Chemistry
Tigard High
2017 - 2018

Name KEY Block___ Date____

Due ☞ Test Day!

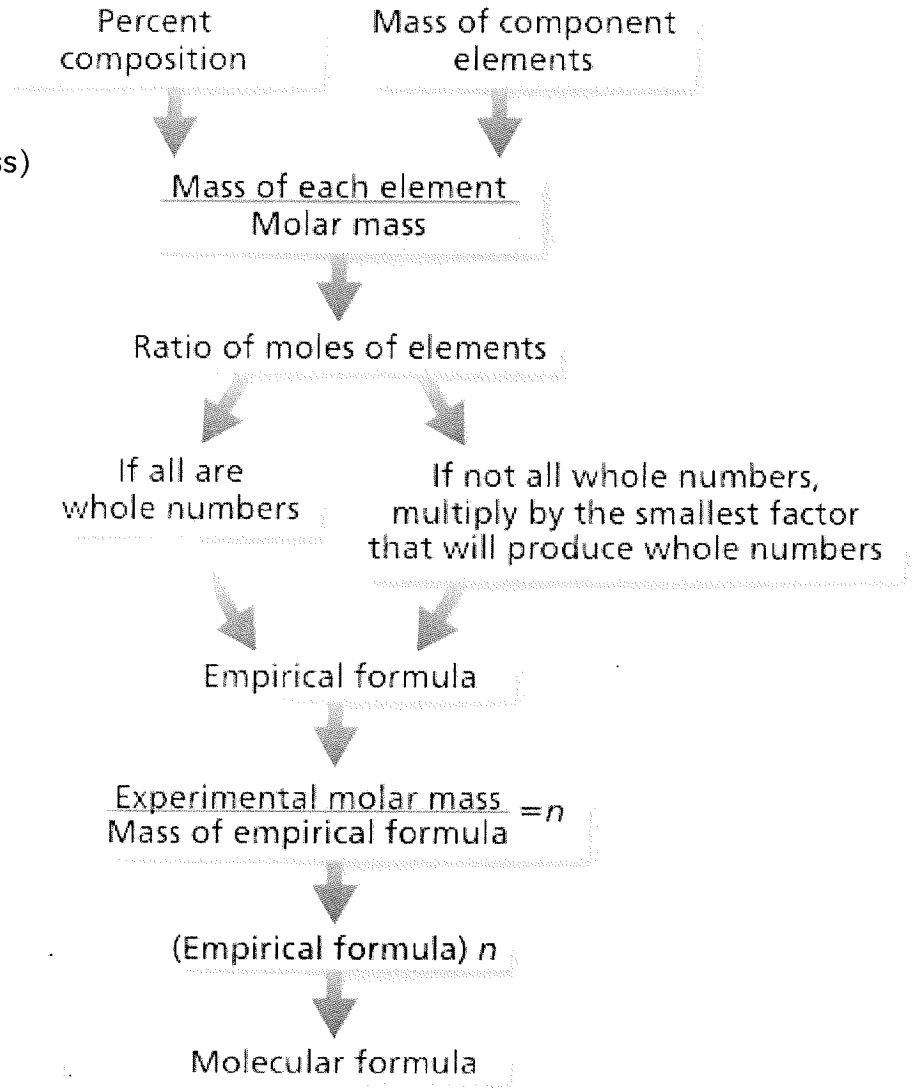
Pretest Unit 7
The Mole

The following is an overview of the concepts, ideas, and problems we have covered in this unit. You are, however, responsible for all material covered, regardless if found here or not! Therefore, be sure to review all your notes, worksheets, assignments, handouts, readings, labs, problems, etc.. On the day of the test you will want to be well-acquainted with the material and organized, you will not want to waste time trying to understand an idea or searching for some needed information. Arrive prepared!

