this number? Avogadro's number
- 3) What is the mass of one mole of $C_6H_{12}O_6$ (glucose)
180.18 g
- 4) Find the molar mass of $Al_2(SO_4)_3$
342.2 g
- 5) Determine the formula mass of $(NH_4)_2S$
68.08 g

6) How many liters of any gas are in one mole? **22.4**

7) Draw the chart that shows how to convert between grams, moles, and liters:



Assignment 2 - Single Step Conversions

Examples of how to use dimensional analysis for molar conversions:

$$2.50 \cancel{\text{ mol}} \times \frac{16.00 \text{ g}}{1 \cancel{\text{ mol}}} = \underline{\hspace{2cm}} \text{ g}$$

OR

$$24.02 \cancel{\text{ g}} \times \frac{1 \text{ mol}}{12.01 \cancel{\text{ g}}} = \underline{\hspace{2cm}} \text{ mol}$$

8) Convert 0.89 mol of CaCl_2 to grams.

98.77 g

9) How many moles are in 158.1 grams of PbSO_4 ?

0.52 mol

10) Find the mass of 1.112 mol of HF. **Hint:** What unit is "mass" measured in? grams!

22.25 g

11) What are the three types of "particles" in chemistry?

atoms, molecules, formula units

12) Determine the number of atoms that are in 0.58 mol of Se.

3.49×10^{23} atoms

13) How many moles of barium nitride (Ba_3N_2) are there in 4.7×10^{24} formula units?

7.80 mol

14) Determine the number of molecules that are in 1.25 mol of O_2 .

7.53×10^{23} molecules

15) What does "STP" stand for? **standard temperature & pressure**

16) What volume will 0.37 mol of N₂ gas occupy at STP?

8.29 L

17) A canister with a volume of 69.4 L contains how many moles of oxygen at STP?

3.10 mol

18) A chemical reaction produces 13.8 mol of carbon monoxide. What volume will the gas occupy at STP?

309.12 L

Assignment 3 - Multi-Step Conversions

Examples of how to use dimensional analysis for multi-step molar conversions:

***your dimensional analysis setup will have "two bars"*

$$2.0 \times 10^{10} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{312.4 \text{ grams}}{1 \text{ mol}} =$$

19) What mass of C₂H₆ is in 6.45 × 10²⁴ molecules?

322.18 g

20) How many formula units are in 5.1 g of TiO₂?

3.85 × 10²² formula units

21) What mass of helium will occupy 5.6 L at STP?

1.0 g

22) What volume would 46.8 grams of Cl₂ occupy at STP?

14.79 L

23) What volume would 3.33×10^{25} atoms of krypton occupy at STP?

1238.66 L

24) How many molecules are there in 12 L of carbon dioxide at STP?

3.23×10^{23} molecules

25) What would the volume be of 2.3×10^{23} molecules of CO at STP?

8.56 L

26) What is the mass of 3.62×10^{24} molecules of methanol (CH₃OH)?

192.36 g

Review Questions for Assignment 3

27) How many particles are in a mole? 6.022×10^{23}

28) How many liters are in one mole of a gas? 22.4

29) What are the three types of "particles" in chemistry?

atoms, molecules, formula units

30) What are the units for molar mass? grams or $\frac{g}{mol}$

Assignment 4 - Percent Composition

Steps:

1. Find mass of individual elements
2. Add together to get molar mass
3. Divide individual mass of element by the total molar mass
**multiply by 100

$$\frac{\text{part}}{\text{whole}} \times 100 = \text{percent}$$

31) What is the percent composition of each element in GaBr₃?

% Ga = 22.53 %

% Br = 77.47 %

32) What is the percent composition of *each* element in $\text{Al}_2(\text{CO}_3)_3$?

% Al = 23.06 %

% C = 15.40 %

% O = 61.54 %

33) What is the percent composition of *phosphorus* in $\text{Mg}_3(\text{PO}_4)_2$?

