

Empirical formulas

1. Define empirical formula.

Elements in lowest whole # ratio

1.5 Define molecular formula and give 3 examples.

Some multiple of the emp C_2H_4 C_3H_6 H_2O_2

1.8 Give the empirical formula that corresponds to each of the following molecular compounds.

Sodium peroxide Na_2O_2 NaO terephthalic acid $C_8H_6O_4$ $C_4H_3O_2$

Phenobarbital ($C_{12}H_{12}N_2O_3$) 1,4-dichloro-2-butene $C_4H_6Cl_2$ C_2H_3Cl

2. A compound was found to contain 11.2% hydrogen and 88.8% oxygen by mass. What is the empirical formula of this compound? What assumption is made? *100g sample*

$$11.2g H \times \frac{1 \text{ mol H}}{1.008g H} = \frac{11.11 \text{ mol H}}{5.55} = 2 \text{ mol H} \quad H_2O$$

$$88.8g O \times \frac{1 \text{ mol O}}{16.00g O} = \frac{5.55 \text{ mol O}}{5.55} = 1 \text{ mol O}$$

3. A compound was found to contain 29.4% calcium, 23.5% sulfur, and 47.1% oxygen by mass. What is its empirical formula? What assumption is made? *100g sample*

$$29.4g Ca \times \frac{1 \text{ mol Ca}}{40.08g Ca} = \frac{.734 \text{ mol Ca}}{.733} = 1 \text{ mol Ca} \quad CaSO_4$$

$$23.5g S \times \frac{1 \text{ mol S}}{32.07g S} = \frac{.733 \text{ mol S}}{.733} = 1 \text{ mol S}$$

$$47.1g O \times \frac{1 \text{ mol O}}{16.00g O} = \frac{2.94 \text{ mol O}}{.733} = 4 \text{ mol O}$$

4. A compound was found to contain 33.8% copper, 14.9% nitrogen and the rest oxygen. What is its empirical formula? What assumption is made? *100g sample*

$$33.8g Cu \times \frac{1 \text{ mol Cu}}{63.55g Cu} = \frac{.532 \text{ mol Cu}}{.532} = 1 \text{ mol Cu}$$

$$14.9g N \times \frac{1 \text{ mol N}}{14.01g N} = \frac{1.06 \text{ mol N}}{.532} = 2 \text{ mol N}$$

$$51.3g O \times \frac{1 \text{ mol O}}{16.00g O} = \frac{3.21 \text{ mol O}}{.532} = 6 \text{ mol O}$$

CuN_2O_6

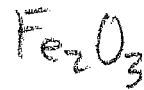
or

$Cu(NO_3)_2$

5. A compound was found to contain 69.9% iron and the rest oxygen by mass. What is its empirical formula? What assumption is made? *100g sample*

$$69.9 \text{ g Fe} \times \frac{1 \text{ mol Fe}}{55.85 \text{ g Fe}} = \frac{1.25 \text{ mol Fe}}{1.25} = 1 \text{ mol Fe} \times 2 = 2$$

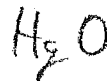
$$30.1 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = \frac{1.88 \text{ mol O}}{1.25} = 1.5 \text{ mol O} \times 2 = 3$$



6. When 4.01 g of mercury is strongly heated in air, the resulting oxide weighs 4.33 g. Calculate the empirical formula of the oxide.

$$4.01 \text{ g Hg} \times \frac{1 \text{ mol Hg}}{200.6 \text{ g Hg}} = \frac{0.0200 \text{ mol Hg}}{1.02} = 1 \text{ mol Hg}$$

$$0.32 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = \frac{0.0200 \text{ mol O}}{1.02} = 1 \text{ mol O}$$



7. The compound A_2O is 63.7% A (a mystery element) and 36.3% oxygen. What is the identity of element A? *100g sample*

$$36.3 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 2.27 \text{ mol O} \times \frac{2 \text{ mol A}}{1 \text{ mol O}} = 4.54 \text{ mol A}$$

$$\text{molar mass} = \frac{63.7 \text{ g A}}{4.54 \text{ mol A}}$$

$$= 14.0 \text{ g A} = \text{N}$$

8. A compound containing only sulfur and ~~oxygen~~ ^{nitrogen} is 69.6% S by mass; the molar mass is 184 g/mol. What are the empirical and molecular formulas of the compound? *100g sample*

$$69.6 \text{ g S} \times \frac{1 \text{ mol S}}{32.07 \text{ g S}} = \frac{2.17 \text{ mol S}}{2.17} = 1 \text{ mol S}$$

empirical $\text{SN} = 46.08 \text{ g/mol}$

$$30.4 \text{ g N} \times \frac{1 \text{ mol N}}{14.01 \text{ g N}} = \frac{2.17 \text{ mol N}}{2.17} = 1 \text{ mol N}$$

$$\frac{184}{46} = 4 \times \text{SN} = \text{molecular } \text{S}_4\text{N}_4$$

9. Maleic acid is an organic compound composed of 41.39% C, 3.47% H, and the rest O. If 0.129 mol of maleic acid has a mass of 15.0 g, what are the empirical and molecular formulas for maleic acid? *100g sample*

$$41.39 \text{ g C} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = \frac{3.44 \text{ mol C}}{3.44} = 1 \text{ mol C}$$

$$\text{CHO} = 29.02 \text{ g/mol}$$

$$3.47 \text{ g H} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = \frac{3.44 \text{ mol H}}{3.44} = 1 \text{ mol H}$$

$$\text{molar mass} = \frac{15.0 \text{ g}}{0.129 \text{ mol}} = 116.3 \text{ g/mol}$$

$$\frac{116.3 \text{ g/mol}}{29.02 \text{ g/mol}} = 4$$

$$55.14 \text{ g O} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = \frac{3.44 \text{ mol O}}{3.44} = 1 \text{ mol O}$$

$$\text{CHO} \times 4 = \text{C}_4\text{H}_4\text{O}_4$$