

Key

Name _____
Period ____ Date ____/____/____

3 · The Mole & Stoichiometry

MOLE WS #1 - MOLAR MASSES

Calculate the molar masses of the following substances. Show ALL work and round your answer to 2 decimal places!

1) $\text{Cl}_2 = 2(35.45) = 70.9 \text{ g/mole}$

2) potassium hydroxide
 $\text{KOH} = 39.10 + 16 + 1.01 = 56.11 \text{ g/mole}$

3) beryllium chloride
 $\text{BeCl}_2 = 9.01 + 2(35.45) = 79.91 \text{ g/mole}$

4) iron (III) chloride
 $\text{FeCl}_3 = 55.85 + 3(35.45) = 162.2 \text{ g/mole}$

5) boron trifluoride
 $\text{BF}_3 = 10.81 + 3(19) = 67.81 \text{ g/mole}$

6) magnesium hydroxide
 $\text{Mg(OH)}_2 = 24.31 + 2(16) + 2(1.01) = 58.32 \text{ g/mole}$

7) $\text{UF}_6 = 238.03 + 6(19) = 352.03 \text{ g/mole}$

8) sulfur dioxide
 $\text{SO}_2 = 32.07 + 2(16) = 64.07 \text{ g/mole}$

9) phosphoric acid (H_3PO_4)
 $3(1.01) + 30.97 + 4(16) = 98.00 \text{ g/mole}$

10) ammonium sulfate
 $(\text{NH}_4)_2\text{SO}_4 = 2(14) + 8(1.01) + 32.07 + 4(16) = 132.15 \text{ g/mole}$

11) acetic acid ($\text{HC}_2\text{H}_3\text{O}_2$)
 $1.01 + 2(12.01) + 3.03 + 2(16) = 60.06 \text{ g/mole}$

12) lead (II) nitrate
 $\text{Pb(NO}_3)_2 = 207.2 + 2(14) + 6(16) = 331.2 \text{ g/mole}$

13) gallium sulfite
 $\text{Ga}_2(\text{SO}_3)_3 = 2(69.72) + 3(32.07) + 9(16) = 379.65 \text{ g/mole}$

3 The Mole & Stoichiometry

MOLE WS #2 - 1-STEP MOLE CONVERSIONS

1. Calculate the mass of 1.58 moles of CH_4 .

$$\frac{1.58 \text{ moles CH}_4}{1 \text{ mole CH}_4} \times \frac{16.05 \text{ g CH}_4}{1 \text{ mole CH}_4} = \boxed{25.4 \text{ g CH}_4}$$

2. What volume will 7.29 moles of CO_2 gas occupy at STP?

$$\frac{7.29 \text{ moles CO}_2}{1 \text{ mole CO}_2} \times \frac{22.4 \text{ L CO}_2}{1 \text{ mole CO}_2} = \boxed{163 \text{ L CO}_2}$$

3. How many molecules are there in a 0.00583 mole sample of H_2O ?

$$\frac{0.00583 \text{ moles H}_2\text{O}}{1 \text{ mole H}_2\text{O}} \times \frac{6.02 \times 10^{23} \text{ molecules H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = \boxed{3.51 \times 10^{21} \text{ mc H}_2\text{O}}$$

4. What volume will 2.22 moles of N_2 gas occupy at STP?

$$\frac{2.22 \text{ moles N}_2}{1 \text{ mole N}_2} \times \frac{22.4 \text{ L N}_2}{1 \text{ mole N}_2} = \boxed{49.7 \text{ L N}_2}$$

5. A bottle of lead (II) sulfate contains 158.1 g of the compound. How many moles of lead (II) sulfate are in the bottle?

$$\frac{158.1 \text{ g PbSO}_4}{303.27 \text{ g PbSO}_4} \times \frac{1 \text{ mole PbSO}_4}{303.27 \text{ g PbSO}_4} = \boxed{0.5213 \text{ moles PbSO}_4}$$

6. How many moles of magnesium bromide contain 5.38×10^{24} formula units?

$$\frac{5.38 \times 10^{24} \text{ Fu's MgBr}_2}{6.02 \times 10^{23} \text{ Fu's MgBr}_2} \times \frac{1 \text{ mole MgBr}_2}{6.02 \times 10^{23} \text{ Fu's MgBr}_2} = \boxed{8.94 \text{ moles MgBr}_2}$$

