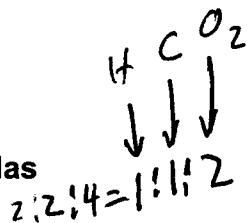


## Worksheet: Calculating Empirical & Molecular Formulas



- B
- The empirical formula for the compound having the formula  $\text{H}_2\text{C}_2\text{O}_4$  is  
 [A]  $\text{C}_2\text{H}_2$     **[B]  $\text{CO}_2\text{H}$**     [C]  $\text{COH}$     [D]  $\text{C}_2\text{O}_4\text{H}_2$     [E]  $\text{COH}_2$
  - Calculate the empirical formula of a compound that is 85.6% C and 14.4% H (by mass).  
**[A]  $\text{CH}_2$**     [B]  $\text{CH}$     [C]  $\text{C}_3\text{H}_5$     [D]  $\text{C}_2\text{H}_4$     [E]  $\text{C}_2\text{H}$
  - A compound is analyzed and found to contain 12.1% carbon, 16.2% oxygen, and 71.7% chlorine (by mass). Calculate the empirical formula of this compound.  
**[A]  $\text{COCl}_2$**     [B]  $\text{CO}_2\text{Cl}_2$     [C]  $\text{CO}_2\text{Cl}$     [D]  $\text{COCl}_4$     [E]  $\text{COCl}$
  - A compound contains 40.0% carbon, 6.7% hydrogen, and 53.3% oxygen (by mass). Calculate the empirical formula.  
 [A]  $\text{C}_2\text{H}_2\text{O}$     **[B]  $\text{CH}_2\text{O}$**     [C]  $\text{CH}_4\text{O}$     [D]  $\text{C}_2\text{HO}_2$     [E]  $\text{C}_3\text{H}_6\text{O}_3$
  - A compound contains 25.94% N and 74.06% O (by mass). What is the empirical formula?  

$$\text{N}_2\text{O}_5$$
  - Calculate the empirical formula of a compound containing 18.29% H and 81.71% C (by mass).  

$$\text{C}_3\text{H}_8$$
  - Determine the empirical formula of a compound containing 54.2% F and 45.8% S (by mass).  

$$\text{SF}_2$$
  - A compound has 40.68% carbon, 5.12% hydrogen, and 54.20% oxygen (by mass). Calculate its empirical formula.  

$$\text{C}_2\text{H}_3\text{O}_2$$
  - Calculate the empirical formula of a compound that is 50.04% C, 5.59% H, and 44.37% O (by mass).  

$$\text{C}_3\text{H}_4\text{O}_2$$
  - A 7.33-g sample of lanthanum, La, combines with oxygen to give 10.29 g of the oxide. Calculate the empirical formula of this oxide.  

$$\text{La}_2\text{O}_7$$
  - Calculate the molecular formula of a compound with the empirical formula  $\text{CH}_2\text{O}$  and a molar mass of 150 g/mol.  
 [A]  $\text{C}_3\text{H}_6\text{O}_3$     **[B]  $\text{C}_5\text{H}_{10}\text{O}_5$**     [C]  $\text{C}_2\text{H}_4\text{O}_2$     [D]  $\text{C}_4\text{H}_8\text{O}_4$     [E]  $\text{C}_6\text{H}_{12}\text{O}_6$

