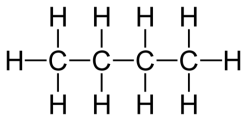
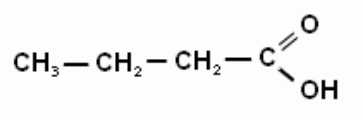
Chemistry 11 — Day 1 #1-5 — Day 2 #6

Empirical Formula & Percent Composition

Name: Key
Date:
Block:

1. Complete the following table:

Structural Formula	Molecular Formula	Empirical Formula
	C_4H_{10}	C_2H_5
	$C_4H_8O_2$	C_2H_4O

2. A pigment on a suspected forgery is analyzed using X-ray fluorescence and found to contain 0.5068 mol Ba, 0.5075 mol C, and 1.520 mol O. Determine its empirical formula. — simplest!

- already in mol ☺
- smallest = Ba

C: $\frac{0.5075\ mol_C}{0.5068\ mol_{Ba}} = \sim 1$

O: $\frac{1.520\ mol_O}{0.5068\ mol_{Ba}} = \sim 3$

$BaCO_3$

3. A sample of caffeine is analyzed and found to contain 1.4844 g C, 0.1545 g H, 0.4947g O and 0.8661 g N. Determine the empirical formula of caffeine.

C: $1.4844\ g \times \frac{1\ mol}{12.00\ g} = 0.1237\ mol_C \rightarrow \frac{0.1237\ mol_C}{0.0309\ mol_O} = \sim 4\ C$

H: $0.1545\ g \times \frac{1\ mol}{1.01\ g} = 0.1545\ mol_H \rightarrow \frac{0.1545\ mol_H}{0.0309\ mol_O} = \sim 5\ H$

O: $0.4947\ g \times \frac{1\ mol}{16.00\ g} = 0.0309\ mol_O \rightarrow$ smallest = 1 O

N: $0.8661\ g \times \frac{1\ mol}{14.01\ g} = 0.0619\ mol_N \rightarrow \frac{0.0619\ mol_N}{0.0309\ mol_O} = \sim 2\ N$

$C_4H_5ON_2$

4. A sample of ascorbic acid, also known as vitamin C, was analyzed and found to contain 1.080 g C, 0.121 g H, and 1.439 g O. Ascorbic acid has a molar mass of 176.1 g/mol. Determine the molecular formula of ascorbic acid.

C: $1.080\ g \times \frac{1\ mol}{12.01\ g} = 0.090\ mol_C \rightarrow$ smallest = 1 C ×3

H: $0.121\ g \times \frac{1\ mol}{1.01\ g} = 0.121\ mol_H \rightarrow \frac{0.121\ mol_H}{0.090\ mol_O} = \sim 1.34\ H$ ×3

O: $1.439\ g \times \frac{1\ mol}{16.0\ g} = 0.090\ mol_O \rightarrow$ smallest = 1 O ×3

$C_3H_4O_3$ — empirical formula

Molar mass:
$(12.01 \times 3) + (1.01 \times 4) + (16.00 \times 3) = 88.07\ g/mol$

$\frac{176.1\ g/mol}{88.07\ g/mol} = \sim 2$

$2 \times (C_3H_4O_3)$

$= C_6H_8O_6$

5. A hydrocarbon is a compound containing only carbon and hydrogen. One particular hydrocarbon is 92.29% carbon by mass. If the compound's molar mass is 39.0g/mol then what is its molecular formula?

C: $92.29\,g \times \frac{1\,mol}{12.01\,g} = 7.69\,mol_C \rightarrow$ smallest = 1 C

100 − 92.29

H: $7.71\,g \times \frac{1\,mol}{1.01\,g} = 7.71\,mol_H \rightarrow \frac{7.71\,mol_H}{7.69\,mol_C} = \sim 1\,H$

empirical formula

CH

molar mass

$(12.01 \times 1) + (1.01 \times 1) = 13.02\,g/mol$

$\frac{78.0\,g/mol}{13.02\,g/mol} = \sim 6$

$6 \times (CH)$

$= \boxed{C_6H_6}$

6. Find the percent composition by mass of the following compounds:

a. Carbon dioxide $CO_2 = (12.01 \times 1) + (16.00 \times 2) = 44.01\,g/mol$

C: $\frac{12.01}{44.01} \times 100\% = \boxed{27.29\%\,C}$ O: $\frac{16.00 \times 2}{44.01} \times 100\% = \boxed{72.71\%\,O}$

b. $K_2CO_3 = (39.10 \times 2) + (12.01 \times 1) + (16.00 \times 3) = 138.21\,g/mol$

K: $\frac{39.10 \times 2}{138.21} \times 100\% = \boxed{56.58\%\,K}$ C: $\frac{12.01}{138.21} \times 100\% = \boxed{8.69\%\,C}$ O: $\frac{16.00 \times 3}{138.21} \times 100\% = \boxed{34.73\%\,O}$

c. Ammonium phosphate $(NH_4)_3PO_4 = (14.01 \times 3) + (1.01 \times 12) + (30.97 \times 1) + (16.00 \times 4) = 149.12\,g/mol$

N: $\frac{14.01 \times 3}{149.12} \times 100\% = \boxed{28.19\%\,N}$

H: $\frac{1.01 \times 12}{149.12} \times 100\% = \boxed{8.13\%\,H}$

P: $\frac{30.97}{149.12} \times 100\% = \boxed{20.77\%\,P}$

O: $\frac{16.00 \times 4}{149.12} \times 100 = \boxed{42.92\%\,O}$

d. $C_8H_{18} = (12.01 \times 8) + (1.01 \times 18) = 114.26\,g/mol$

C: $\frac{12.01 \times 8}{114.26} \times 100\% = \boxed{84.09\%\,C}$ H: $\frac{1.01 \times 18}{114.26} \times 100\% = \boxed{15.91\%\,H}$

e. $C_4H_{10}O = (12.01 \times 4) + (1.01 \times 10) + (16.00 \times 1) = 74.14\,g/mol$

C: $\frac{12.01 \times 4}{74.14} \times 100\% = \boxed{64.80\%\,C}$ H: $\frac{1.01 \times 10}{74.14} \times 100 = \boxed{13.62\%\,H}$ O: $\frac{16.00}{74.14} \times 100 = \boxed{21.58\%\,O}$

1. C_4H_{10}, C_2H_5, $C_4H_8O_2$, C_2H_4O 2. $BaCO_3$ 3. $C_4H_5N_2O$ 4. $C_6H_8O_6$ 5. C_3H_3 6a. 27.30% C, 72.71% O b. 56.58% K, 8.690% C, 34.73% O c. 28.19% N, 8.13% H, 20.77% P, 42.92% O d. 84.09% C, 15.91% H e. 64.80% C, 13.62% H, 21.58% O

= $C_4H_5ON_2$