7. How many molecules are there in a 0.0752 mole sample of H_2O ?

$$\frac{0.0752 \text{ moles H}_2\text{O}}{1 \text{ mole H}_2\text{O}} \times \frac{6.02 \times 10^{23} \text{ mc H}_2\text{O}}{1 \text{ mole H}_2\text{O}} = \boxed{4.53 \times 10^{22} \text{ mc H}_2\text{O}}$$

8. How many moles of ammonia are in 1.20×10^{25} molecules of ammonia?

$$\frac{1.20 \times 10^{25} \text{ mc NH}_3}{6.02 \times 10^{23} \text{ mc NH}_3} \times \frac{1 \text{ mole NH}_3}{6.02 \times 10^{23} \text{ mc NH}_3} = \boxed{19.9 \text{ moles NH}_3}$$

9. You need 2.5 moles of aluminum for an experiment. How many atoms of aluminum is this?

Chemistry $\frac{2.5 \text{ moles Al}}{1 \text{ mole Al}} \times \frac{6.02 \times 10^{23} \text{ Atoms Al}}{1 \text{ mole Al}} = \boxed{1.5 \times 10^{24} \text{ Atoms Al}}$

1-Step Mole Conversions

3 · The Mole & Stoichiometry**MOLE WS #3 - 2-STEP MOLE CONVERSIONS**

Show all work using dimensional analysis! Show the "given" and "find" and include correct significant figures and units.

1) How many formula units are there in 24 grams of iron (III) fluoride?

$$\frac{24 \text{ g FeF}_3}{112.85 \text{ g FeF}_3} \times \frac{1 \text{ mole FeF}_3}{1 \text{ mole FeF}_3} \times \frac{6.02 \times 10^{23} \text{ Fu's FeF}_3}{1 \text{ mole FeF}_3} = 1.3 \times 10^{23} \text{ Fu's FeF}_3$$

2) How many grams are there in 2.3×10^{24} atoms of silver?

$$\frac{2.3 \times 10^{24} \text{ atoms Ag}}{6.02 \times 10^{23} \text{ atoms Ag}} \times \frac{1 \text{ mole Ag}}{1 \text{ mole Ag}} \times \frac{107.87 \text{ g Ag}}{1 \text{ mole Ag}} = 410 \text{ g Ag}$$

3) How many grams are there in 7.4×10^{23} formula units of silver nitrate?

$$\frac{7.4 \times 10^{23} \text{ Fu's AgNO}_3}{6.02 \times 10^{23} \text{ Fu's AgNO}_3} \times \frac{1 \text{ mole AgNO}_3}{1 \text{ mole AgNO}_3} \times \frac{169.87 \text{ g AgNO}_3}{1 \text{ mole AgNO}_3} = 210 \text{ g AgNO}_3$$

4) How carbon atoms are in 2.5g of C_2H_6 ?

$$\frac{2.5 \text{ g C}_2\text{H}_6}{30.08 \text{ g C}_2\text{H}_6} \times \frac{1 \text{ mole C}_2\text{H}_6}{1 \text{ mole C}_2\text{H}_6} \times \frac{2 \text{ mole C}}{1 \text{ mole C}_2\text{H}_6} \times \frac{6.02 \times 10^{23} \text{ atoms C}}{1 \text{ mole C}} = 1.0 \times 10^{23} \text{ atoms C}$$

5) How many formula units are there in 122 grams of copper (II) nitrate?

$$\frac{122 \text{ g Cu(NO}_3)_2}{187.57 \text{ g Cu(NO}_3)_2} \times \frac{1 \text{ mole Cu(NO}_3)_2}{1 \text{ mole Cu(NO}_3)_2} \times \frac{6.02 \times 10^{23} \text{ Fu's Cu(NO}_3)_2}{1 \text{ mole Cu(NO}_3)_2} = 3.92 \times 10^{23} \text{ Fu's Cu(NO}_3)_2$$

6) How many grams are there in 9.4×10^{25} molecules of hydrogen gas?

