Empirical and Molecular Formula Practice Solutions

1. A compound is found to contain 63.52 % iron and 36.48% sulfur. Find its empirical formula.

$$63.52\ \text{g Fe} \times \frac{1\ \text{mol}}{55.85\ \text{g}} = 1.137\ \text{mol Fe}$$

$$36.48\ \text{g S} \times \frac{1\ \text{mol}}{32.06\ \text{g}} = 1.138\ \text{mol S}$$

$$\frac{1.137\ \text{mol Fe}}{1.137} : \frac{1.138\ \text{mol S}}{1.137} = 1\ \text{mol Fe}: 1.001\ \text{mol S}$$

$$\text{empirical formula} = \text{FeS}$$

2. A compound is found to contain 26.56% potassium, 35.41% chromium, and the remainder oxygen. Find its empirical formula.

$$26.56\ \text{g K} \times \frac{1\ \text{mol}}{39.10\ \text{g}} = 0.6793\ \text{mol K}$$

$$36.48\ \text{g Cr} \times \frac{1\ \text{mol}}{52.00\ \text{g}} = 0.7015\ \text{mol Cr}$$

$$36.96\ \text{g O} \times \frac{1\ \text{mol}}{16.00\ \text{g}} = 2.310\ \text{mol O}$$

$$\frac{0.6793\ \text{mol K}}{0.6793} : \frac{0.7015\ \text{mol Cr}}{0.6793} : \frac{2.310\ \text{mol O}}{0.6793} = 1\ \text{mol K}: 1.033\ \text{mol Cr}: 3.401\text{mol O}$$

$$\rightarrow 2\ \text{mol K}: 2.066\ \text{mol Cr}: 6.802\ \text{mol O}$$

$$\text{empirical formula} = \text{K}_2\text{Cr}_2\text{O}_7$$

3. A 60.00 g sample of tetraethyllead, a gasoline additive, is found to contain 38.43 g lead, 17.83 g carbon, and 3.74 g hydrogen. Find its empirical formula.

$$38.43\ \text{g Pb} \times \frac{1\ \text{mol}}{207.20\ \text{g}} = 0.1855\ \text{mol Pb}$$

$$17.83\ \text{g C} \times \frac{1\ \text{mol}}{12.01\ \text{g}} = 1.485\ \text{mol C}$$

$$3.74\ \text{g H} \times \frac{1\ \text{mol}}{1.01\ \text{g}} = 3.78\ \text{mol H}$$

$$\frac{0.1855\ \text{mol Pb}}{0.1855} : \frac{1.485\ \text{mol C}}{0.1855} : \frac{3.78\ \text{mol H}}{0.1855} = 1\ \text{mol Pb}: 8.005\ \text{mol C}: 20.4\ \text{mol H}$$

$$\text{empirical formula} = \text{PbC}_8\text{H}_{20}$$

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4. A 170.00 g sample of an unidentified compound contains 29.84 g sodium, 67.49 g chromium, and 72.67 g oxygen. Find the empirical formula.

$$29.84\ \text{g Na} \times \frac{1\ \text{mol}}{22.99\ \text{g}} = 1.298\ \text{mol Na}$$

$$67.49\ \text{g Cr} \times \frac{1\ \text{mol}}{52.00\ \text{g}} = 1.298\ \text{mol Cr}$$

$$72.67\ \text{g O} \times \frac{1\ \text{mol}}{16.00\ \text{g}} = 4.54\ \text{mol O}$$

$$\frac{1.298\ \text{mol Na}}{1.298} : \frac{1.298\ \text{mol Cr}}{1.298} : \frac{4.54\ \text{mol O}}{1.298} = 1\ \text{mol Na}: 1\ \text{mol Cr}: 3.50\ \text{mol O}$$

$$\rightarrow 2\ \text{mol Na}: 2\ \text{mol Cr}: 7.00\ \text{mol O}$$

$$\text{empirical formula} = \text{Na}_2\text{Cr}_2\text{O}_7$$

5. Determine the molecular formula of the compound with an empirical formula of CH and a formula mass of 78.110 u.

$$1\ \text{atom C} \times \frac{12.01\ \text{u}}{1\ \text{atom C}} = 12.01\ \text{u}$$

$$1\ \text{atom H} \times \frac{1.01\ \text{u}}{1\ \text{atom H}} = 1.01\ \text{u}$$

$$\text{empirical formula mass} = 13.02\ \text{u}$$

$$\text{molecular formula mass} = 78.110\ \text{u}$$

$$\frac{\text{molecular formula mass}}{\text{empirical formula mass}} = \frac{78.110\ \text{u}}{13.02\ \text{u}} = 5.999$$

$$\text{molecular formula: } (\text{CH})_6 = \text{C}_6\text{H}_6$$

6. Determine the molecular formula of a compound with an empirical formula of NH_2 and a formula mass of 32.06 u.

$$1\ \text{atom N} \times \frac{14.01\ \text{u}}{1\ \text{atom N}} = 14.01\ \text{u}$$

$$2\ \text{atom H} \times \frac{2.02\ \text{u}}{1\ \text{atom H}} = 2.02\ \text{u}$$

$$\text{empirical formula mass} = 16.03\ \text{u}$$

$$\text{molecular formula mass} = 32.06\ \text{u}$$

$$\frac{\text{molecular formula mass}}{\text{empirical formula mass}} = \frac{32.06\ \text{u}}{16.03\ \text{u}} = 2$$

$$\text{molecular formula: } (\text{NH}_2)_2 = \text{N}_2\text{H}_4$$

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7. A sample of a compound with a formula mass of 34.00 u is found to consist of 0.44 g H and 6.92 g O. Find its molecular formula.

$$0.44\text{ g H} \times \frac{1\text{ mol}}{1.01\text{ g}} = 0.436\text{ mol H}$$

$$6.92\text{ g O} \times \frac{1\text{ mol}}{16.00\text{ g}} = 0.433\text{ mol O}$$

$$\frac{0.436\text{ mol H}}{0.433} : \frac{0.433\text{ mol O}}{0.433} = 1.01\text{ mol H}: 1\text{ mol O}$$

$$\text{empirical formula} = \text{HO}$$

$$1\text{ atom H} \times \frac{1.01\text{ u}}{1\text{ atom H}} = 1.01\text{ u}$$

$$1\text{ atom O} \times \frac{16.00\text{ u}}{1\text{ atom N}} = 16.00\text{ u}$$

$$\text{empirical formula mass} = 17.01\text{ u}$$

$$\text{molecular formula mass} = 34.00\text{ u}$$

$$\frac{\text{molecular formula mass}}{\text{empirical formula mass}} = \frac{34.00\text{ u}}{17.01\text{ u}} = 1.999$$

$$\text{molecular formula: } (\text{HO})_2 = \text{H}_2\text{O}_2$$