Name : _____ Date : _____

Percent Composition, Molecular Formula, and Empirical Formula

1. What is the percent composition by mass of all elements in iron (III) oxide?

2. Analysis of a compound's sample indicates that it has 1.04 g K, 0.70 g Cr, and 0.86 g O. What is its empirical formula?

3. If 4.04 g of nitrogen combine with 11.46 g of oxygen to produce a compound with a molar mass of 108 g, what is the molecular formula of this compound? What is its molecular mass?

4. Phosphoric acid is found in some soft drinks. A sample of phosphoric acid contains 3.161 g of phosphorous, 0.3086 g of hydrogen, and 6.531 g of oxygen. What is its empirical formula?

5. What is the empirical formula of a compound with three times as many hydrogen atoms as carbon atoms but only half as many oxygen atoms as carbon atoms?

6. Can the molecular formula of a compound ever be the same as the empirical formula?

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Percent Composition, Molecular Formula, and Empirical Formula

Answers

1. What is the percent composition by mass of all elements in iron (III) oxide?

Molecular formula = Fe_2O_3

Fe: 2 x 56 g = 112 g

O: 3 x 16 g = 48 g

Mass of Fe_2O_3 = 112 g + 48 g = 160 g

Fe: 112 g/ 160 g = 70%

O: 48 g/ 160 g = 30%

2. Analysis of a compound's sample indicates that it has 1.04 g K, 0.70 g Cr, and 0.86 g O. What is its empirical formula?

K: 1.04 g /39 g mol^{-1} = 0.027 mol/0.0135 mol → 2

Cr: 0.70 g /52 g mol^{-1} = 0.0135 mol/0.0135 mol → 1

O: 0.86 g /16 g mol^{-1} = 0.054 mol/0.0135 mol → 4

The empirical formula is K_2CrO_4

3. If 4.04 g of nitrogen combine with 11.46 g of oxygen to produce a compound with a molar mass of 108 g, what is the molecular formula of this compound? What is its molecular mass?

N: 4.04 g / 14 g mol^{-1} = 0.289 mol/0.289 mol → 1 x 2 = 2

O: 11.46 g /16 g mol^{-1} = 0.716 mol/0.289 mol → 2.48 x 2 = 5

The empirical formula is N_2O_5

Molecular mass = 28 g + 80 g = 108 g

N: 2 x 14 g = 28 g

O: 5 x 16 g = 80 g

4. Phosphoric acid is found in some soft drinks. A sample of phosphoric acid contains 3.161 g of phosphorous, 0.3086 g of hydrogen, and 6.531 g of oxygen. What is its empirical formula?

P: 3.161 g / 30.97 g mol^{-1} = 0.102 mol/0.102 mol → 1

H: 0.3086 g / 1.01 g mol^{-1} = 0.306 mol/0.102 mol → 3

O: 6.531 g / 16 g mol^{-1} = 0.408 mol/0.102 mol → 4

The empirical formula is H_3PO_4

5. What is the empirical formula of a compound with three times as many hydrogen atoms as carbon atoms but only half as many oxygen atoms as carbon atoms?

3 x H as C and ½ O as C => 6 H as 2 C and O as 2 C

The empirical formula is C_2H_6O

6. Can the molecular formula of a compound ever be the same as the empirical formula?

Yes, if the molar mass matches the mass of the compound's empirical formula.