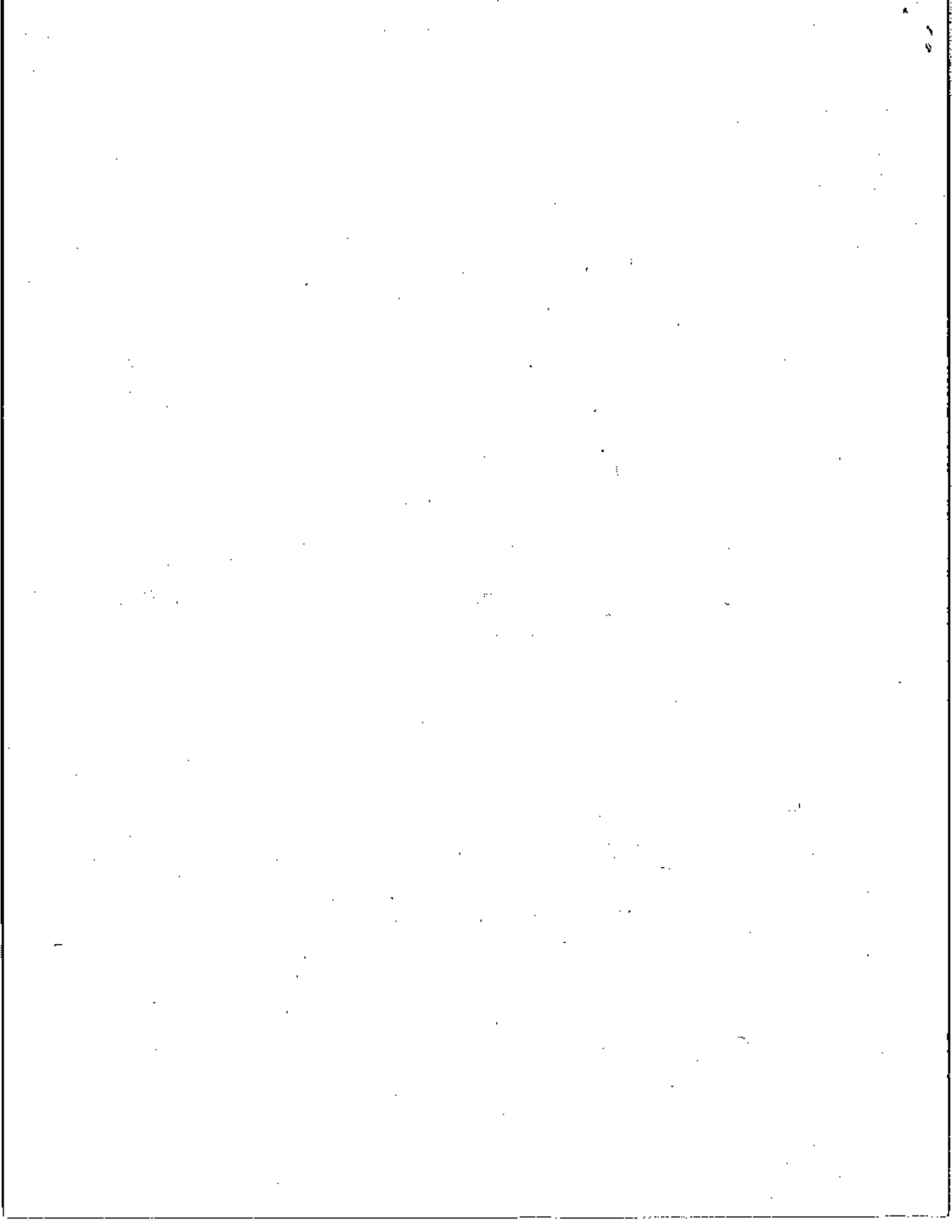
$$\frac{9.4 \times 10^{25} \text{ mc H}_2}{6.02 \times 10^{23} \text{ mc H}_2} \times \frac{1 \text{ mole H}_2}{1 \text{ mole H}_2} \times \frac{2.02 \text{ g H}_2}{1 \text{ mole H}_2} = 320 \text{ g H}_2$$

7) How many formula units are there in 230 grams of cobalt (II) chloride?

$$\frac{230 \text{ g CoCl}_2}{129.83 \text{ g CoCl}_2} \times \frac{1 \text{ mole CoCl}_2}{1 \text{ mole CoCl}_2} \times \frac{6.02 \times 10^{23} \text{ Fu's CoCl}_2}{1 \text{ mole CoCl}_2} = 1.1 \times 10^{24} \text{ Fu's CoCl}_2$$

8) How many liters are occupied by 28.5 grams of nitrogen trihydride gas at STP?

$$\frac{28.5 \text{ g NH}_3}{17.04 \text{ g NH}_3} \times \frac{1 \text{ mole NH}_3}{1 \text{ mole NH}_3} \times \frac{22.4 \text{ L NH}_3}{1 \text{ mole NH}_3} = 37.5 \text{ L NH}_3$$