Text References:
- Introduction to the Mole (3.3, pages 79-83)
- Using Chemical Formulas (7.3)
- Determining Chemical Formulas (7.4)

Know the following vocabulary terms:

- the mole
- molar mass (formula mass)
- percent composition
- empirical formula
- molecular formula
- mole ratio
- hydrate
- anhydrate



Practice Problems (Show all work, with correct units and sig figs!)

1. Perform the following conversions:

   a. How many molecules are in 100.0 grams of ammonia, NH_3?

$$100.0\text{ g } NH_3 \times \frac{1\text{ mol } NH_3}{17.04\text{ g } NH_3} \times \frac{6.02\times10^{23}\text{ molecules}}{1\text{ mol } NH_3} = \boxed{3.533\times10^{24}\text{ molecules } NH_3}$$

   b. 4.50 g $Al(OH)_3$ = ___?___ mol

$$4.50\text{ g } Al(OH)_3 \times \frac{1\text{ mol}}{78.01\text{ g}} = \boxed{0.0577\text{ mol}}$$

   c. 0.00120 mol H_2O = ___?___ g

$$0.00120\text{ mol } H_2O \times \frac{18.02\text{ g}}{1\text{ mol}} = \boxed{0.0216\text{ g}}$$

   d. 0.100 g $AuCl_3$ = ___?___ mol

$$0.100\text{ g } AuCl_3 \times \frac{1\text{ mol}}{303.32\text{ g}} = \boxed{0.000330\text{ mol}} \quad \text{or } 3.30\times10^{-4}\text{ mol}$$

   e. 0.0250 mol magnesium phosphate = ___?___ g

$$0.0250\text{ mol } Mg_3(PO_4)_2 \times \frac{262.87\text{ g}}{1\text{ mol}} = \boxed{6.57\text{ g}}$$

2. How many moles of nitrogen are in 10.0 grams of aluminum nitrate, $Al(NO_3)_3$?

$$10.0\text{ g } Al(NO_3)_3 \times \frac{1\text{ mol } Al(NO_3)_3}{213.01\text{ g}} \times \frac{3\text{ mol N}}{1\text{ mol } Al(NO_3)_3} = \boxed{0.141\text{ mol N}}$$

3. How many <u>total</u> atoms are in 25.0 g of methane, CH_4?

$$25.0\text{ g } CH_4 \times \frac{1\text{ mol } CH_4}{16.05\text{ g } CH_4} \times \frac{6.02\times10^{23}\text{ molecules } CH_4}{1\text{ mol } CH_4} \times \frac{5\text{ atoms}}{1\text{ molecule } CH_4} = \boxed{4.69\times10^{24}\text{ atoms}}$$

4. One mole of any gas at standard temperature and pressure (STP) will have a volume of 22.4 L. This is called the molar volume of a gas. Use this relationship to calculate the density of neon gas in g/L. [Recall, density = mass/volume]

Ne molar mass → 1 mol = 22.4 L

$$\frac{20.18\text{ g}}{22.4\text{ L}} = \boxed{0.901\text{ g/L}} \quad \text{or} \quad \frac{20.18\text{ g}}{1\text{ mol}} \times \frac{1\text{ mol}}{22.4\text{ L}} = 0.901\text{ g/L}$$

5. What is the percent composition (percentage by mass) of sucrose ($C_{12}H_{22}O_{11}$)?

molar mass = $12(12.01) + 22(1.01) + 11(16.00) = 342.34\,g$

$\%\,C = \frac{12(12.01\,g)}{342.34\,g} \times 100 = \boxed{42.10\%}$

$\%\,H = \frac{22(1.01)\,g}{342.34\,g} \times 100 = \boxed{6.49\%}$

$\%\,O = \frac{11(16.00\,g)}{342.34\,g} \times 100 = \boxed{51.41\%}$

6. What is the percent composition (percentage by mass) of a compound if a sample is found to contain 60.117 g Ca and 106.359 g Cl. [Hint: What is the total mass of the sample?]

total mass = $60.117\,g + 106.359\,g = 166.476\,g$

$\%\,Ca = \frac{60.117\,g}{166.476\,g} \times 100 = \boxed{36.112\%}$

$\%\,Cl = \frac{106.359\,g}{166.476\,g} \times 100 = \boxed{63.888\%}$

7. When an oxide of potassium is decomposed, 19.55 g K and 4.00 g O are obtained. What is the empirical formula and name for the compound?

