Non Sibi High School

Andover's Chem 550/580: Advanced Chemistry

Chapter 3, Review Quiz 1 Answers

1

What is the percent by mass of sulfur in $Fe_2(S_2O_3)_3$?

$$\frac{6(32.07)}{2(55.85)+6(32.07)+9(16.00)} = 42.94\%\,\text{S by mass}$$

2

What is the empirical formula of $C_{10}H_{14}N_2$?

divide all subscripts by 2 to get simplest ratio= C_5H_7N

3

a. An unknown compound was found to be 21.84% carbon and 76.93% iodine by mass, with the remainder being hydrogen. Determine the empirical formula of the compound.

$$100\% - 21.84\%\,\text{C} - 76.93\%\,\text{I} = 1.23\%\,\text{H}$$

Assume one hundred grams of unknown compound:

$$21.84\,\text{g C}\left(\frac{1\,\text{mol}}{12.01\,\text{g}}\right) = 1.818\,\text{mol C}$$

$$1.23\,\text{g H}\left(\frac{1\,\text{mol}}{1.008\,\text{g}}\right) = 1.22\,\text{mol H}$$

$$76.93\,\text{g I}\left(\frac{1\,\text{mol}}{126.9\,\text{g}}\right) = 0.6062\,\text{mol I}$$

$$\frac{1.818}{0.6062}\,\text{mol C} : \frac{1.22}{0.6062}\,\text{mol H} : \frac{0.6062}{0.6062}\,\text{mol I}$$

$$\text{empirical formula} = C_3H_2I$$

b. In a separate experiment, the molar mass of the compound was found to be about 330 g/mol. Determine the molecular formula of the compound.

$$\frac{M}{EM} = \frac{330}{164.9} = 2$$

$$\text{molecular formula} = C_3H_2I \times 2 = C_6H_4I_2$$

4

After 8.75 grams of the hydrate $LiClO_4 \cdot xH_2O$ was heated, the mass of anhydrous $LiClO_4$ remaining was 5.79 grams. Determine the value of x to the correct number of significant figures and the most likely formula of the hydrate.

$$8.75\,\text{g} - 5.79\,\text{g} = 2.96\,\text{g}\,H_2O$$

$$2.96\,\text{g}\,H_2O\left(\frac{1\,\text{mol}}{18.02\,\text{g}}\right) = 0.1643\,\text{mol}\,H_2O$$

$$5.79\,\text{g}\,LiClO_4\left(\frac{1\,\text{mol}}{106.4\,\text{g}}\right) = 0.05442\,\text{mol}\,LiClO_4$$

$$x = \frac{0.1643\,\text{mol}\,H_2O}{0.05442\,\text{mol}\,LiClO_4} = 3.02$$

$$\text{most likely formula} = LiClO_4 \cdot 3H_2O$$

5

a. An unknown compound contains carbon, hydrogen, and nitrogen. When 12.6 grams of the compound was burned completely in the presence of oxygen gas, 19.1 grams of CO_2 and 11.7 grams of H_2O were produced. Determine the empirical formula of the compound.

$$19.1\,\text{g}\,CO_2\left(\frac{1\,\text{mol}\,CO_2}{44.01\,\text{g}\,CO_2}\right)\left(\frac{1\,\text{mol}\,C}{1\,\text{mol}\,CO_2}\right) = 0.4340\,\text{mol}C\left(\frac{12.01\,\text{g}\,C}{1\,\text{mol}\,C}\right) = 5.212\,\text{g}\,C$$

$$11.7\,\text{g}\,H_2O\left(\frac{1\,\text{mol}\,H_2O}{18.02\,\text{g}\,H_2O}\right)\left(\frac{2\,\text{mol}\,H}{1\,\text{mol}\,H_2O}\right) = 1.299\,\text{mol}H\left(\frac{1.008\,\text{g}\,H}{1\,\text{mol}\,H}\right) = 1.309\,\text{g}\,H$$

$$12.6\text{ g compound - }5.212\text{ g C - }1.309\text{ g H} = 6.079\,\text{g}\,N\left(\frac{1\,\text{mol}\,N}{14.01\,\text{g}\,N}\right) = 0.4339\,\text{mol}\,N$$

$$\frac{0.4340}{0.4339}\,\text{mol}\,C : \frac{1.299}{0.4339}\,\text{mol}\,H : \frac{0.4339}{0.4339}\,\text{mol}\,N$$

$$\text{empirical formula} = CH_3N$$

b. In a separate experiment, the molar mass of the compound was found to be about 58 g/mol. Determine the molecular formula of the compound.

$$\frac{M}{EM} = \frac{58}{29.04} = 2$$

$$\text{molecular formula} = \text{CH}_3\text{N} \times 2 = \text{C}_2\text{H}_6\text{N}_2$$