3 · The Mole & Stoichiometry

MOLE WS - % COMPOSITION

Percent Composition Using Molar Masses

It is useful to determine how much of a compound's mass is made up of each element. Water, H₂O, for example has a mass of 18.02 g/mol. The H's mass is 2(1.01) = 2.02 g/mol. The O's mass is 16.00

g/mol. We can set up ratios for each element: $H = \frac{2.02}{18.02} \times 100 = 11.2\%$, $O = \frac{16.00}{18.02} \times 100 = 88.8\%$
 Determine the percent composition of each element in each compound below:

$Ca(OH)_2$ 1. calcium hydroxide 74.1	$Ca = \frac{40.08}{74.1} \times 100 = 54.1\%$	$O = \frac{32}{74.1} \times 100 = 43.2\%$	$H = \frac{2.02}{74.1} \times 100 = 2.7\%$
CO_2 2. carbon dioxide 44.01	$C = \frac{12.01}{44.01} \times 100 = 27.3\%$	$O = \frac{32}{44.01} \times 100 = 72.7\%$	
$Ca(NO_3)_2$ 3. calcium nitrate 164.1	$Ca = \frac{40.08}{164.1} \times 100 = 24.4\%$	$N = \frac{28.02}{164.1} \times 100 = 17.1\%$	$O = \frac{96}{164.1} \times 100 = 58.5\%$
4. CH ₃ OH	$C = \frac{12.01}{32.05} \times 100 = 37.5\%$	$O = \frac{16}{32.05} \times 100 = 49.9\%$	$H = \frac{4.04}{32.05} \times 100 = 12.6\%$

Percent Composition Using Laboratory Data

Find the percent composition of each compound below.

10. Analysis of a compound shows that it consists of 43.40 g of copper and 10.95 g of sulfur.

$$\text{total} = 43.40\text{g} + 10.95\text{g} = 54.35\text{g}$$

$$Cu: \frac{43.40\text{g}}{54.35\text{g}} \times 100 = \boxed{79.9\%}$$

$$S: \frac{10.95\text{g}}{54.35\text{g}} \times 100 = \boxed{20.1\%}$$

11. A sample of benzene is analyzed and found to consist of 13.74 g of carbon and 1.15 g of hydrogen.

$$C: \frac{13.74\text{g}}{(13.74 + 1.15)\text{g}} \times 100 = \boxed{92.3\%}$$

$$H: \frac{1.15\text{g}}{(13.74 + 1.15)\text{g}} \times 100 = \boxed{7.7\%}$$

12. Analysis of an unknown compound shows that it consists of 21.8 g of oxygen, 4.09 g of aluminum, and 6.36 g of nitrogen.

$$O: \frac{21.8\text{g}}{32.25\text{g}} \times 100 = \boxed{67.6\%}$$

$$Al: \frac{4.09\text{g}}{32.25\text{g}} \times 100 = \boxed{12.7\%}$$

$$N: \frac{6.36\text{g}}{32.25\text{g}} \times 100 = \boxed{19.7\%}$$

The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry should be supported by a valid receipt or invoice. This not only helps in tracking expenses but also ensures compliance with tax regulations.

In the second section, the author outlines the various methods used to collect and analyze data. These include direct observation, interviews, and the use of specialized software tools. Each method has its own strengths and limitations, and the choice of which to use depends on the specific requirements of the study.

The third section provides a detailed overview of the results obtained from the data analysis. It shows a clear trend of increasing activity over the period studied, which is consistent with the initial hypothesis. The data also reveals some unexpected patterns, particularly in the latter half of the study, which may be due to external factors.

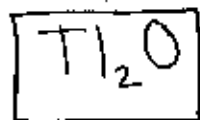
Finally, the document concludes with a summary of the findings and some recommendations for future research. It suggests that further investigation into the underlying causes of the observed trends would be beneficial. Additionally, it recommends that the current findings be applied to improve the efficiency of the processes being studied.

3 · The Mole & Stoichiometry

MOLE WS #8 - EMPIRICAL & MOLECULAR FORMULAS

1. A compound used to test for the presence of ozone in the stratosphere contains 96.2% thallium and 3.77% oxygen. What is its empirical formula?

