

WKS 3-5 – Chem Honors
% Composition & Empirical Formula

Name Answer Key
 Period _____ Date _____

Part I Given the chemical formulas, calculate the percent composition for the following compounds:

1. What is the percent by mass of sulfur in H_2SO_3 and $\text{H}_2\text{S}_2\text{O}_8$?

$$\text{MM}_{\text{H}_2\text{SO}_3} = 2(1.008) + 32.07 + 3(16.00) = 82.09 \text{ g/mol H}_2\text{SO}_3$$

$$\text{MM}_{\text{H}_2\text{S}_2\text{O}_8} = 2(1.008) + 2(32.07) + 8(16.00) = 194.16 \text{ g/mol H}_2\text{S}_2\text{O}_8$$

$$\text{H}_2\text{SO}_3: \frac{32.07 \text{ g S}}{82.09 \text{ g H}_2\text{SO}_3} \times 100 = \boxed{39.07\% \text{ S}}; \text{H}_2\text{S}_2\text{O}_8: \frac{2 \times 32.07 \text{ g S}}{194.16 \text{ g H}_2\text{S}_2\text{O}_8} \times 100 = \boxed{33.04\% \text{ S}}$$

2. Fe_2O_3

$$\text{MM}_{\text{Fe}_2\text{O}_3} = 2(55.85) + 3(16.00) = 159.7 \text{ g/mol}$$

$$?\% \text{ Fe} = \frac{111.7 \text{ g Fe}}{159.7 \text{ g Fe}_2\text{O}_3} \times 100\% = \boxed{69.94\% \text{ Fe}}$$

$$?\% \text{ O} = \frac{48.00 \text{ g O}}{159.7 \text{ g Fe}_2\text{O}_3} \times 100\% = \boxed{30.06\% \text{ O}}$$

3. $\text{Ca}_3(\text{PO}_4)_2$

$$\text{MM}_{\text{Ca}_3(\text{PO}_4)_2} = 3(40.08) + 2(30.97) + 8(16.00) = 310.2 \text{ g/mol}$$

$$\% \text{ Ca} = \frac{120.2 \text{ g Ca}}{310.2 \text{ g Ca}_2(\text{PO}_4)_3} \times 100\% = \boxed{38.75\% \text{ Ca}}$$

$$\text{P} = \frac{61.94 \text{ g P}}{310.2 \text{ g Ca}_2(\text{PO}_4)_3} \times 100\% = \boxed{19.97\% \text{ P}}$$

$$\% \text{ O} = \frac{128.0 \text{ g O}}{310.2 \text{ g Ca}_2(\text{PO}_4)_3} \times 100\% = \boxed{41.26\% \text{ O}}$$

4. Given the % P in #3, what mass of P would be present in 58.2 g $\text{Ca}_3(\text{PO}_4)_2$?

$$? \text{ g P} = 58.2 \text{ g Ca}_2(\text{PO}_4)_3 \times \frac{19.97\% \text{ P}}{100\% \text{ Ca}_2(\text{PO}_4)_3} = \boxed{11.6 \text{ g P}}$$

Part II Given the following mass analyses, calculate the percent composition for the following compounds:

5. 52.96 g Hg, 7.37 g N, 25.37 g O

$$m_{\text{total}} = 52.96 \text{ g} + 7.37 \text{ g} + 25.37 \text{ g} = 85.70 \text{ g}$$

$$\% \text{ Hg} = \frac{52.96 \text{ g Hg}}{85.70 \text{ g}} \times 100 = \boxed{61.80\% \text{ Hg}}$$

$$\% \text{ N} = \frac{7.37 \text{ g N}}{85.70 \text{ g}} \times 100 = \boxed{8.60\% \text{ N}}$$

$$\% \text{ O} = \frac{25.37 \text{ g O}}{85.70 \text{ g}} \times 100 = \boxed{29.60\% \text{ O}}$$

6. 9.91 g P, 30.67 g Cl

$$m_{\text{total}} = 9.91 \text{ g} + 30.67 \text{ g} = 40.58 \text{ g}$$

$$\% \text{ P} = \frac{9.91 \text{ g P}}{40.58 \text{ g}} \times 100 = \boxed{24.42\% \text{ P}}$$

$$\% \text{ Cl} = \frac{30.67 \text{ g Cl}}{40.58 \text{ g}} \times 100 = \boxed{75.58\% \text{ Cl}}$$

Part III Find the empirical formulas of the following samples.