## Worksheet: Calculating Empirical & Molecular Formulas

12. Acetylene gas is 92.3% carbon and 7.7% hydrogen (by mass), and its molar mass is 26 g/mol. What is its molecular formula?  
[A]  $C_2H_2$       [B]  $CH_4$       [C]  $CH$       [D]  $C_4H_4$       [E] none of these
13. The empirical formula of a compound is known to be  $CH_2$ , and its molar mass is 56 g/mol. What is the molecular formula?  
 $C_4H_8$
14. The empirical formula of a compound is  $CH_2O$ , and its mass is 120 amu/molecule. Calculate its molecular formula.  
[A]  $C_3H_6O_3$       [B]  $C_2H_4O_2$       [C]  $C_4H_8O_4$       [D]  $CH_2O$       [E] none of these
15. A compound contains 12.8% C, 2.1% H, and 85.1% Br (by mass). Calculate the empirical formula and the molecular formula of this compound given that the molar mass is 188 g/mol.  
 $CH_2Br$
16. A compound contains 10.13% C and 89.87% Cl (by mass). Determine both the empirical formula and the molecular formula of the compound given that the molar mass is 237 g/mol.
17. A certain compound has an empirical formula of  $NH_2O$ . Its molar mass is between 55 and 65 g/mol. Its molecular formula is  
[A]  $N_2H_4O_2$       [B]  $N_2H_2O_2$       [C] not calculable      [D]  $NH_2O$
18. A compound has a molar mass of 86 g/mol and has the percent composition (by mass) of 55.8% C, 37.2% O, and 7.0% H. Determine the empirical formula and the molecular formula.  
 $C_2H_2O$
19. A compound has a molar mass of 100 g/mol and the percent composition (by mass) of 65.45% C, 5.45% H, and 29.09% O. Determine the empirical formula and the molecular formula.  
[A]  $CHO$  and  $C_6H_6O_6$       [B]  $CH_4O$  and  $C_3H_{12}O_3$       [C]  $C_3HO$  and  $C_6H_2O_2$   
[D]  $CH_2O$  and  $C_4H_8O_4$       [E]  $C_3H_3O$  and  $C_6H_6O_2$

#20  $(C \times 1) + (H \times 2) + (O \times 1) = 12 + 2 + 16 = 30$   
 $60/30 = 2$   $C_2H_4O_2$

Worksheet: Calculating Empirical & Molecular Formulas

20. The empirical formula for acetic acid is  $CH_2O$ . Its molar mass is 60 g/mol. The molecular formula is

- [A]  $C_2H_6O$  [B]  $CH_2O$  [C]  $C_2H_4O_2$  [D]  $C_2HO_2$  [E] none of these

(2)  $85.6g C \times \frac{1 \text{ mol}}{12 g} = 7.13 \text{ mol}$   ~~$14.4g H \times \frac{1 \text{ mol}}{1.01 g} = 14.26 \text{ mol}$~~   
 $\frac{14.26}{7.13} = \frac{H}{C} = \frac{2}{1} \rightarrow C_1H_2 \rightarrow CH_2$

(3)  $12.1g C \times \frac{1 \text{ mol}}{12.0 g} = 1.01 \text{ mol}$   $16.2g O \times \frac{1 \text{ mol}}{16.0g O} = 1.01 \text{ mol}$   
 $71.7g Cl \times \frac{1 \text{ mol}}{35.45g} = 2.02 \text{ mol}$   
 $C_{1.01}O_{1.01}Cl_{2.02}$   
 $C_1O_1Cl_2$   $COCl_2$

(4)  $40.0g C \times \frac{1 \text{ mol}}{12g} = 3.33 \text{ mol}$   $6.7g H \times \frac{1 \text{ mol}}{1.01g} = 6.63 \text{ mol}$   
 $53.3g O \times \frac{1 \text{ mol}}{16g} = 3.33 \text{ mol}$   $\frac{H}{C} = \frac{H}{O} = \frac{6.63}{3.33} \approx \frac{2}{1}$   
 $C_1H_2O_1$   $CH_2O$

(5)  $25.94g \times \frac{1 \text{ mol}}{14g} = 1.85 \text{ mol}$   $74.06g \times \frac{1 \text{ mol}}{16g} = 4.63 \text{ mol}$   
 $\frac{O}{N} = \frac{4.63}{1.85} = \frac{2.5}{1} = \frac{5}{2}$   $N_2O_5$

(6)  $18.29g H \times \frac{1 \text{ mol}}{1.01g H} = 18.1 \text{ mol H}$   $81.71g C \times \frac{1 \text{ mol}}{12.0g} = 6.81 \text{ mol}$   
 $\frac{H}{C} = \frac{18.1}{6.81} = 2.66 = 2\frac{2}{3} = \frac{8}{3}$   $C_3H_8$

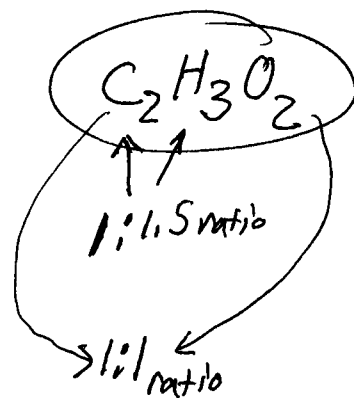
$$\textcircled{7} 54.2\text{g F} \times \frac{1 \text{ mol F}}{19.0 \text{ g F}} = 2.85 \text{ mol F} \quad ||| \quad 45.8\text{g S} \times \frac{1 \text{ mol S}}{32.1 \text{ g S}} = 1.43 \text{ mol S}$$

