1.7.2.3: Practice Empirical and Molecular Formulas

Percent Composition Problems

Exercise 1.7.2.3.1

What is the percent composition of $Co(NO_3)_2$?

Hint: What is formula mass?

Co mass $= 1 \times 58.93 = 58.93$ amu

N mass $= 2 \times 14.01 = 28.02$ amu

O mass $= 6 \times 16.00 = 96.00$ amu

Total = 182.95 amu

Answer

Co mass percent $= \frac{58.93 amu}{182.95 amu} \times 100\ \%$ = 32.21 %

N mass percent $= \frac{28.02 amu}{182.95 amu} \times 100\ \%$ = 15.32 %

O mass percent $= \frac{96.00 amu}{182.95 amu} \times 100\ \%$ = 52.47 %

What is the percent composition of $Ni_2(SO_4)_3$?

Hint: What is formula mass?

Ni mass $= 2 \times 58.69 = 117.38$ amu

S mass $= 3 \times 32.07 = 96.21$ amu

O mass $= 12 \times 16.00 = 192.00$ amu

Total = 405.59 amu

Answer

Ni mass percent $= \frac{117.38 amu}{405.59 amu} \times 100\ \%$ = 28.94 %

S mass percent $= \frac{96.21 amu}{405.59 amu} \times 100\ \%$ = 23.72 %

O mass percent $= \frac{192.00 amu}{405.59 amu} \times 100\ \%$ = 47.34 %

You analyze a sample and find that it contains 22.46 g of Fe and 42.76 g Cl. What is the percent composition of this sample?

Hint: What is total mass?

Your sample is 22.46 g + 42.76 g = 65.22 g

Answer

Fe mass percent $= \frac{22.46 g}{65.22 g} \times 100\ \%$ = 34.44 %

Cl mass percent $= \frac{42.76 g}{65.22 g} \times 100\ \%$ = 65.56 %

Empirical Formula from Percent Composition

Exercise 1.7.2.3.1

What is the empirical formula of a compound that is 73.42 % Co and 26.58% O by mass?

Hint

Convert 73.42 g Co to moles Co (Co = 58.93 g/mol) and 26.58 g O to moles O (O = 16.00 g/mol).

Answer

At first, you get 1.246 mol Co and 1.661 mol O. Divide both of these by the smaller number (1.246)

This gives 1 mol Co and 1.33 mol O. Now multiply both of these by 3.

This gives 3 mol Co and 4 mol O.

Co_3O_4

What is the empirical formula of a compound that is 26.52 % Cr, 24.53 % S, and 48.95% O by mass?

Hint

Convert 26.52 g Cr to moles Cr (Cr = 52.00 g/mol), 24.53 g S to moles S (S = 32.07 g/mol), and 48.95 g O to moles O (O = 16.00 g/mol).

Answer

At first, you get 0.5100 mol Cr, 0.7649 mol S, and 3.059 mol O. Divide all of these by the smallest number (0.5100)

This gives 1 mol Cr, 1.5 mol S, and 6 mol O. Now multiply all of these by 2.

This gives 2 mol Cr, 3 mol S, and 12 mol O.

$Cr_2S_3O_{12}$ (this is actually the compound $Cr_2(SO_4)_3$)

Empirical and Molecular Formulas

Exercise 1.7.2.3.1

For each formula below, give the empirical formula. Sometimes the formula given is the same as the empirical, sometimes it is different.

a) $C_3H_6O_3$

b) N_2O_4

c) Mg_3N_2

d) $C_7H_{14}O_2$

e) P_2O_5

f) $C_4H_8N_2$

Answer a and b

CH_2O and NO_2

Answer c and d

Mg_3N_2 and $C_7H_{14}O_2$

Answer e and f

P_2O_5 and C_2H_4N

What is the molecular formula for a compound with empirical formula of CH_2O and molecular mass of 150.15 amu?

Answer

$C_5H_{10}O_5$ (Molecular mass is five times as big as empirical formula mass.)

What is the molecular formula for a compound with empirical formula of CH_2NO_2 and molecular mass of 180.12 amu?

Answer

$C_3H_6N_3O_6$ (Molecular mass is three times as big as empirical formula mass.)

What is the molecular formula for a compound with a molecular mass of 86.18 amu that is found to be 83.62 % C and 16.38 % H by mass? (Must find empirical formula first using percent composition.)

Empirical Formula

C_3H_7

At first, you get 6.963 mol C and 16.22 mol H. Divide both of these by the smallest number (6.963)

This gives 1 mol C and 2.33 mol H. Now multiply both of these by 3.

This gives 3 mol C and 7 mol H.

Molecular Formula

C_6H_{14} (Molecular mass is two times as big as empirical formula mass.)