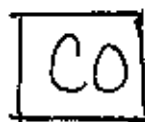
$$\text{Tl: } \frac{96.2 \text{ g} / 1 \text{ mole}}{204.38 \text{ g}} = \frac{0.470691849 \text{ moles}}{0.235625 \text{ moles}} = 1.997 \approx 2$$



$$\text{O: } \frac{3.77 \text{ g} / 1 \text{ mole}}{16 \text{ g}} = \frac{0.235625 \text{ moles}}{0.235625 \text{ moles}} = 1$$

2. What is the empirical formula of a compound that contains 42.9% carbon and 57.1% O?

$$\text{C: } \frac{42.9 \text{ g} / 1 \text{ mole}}{12.01 \text{ g}} = \frac{3.572023314 \text{ moles}}{3.56875 \text{ moles}} = 1$$



$$\text{O: } \frac{57.1 \text{ g} / 1 \text{ mole}}{16 \text{ g}} = \frac{3.56875 \text{ moles}}{3.56875 \text{ moles}} = 1$$

3. Calculate the molecular formula of a compound that contains 94.1% O and 5.9% H and has a molar mass of 34 grams.

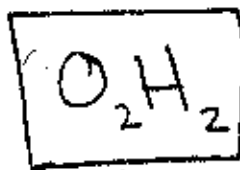
$$\text{O: } \frac{94.1 \text{ g} / 1 \text{ mole}}{16 \text{ g}} = \frac{5.88125 \text{ moles}}{5.841584158 \text{ moles}} = 1$$



$$\text{H: } \frac{5.9 \text{ g} / 1 \text{ mole}}{1.01 \text{ g}} = \frac{5.841584158 \text{ moles}}{5.841584158 \text{ moles}} = 1$$

$$EF_{\text{mass}} = 16 + 1.01 = 17.01 \text{ g/mole}$$

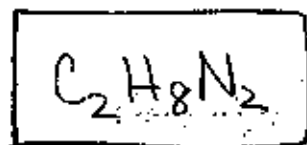
$$\frac{34 \text{ g}}{17.01 \text{ g}} = 1.9988 \approx 2$$



4. Calculate the molecular formula of a compound whose molar mass is 60.0 g/mol and the empirical formula is CH_2N .

$$EF_{\text{mass}} = 12.01 + 4(1.01) + 14.01 = 30.06 \text{ g/mol}$$

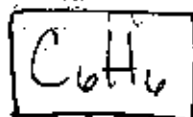
$$\frac{60.0 \text{ g/mol}}{30.06 \text{ g/mol}} = 1.996 \approx 2$$



5. The molecular mass of benzene, an important industrial solvent and known carcinogen, is 78 g/mol and its empirical formula is CH . What is the molecular formula of benzene?

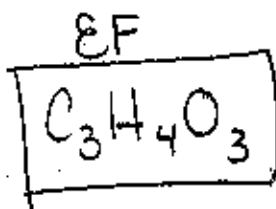
$$EF_{\text{mass}} = 12.01 + 1.01 = 13.02 \text{ g/mol}$$

$$\frac{78 \text{ g/mol}}{13.02 \text{ g/mol}} = 5.99 \approx 6$$



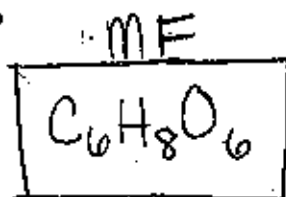
6. Ascorbic acid, or vitamin C, has a percent composition of 40.9% C, 4.58% H, and 54.5% O. Its molecular mass is 176.1 g/mol. Find its empirical and molecular formulas. (HINT: Multiply by 2, 3, or 4 to get whole number subscripts.)

$$\text{C: } \frac{40.9 \text{ g/mole}}{12.01 \text{ g}} = \frac{3.40549542 \text{ moles}}{3.40549542 \text{ moles}} = 1 \times 3 = 3$$



$$\text{H: } \frac{4.58 \text{ g/mole}}{1.01 \text{ g}} = \frac{4.534653465 \text{ moles}}{3.40549542 \text{ moles}} = 1.33 \times 3 = 4$$

$$\text{O: } \frac{54.5 \text{ g/mole}}{16 \text{ g}} = \frac{3.40625 \text{ moles}}{3.40549542 \text{ moles}} = 1.000 \approx 1 \times 3 = 3$$



$$EF_{\text{mass}} = \frac{3(12.01) + 4(1.01) + 3(16)}{88.07 \text{ g/mol}}$$

$$\frac{176.1 \text{ g/mol}}{88.07 \text{ g/mol}} = 1.999 \approx 2$$

Chemistry 88.07 g/mole

Empirical & Molecular Formulas