$$\frac{2.85}{1.43} = \frac{\text{F}}{\text{S}} = \frac{2}{1} \rightarrow \text{S}_1\text{F}_2 \rightarrow \text{SF}_2$$

$$\textcircled{8} 40.68\text{g C} \times \frac{1 \text{ mol}}{12 \text{ g}} = 3.39 \text{ mol C} \quad ||| \quad 54.20\text{g O} \times \frac{1 \text{ mol}}{16 \text{ g}} = 3.39 \text{ mol O}$$

$$5.12\text{g H} \times \frac{1 \text{ mol H}}{1.01 \text{ g H}} = 5.07 \text{ mol H}$$

$$\frac{\text{C}}{\text{O}} = \frac{3.39}{3.39} = \frac{1}{1} \quad \frac{5.07}{3.39} = \frac{\text{H}}{\text{C}} = \frac{1.5}{1} = \frac{3}{2}$$

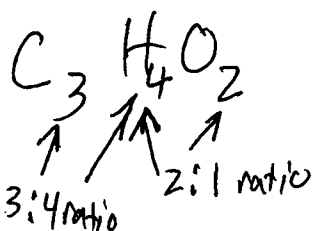


$$\textcircled{9} 50.04\text{g C} \times \frac{1 \text{ mol}}{12 \text{ g}} = 4.17 \text{ mol C} \quad ||| \quad 5.59\text{g H} \times \frac{1 \text{ mol H}}{1.01 \text{ g H}} = 5.53 \text{ mol H}$$

$$44.37\text{g O} \times \frac{1 \text{ mol O}}{16 \text{ g O}} = 2.77 \text{ mol O}$$

$$\frac{5.53}{2.77} = \frac{\text{H}}{\text{O}} = \frac{2}{1} \quad ||| \quad \frac{5.53}{4.17} = 1.33 = \frac{4}{3} \frac{\text{H}}{\text{C}}$$

$$\frac{4.17}{2.77} = \frac{1.5}{1} = \frac{3}{2} = \frac{\text{C}}{\text{O}}$$



$\textcircled{10}$  The compound is lanthanum oxide. "The oxide" refers to lanthanum oxide.

Total mass = mass of the oxide = 10.29g

— mass of lanthanum alone = 7.33g

— mass of oxygen alone = 2.96g

$$7.33\text{g} \times \frac{1 \text{ mol}}{138.9 \text{ g}} = 0.0528 \text{ mol La}$$

$$2.96\text{g} \times \frac{1 \text{ mol}}{16 \text{ g}} = 0.185 \text{ mol O}$$

$$\frac{0.185 \text{ mol O}}{0.0528 \text{ mol La}} = \frac{3.5}{1} = \frac{7}{2} = \text{La}_2\text{O}_7$$

(11)  $\text{CH}_2\text{O} = 12 + 2 + 16 = 30$   $\frac{150}{30} = 5$   $\text{CH}_2\text{O} \times 5 = \text{C}_5\text{H}_{10}\text{O}_5$

(12)  $92.3\text{g} \times \frac{1\text{mol}}{12\text{g}} = 7.69\text{mol}$   $7.7\text{g H} \times \frac{1\text{mol}}{1.01\text{g}} = 7.62\text{mol}$

$\frac{\text{C}}{\text{H}} = \frac{7.69}{7.62} = 1.0 = \frac{1}{1}$   $\text{CH}$

(13)  $\text{CH}_2 = 12 + 2 = 14$   $56/14 = 4$   $\text{C}_4\text{H}_8$

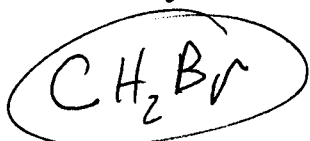
(14)  $\text{CH}_2\text{O} = 12 + 2 + 16 = 30$   $\frac{120}{30} = 4$   $\text{C}_4\text{H}_8\text{O}_4$

(15)  $12.8\text{g C} \times \frac{1\text{mol}}{12\text{g}} = 1.07\text{mol}$   $2.1\text{g H} \times \frac{1\text{mol}}{1.01\text{g}} = 2.08\text{mol H}$