7. An unknown compound was found to have a percent composition as follows: 17.98% Li, 26.75% P, and 55.27% O.

$$\text{Li: } 17.98\% \Rightarrow 17.98 \text{ g} \times \frac{1 \text{ mol Li}}{6.941 \text{ g Li}} = 2.590 \text{ mol Li} \div 0.8637 = 2.999 \approx 3$$

$$\text{P: } 26.75\% \Rightarrow 26.75 \text{ g} \times \frac{1 \text{ mol P}}{30.97 \text{ g P}} = 0.8637 \text{ mol P} \div 0.8637 = 1$$

$$\text{O: } 55.27\% \Rightarrow 55.27 \text{ g} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 3.454 \text{ mol O} \div 0.8637 = 3.999 \approx 4$$



8. Rubbing alcohol was found to contain 60.0 % carbon, 13.4 % hydrogen, and the remaining mass was due to oxygen. % O = 100% – 60.0% – 13.4% = 26.6% O

$$\left. \begin{array}{l} \text{C: } 60.0\% \Rightarrow 60.0 \text{ g} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 5.00 \text{ mol C} \div 1.66 = 3.01 \approx 3 \\ \text{H: } 13.4\% \Rightarrow 13.4 \text{ g} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 13.3 \text{ mol H} \div 1.66 = 7.98 \approx 8 \\ \text{O: } 26.6\% \Rightarrow 26.6 \text{ g} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 1.66 \text{ mol O} \div 1.66 = 1 \end{array} \right\} \text{C}_3\text{H}_8\text{O}$$

9. Isobutylene is a raw material for making synthetic rubber. A sample with a mass of 0.6481 grams was found to contain 0.5555 grams of carbon; the rest was hydrogen.

$$m_{\text{H}} = 0.6481 \text{ g} - 0.5555 \text{ g} = 0.0926 \text{ g H}$$

$$\left. \begin{array}{l} \text{C: } 0.5555 \text{ g} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 0.04625 \text{ mol C} \div 0.04625 = 1 \\ \text{H: } 0.0926 \text{ g} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 0.0919 \text{ mol H} \div 0.04625 = 1.99 \approx 2 \end{array} \right\} \text{CH}_2$$

10. Determine the empirical formula for a compound that contains 35.98% aluminum and 64.02% sulfur.

$$\left. \begin{array}{l} \text{Al: } 35.98\% \Rightarrow 35.98 \text{ g} \times \frac{1 \text{ mol Al}}{26.98 \text{ g Al}} = 1.334 \text{ mol Al} \div 1.334 = 1 \times 2 = 2 \\ \text{S: } 64.02\% \Rightarrow 64.02 \text{ g} \times \frac{1 \text{ mol S}}{32.07 \text{ g S}} = 1.996 \text{ mol S} \div 1.334 = 1.5 \times 2 = 3 \end{array} \right\} \text{Al}_2\text{S}_3$$

11. *Propane is a hydrocarbon, a compound composed only of carbon and hydrogen. It is 81.71% carbon and 18.29% hydrogen.

$$\left. \begin{array}{l} \text{C: } 81.71\% \Rightarrow 81.71 \text{ g} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 6.803 \text{ mol C} \div 6.803 = 1 \times 3 \\ \text{H: } 18.29\% \Rightarrow 18.29 \text{ g} \times \frac{1 \text{ mol H}}{1.008 \text{ g H}} = 18.14 \text{ mol H} \div 6.803 = 2.667 \times 3 = 8.001 \approx 8 \end{array} \right\} \text{C}_3\text{H}_8$$