$19.55\,g\,K \times \frac{1\,mol}{39.10\,g} = \frac{0.50\,mol\,K}{0.25\,mol\,O} = \frac{2\,mol\,K}{1\,mol\,O}$

$4.00\,g\,O \times \frac{1\,mol}{16.00\,g} = 0.25\,mol\,O$

Formula: K_2O	Name: potassium oxide

8. A 200 g sample of a compound was determined to contain 112.6 g oxygen and 87.28 g phosphorus.

a. Calculate the empirical formula of the compound.

$112.6\,g\,O \times \frac{1\,mol}{16.00\,g} = \frac{7.038\,mol\,O}{2.818\,mol\,P} = \frac{2.498\,mol\,O}{1\,mol\,P} \times \frac{2}{2} \approx \frac{5\,mol\,O}{2\,mol\,P}$

$87.28\,g\,P \times \frac{1\,mol}{30.97\,g} = 2.818\,mol\,P$

$\boxed{P_2O_5}$

b. If the molar mass of the compound was determined to be 283.9 g/mol, what is its molecular formula? What is the name of the compound?

$P_2O_5 \quad 2(30.97\,g) + 5(16.00\,g) = 141.94\,g$

$n = \frac{283.9\,g}{141.94\,g} \approx 2 \quad 2(P_2O_5) \Rightarrow \boxed{P_4O_{10}}$

Formula: P_4O_{10}	Name: tetraphosphorus decoxide

9. A compound was found to contain 49.98 g carbon and 10.47 g hydrogen. The molar mass of the compound is 58.12 g/mol. Determine the empirical and molecular formulas.

$$49.98\,g\,C \times \frac{1\,mol}{12.01\,g} = 4.161\,mol\,C$$

$$10.47\,g\,H \times \frac{1\,mol}{1.01\,g} = \frac{10.37\,mol\,H}{4.161\,mol\,C} = \frac{2.493\,mol\,H}{1\,mol\,C} \times \frac{2}{2} \approx \frac{5\,mol\,H}{2\,mol\,C}$$

E.F. C_2H_5 molar mass $= 2(12.01\,g) + 5(1.01\,g) = 29.05\,g$

$$n = \frac{58.12\,g}{29.05\,g} \approx 2 \qquad 2(C_2H_5) \Rightarrow C_4H_{10}$$

Empirical Formula: C_2H_5	Molecular Formula: C_4H_{10}

10. Calculate the empirical formula of a compound composed of 39.7% chromium, 17.6% sodium, and 42.7% oxygen. then name the compound. (Note: You'll again have to think a little outside the box to get this one right!).

$$39.7\,g\,Cr \times \frac{1\,mol}{52.00\,g} = 0.763\,mol\,Cr$$

$$17.6\,g\,Na \times \frac{1\,mol}{22.99\,g} = \frac{0.766\,mol\,Na}{0.763\,mol\,Cr} = \frac{1\,mol\,Na}{1\,mol\,Cr} \times \frac{2}{2} = \frac{2\,mol\,Na}{2\,mol\,Cr}$$

$$42.7\,g\,O \times \frac{1\,mol}{16.00\,g} = \frac{2.67\,mol\,O}{0.763\,mol\,Cr} = \frac{3.49\,mol\,O}{1\,mol\,Cr} \times \frac{2}{2} \approx \frac{7\,mol\,O}{2\,mol\,Cr}$$

denominators in mole ratio must agree!

$Na_2Cr_2O_7$
sodium dichromate

=Do the remaining problems AFTER we have done the hydrate lab=

11. Use the following data to determine the chemical formula and name for a hydrate of aluminum bromide, $AlBr_3 \cdot XH_2O$.