$85.1\text{g Br} \times \frac{1\text{mol}}{79.9\text{g}} = 1.07\text{mol}$

$\frac{\text{H}}{\text{Br}} = \frac{2.08}{1.07} = 1.95 = \frac{2}{1}$

$\frac{\text{H}}{\text{C}} = \frac{1.07}{1.07} = \frac{1}{1}$

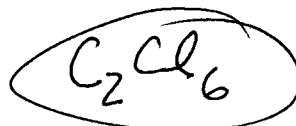


(16)  $10.13\text{g C} \times \frac{1\text{mol}}{12\text{g}} = 0.844\text{mol}$   $89.87\text{g Cl} \times \frac{1\text{mol}}{35.45\text{g}} = 2.54\text{mol Cl}$

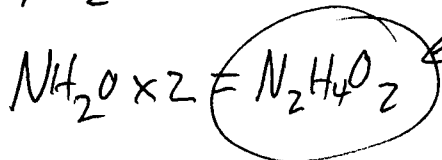
$\frac{\text{Cl}}{\text{C}} = \frac{2.54}{0.844} = \frac{3}{1}$

$\text{CCl}_3 = \text{empirical formula}$   
mass =  $12 + (35.5 \times 3) = 118.35$

$\frac{237}{118.35} = 2$



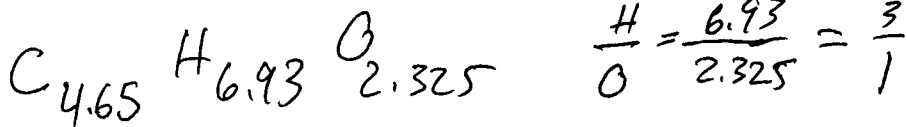
(17)  $\text{NH}_2\text{O} = 14 + 2 + 16 = 32$



~~$32 \times 1 = 32$~~   
 ~~$32 \times 2 = 64$~~   
 ~~$32 \times 3 = 96$~~

← this is in between 55 and 65!

(18)  $55.8g C_x \times \frac{1mol}{12g} = 4.65 mol$        $7.0g H_x \times \frac{1mol}{1.01g} = 6.93 mol$   
 $37.2g O \times \frac{1mol}{16g} = 2.325 mol$



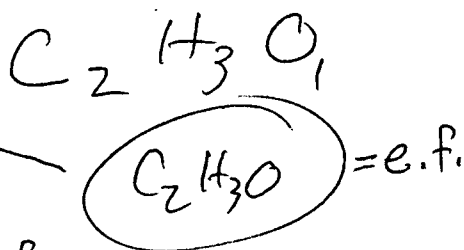
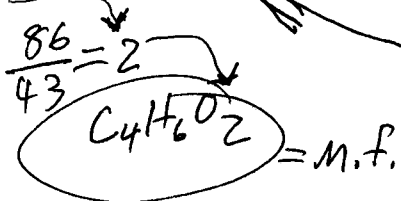
$\frac{C}{O} = \frac{4.65}{2.325} = \frac{2}{1}$

$\frac{H}{C} = \frac{6.93}{4.65} = \frac{1.5}{1} = \frac{3}{2}$

$C \times 2 = 24$   
 $H \times 3 = 3$   
 $+ O \times 1 = 16$   


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 $43$

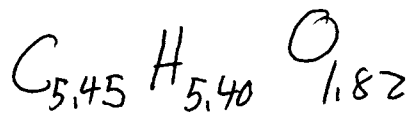


(19)

$65.45g C \times \frac{1mol}{12g} = 5.45 mol$

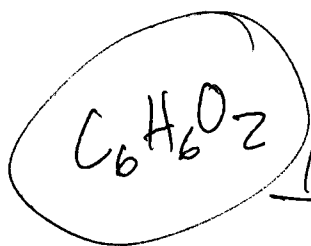
$5.45g H \times \frac{1mol}{1.01g} = 5.40 mol$

$29.0g O \times \frac{1mol}{16g} = 1.82 mol$



$\frac{C}{H} = \frac{5.45}{5.40} = \frac{1}{1}$

$\frac{C}{O} = \frac{5.45}{1.82} = \frac{3}{1}$



$\frac{100}{55} = 1.82 = \text{maybe } Z, \text{ I guess}$

Hmmm....

I think that "100" was supposed to be "110," Typo???

$C \times 3 = 36$   
 $H \times 3 = 3$   
 $+ O \times 1 = 16$   


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 $55g/mol$

(20) See work on top of #20 question