

1.7.2.3: Practice Empirical and Molecular Formulas

Percent Composition Problems

Exercise 1.7.2.3.1

What is the percent composition of $\text{Co}(\text{NO}_3)_2$?

Hint: What is formula mass?

$$\text{Co mass} = 1 \times 58.93 = 58.93 \text{ amu}$$

$$\text{N mass} = 2 \times 14.01 = 28.02 \text{ amu}$$

$$\text{O mass} = 6 \times 16.00 = 96.00 \text{ amu}$$

$$\text{Total} = 182.95 \text{ amu}$$

Answer

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

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

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

What is the percent composition of $\text{Ni}_2(\text{SO}_4)_3$?

Hint: What is formula mass?

$$\text{Ni mass} = 2 \times 58.69 = 117.38 \text{ amu}$$

$$\text{S mass} = 3 \times 32.07 = 96.21 \text{ amu}$$

$$\text{O mass} = 12 \times 16.00 = 192.00 \text{ amu}$$

$$\text{Total} = 405.59 \text{ amu}$$

Answer

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

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

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

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?

$$\text{Your sample is } 22.46 \text{ g} + 42.76 \text{ g} = 65.22 \text{ g}$$

Answer

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

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

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.



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

Hint

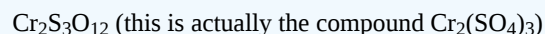
Convert 26.52 g Cr to moles Cr (Cr = 52.00 g/mol), 24.53 g S to moles S (S = 32.07 g/mol), and 48.95 g O to moles O (O = 16.00 g/mol).

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.

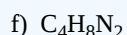
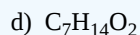
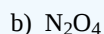
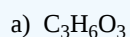
This gives 2 mol Cr, 3 mol S, and 12 mol O.



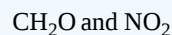
Empirical and Molecular Formulas

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.



Answer a and b



Answer c and d



Answer e and f

P_2O_5 and $\text{C}_2\text{H}_4\text{N}$

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

Answer

$\text{C}_5\text{H}_{10}\text{O}_5$ (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

$\text{C}_3\text{H}_6\text{N}_3\text{O}_6$ (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.)

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