% P = 23.56 %

Relationships between Empirical and Molecular Formulas

Steps:

1. Find molar mass of empirical formula
2. Determine the factor relating the empirical and molecular formulas
 - Use multiplication or division
3. Multiply the subscripts of the empirical formula by that factor

34) What is the molecular formula of a compound that has a molar mass of 132.24 g/mol and an empirical formula of C_3H_8 ?

C_9H_{24}

35) A molecular compound has a molar mass of 128.14 g/mol and the empirical formula SO_2 . What is the molecular formula?

S_2O_4

36) A compound has a molar mass of 283.6 g/mol and its empirical formula is P_2O_5 . What is its molecular formula?

P_4H_{10}

37) What is the molecular formula of a substance that has an empirical formula of NO_2 and a molecular mass of 138 g/mol?

N_3O_6

Assignment 5 - Calculating Empirical Formulas

Steps:

1. Put g in place of % ...if not already in grams
(~~we~~ we are assuming the sample size is 100 g because % are out of 100)
2. Divide each type of atom by its atomic mass
3. Find smallest number and divide all atoms by that number
4. Use the results (a "mole ratio") as subscripts in the chemical formula
5. Adjust fractions to whole numbers using multiplication
Example: $C_1H_{\frac{7}{2}}$ doesn't exist, so multiply all subscripts by the denominator two to get C_2H_7

38) A compound is 75% carbon and 25% hydrogen. What is its empirical formula?



39) A compound is 3.061g of hydrogen, 31.633g of phosphorus, and 65.306g of oxygen. What is the empirical formula?



40) A compound is 38.8% chlorine and 61.2% oxygen. What is its empirical formula?



41) A compound is 35.93% aluminum and 64.07% sulfur. What is its empirical formula?



42) A compound is 50% sulfur and 50% oxygen. What is its empirical formula?



43) An 87g sample contains 6.89g carbon and 80.22g chlorine. What is the empirical formula?



Review Questions for Assignment 5

44) What is the empirical formula of:

- a) $\text{C}_6\text{H}_{12}\text{O}_6$ CH_2O b) N_2O_4 NO_2
c) C_3H_6 CH_2 d) C_6H_6 CH

45) Find the percent composition of each element in $\text{Fe}_2(\text{SO}_4)_3$

$\% \text{Fe} = 27.93 \%$

$\% \text{S} = 24.06 \%$

$\% \text{O} = 48.00 \%$

46) A compound has molar mass of 51g and an empirical formula of NH_3 . What is the molecular formula?



47) What is the mass of 4.30×10^{21} molecules of octane (C_8H_{18})?

0.81 g

Assignment 6 - Calculating Molecular Formulas

*Steps: **this is a continuation of Steps #1-5 for "Calculating Empirical Formulas"*

- 6. Calculate mass of empirical formula and compare to given mass (see Assignment #4)*
- 7. Multiply each subscript of empirical formula by multiplying factor*

48) A compound is 82.76% carbon and 17.24% hydrogen. It has a molecular mass of 58g. What is the molecular formula?



49) Find the molecular formula of a compound that contains 42.56g palladium and 0.80 g of hydrogen. The molar mass of the compound is 216.8 g/mol.



50) A compound is 30.435% nitrogen and 69.565% oxygen. It has a molecular mass of 92g. What is the molecular formula?



51) Find the molecular formula of a compound given that a 212.1g sample contains 169.7g of carbon and 42.4g of hydrogen and the molar mass is 30 g/mol.



52) What is the molecular formula of a compound that has 83.72% carbon and 16.28% hydrogen and a molar mass of 86.2 g?



Review Questions for Assignment 6

53) What volume will be occupied by a gas containing 6.02×10^{23} atoms at STP? **22.4**

54) What is the mass of one mole of $\text{Ca}(\text{OH})_2$? **74.1 g**

55) What is the mass of 2 moles of HgO ? **433.18 g**