Data	Mass (g)
Crucible and lid	*4.26*
Crucible, lid and hydrate	*8.6*
Crucible, lid and anhydrate (after heating)	*7.35*

anhydrate ($AlBr_3$)

$7.35\,g - 4.26\,g = 3.09\,g\ AlBr_3$

$3.09\,g \times \frac{1\,mol}{266.71\,g} = 0.0116\,mol\ AlBr_3$

water

$8.60\,g - 7.35\,g = 1.25\,g\ H_2O$

$1.25\,g\ H_2O \times \frac{1\,mol}{18.02\,g} = 0.0694\,mol\ H_2O$

$\frac{0.0694\,mol\ H_2O}{0.0116\,mol\ AlBr_3}$

$= \frac{5.98\,mol\ H_2O}{1\,mol\ AlBr_3} \approx \frac{6\,mol\ H_2O}{1\,mol\ AlBr_3}$

Formula:	Name:
$AlBr_3 \cdot 6H_2O$	aluminum bromide hexahydrate

12. A common hydrate of cobalt(II) chloride is analyzed in the lab. If 11.75 g of this hydrate is heated, 9.25 g of anhydrous cobalt chloride remains. What is the chemical formula and name for this hydrate?

anhydrate $9.25\,g\ CoCl_2 \times \frac{1\,mol}{129.83\,g} = 0.0712\,mol\ CoCl_2$

H_2O $11.75\,g - 9.25\,g = 2.50\,g\ H_2O$

$2.50\,g\ H_2O \times \frac{1\,mol}{18.02\,g} = 0.139\,mol\ H_2O$

$\frac{0.139\,mol\ H_2O}{0.0712\,mol\ CoCl_2} \approx \frac{2\,mol\ H_2O}{1\,mol\ CoCl_2}$

Formula:	Name:
$CoCl_2 \cdot 2H_2O$	cobalt(II) chloride dihydrate

13. What is the difference between an atom and a molecule?

A molecule is a group of atoms bonded together (atoms make up molecules)

1 molecule
3 atoms

14. What is the difference between a molecule and a mole?

1 mole is the amount of a pure substance that contains 6.02×10^{23} particles

1 mol = 6.02×10^{23} molecules or atoms or formula units

15. What is the relationship between an empirical formula and a molecular formula?

empirical formula = smallest whole-number ratio of atoms in a compound

molecular formula = actual number of atoms in a compound

M.F. is a whole number multiple of the E.F.

16. How many lithium atoms are in one mole of lithium?

a. 1 b. 2 (c.) 6.02×10^{23} d. 1.204×10^{24}

17. How many fluorine atoms are in one mole of molecular fluorine? (hint: what is the formula for fluorine?) F_2

a. 1 b. 2 c. 6.02×10^{23} (d.) 1.204×10^{24}

18. How many atoms of hydrogen are in one molecule of ammonia, NH_3?

$\frac{3 \text{ atoms H}}{1 \text{ molecule } NH_3}$

a. 1 (b.) 3 c. 6.02×10^{23} d. 1.806×10^{24}

19. How many moles of nitrogen are in one mole of ammonia, NH_3?

$\frac{1 \text{ mol N}}{1 \text{ mol } NH_3}$

(a.) 1 b. 3 c. 6.02×10^{23} d. 1.806×10^{24}

20. How many moles of atoms are in 0.5 moles of ammonia, NH_3?

$\frac{4 \text{ mol atoms}}{1 \text{ mol } NH_3}$

a. 1 (b.) 2 c. 6.02×10^{23} d. 1.204×10^{24}

21. What is the empirical formula of C_6H_6?

a. C_3H_3 (b.) CH c. C_6H_6 d. impossible to know

22. Which formula is both an empirical and a molecular formula?

a. C_6H_6 (b.) NO_2 c. H_2O_2 d. $C_9H_{18}O_3$