WKS – 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 $H_2S_2O_8$?

$MM_{H_2SO_3} = 2(1.008) + 32.07 + 3(16.00) = 82.09 \text{ g/mol } H_2SO_3$

$MM_{H_2S_2O_8} = 2(1.008) + 2(32.07) + 8(16.00) = 194.16 \text{ g/mol } H_2S_2O_8$

H_2SO_3: $\frac{32.07 \text{ g S}}{82.09 \text{ g } H_2SO_3} \times 100 = \boxed{39.07\% \text{ S}}$; $H_2S_2O_8$: $\frac{2 \times 32.07 \text{ g S}}{194.16 \text{ g } H_2S_2O_8} \times 100 = \boxed{33.04\% \text{ S}}$

2. Fe_2O_3

$MM_{Fe_2O_3} = 2(55.85) + 3(16.00) = 159.7 \text{ g/mol}$

$?\% \text{ Fe} = \frac{111.7 \text{ g Fe}}{159.7 \text{ g } Fe_2O_3} \times 100\% = \boxed{69.94\% \text{ Fe}}$

$?\% \text{ O} = \frac{48.00 \text{ g O}}{159.7 \text{ g } Fe_2O_3} \times 100\% = \boxed{30.06\% \text{ O}}$

3. $Ca_3(PO_4)_2$

$MM_{Ca_3(PO_4)_2} = 3(40.08) + 2(30.97) + 8(16.00) = 310.2 \text{ g/mol}$

$\% \text{ Ca} = \frac{120.2 \text{ g Ca}}{310.2 \text{ g } Ca_2(PO_4)_3} \times 100\% = \boxed{38.75\% \text{ Ca}}$

$\text{P} = \frac{61.94 \text{ g P}}{310.2 \text{ g } Ca_2(PO_4)_3} \times 100\% = \boxed{19.97\% \text{ P}}$

$\% \text{ O} = \frac{128.0 \text{ g O}}{310.2 \text{ g } Ca_2(PO_4)_3} \times 100\% = \boxed{41.26\% \text{ O}}$

4. Given the % P in #3, what mass of P would be present in 58.2 g $Ca_3(PO_4)_2$?

$? \text{ g P} = 58.2 \text{ g } Ca_2(PO_4)_3 \times \frac{19.97\% \text{ P}}{100\% \text{ } Ca_2(PO_4)_3} = \boxed{11.6 \text{ g P}}$

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

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

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

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

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

6. 9.91 g P, 30.67 g Cl

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

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

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

Part III Find the empirical formulas of the following samples.

7. An unknown compound was found to have a percent composition as follows: 56.6% potassium, 8.69% carbon, and 34.7% oxygen.

$\text{K: } 56.6\% \Rightarrow 56.6 \text{ g} \times \frac{1 \text{ mol K}}{39.10 \text{ g K}} = 1.45 \text{ mol K} \div 0.724 = 2.00$

$\text{C: } 8.69\% \Rightarrow 8.69 \text{ g} \times \frac{1 \text{ mol C}}{12.01 \text{ g C}} = 0.724 \text{ mol C} \div 0.724 = 1$

$\text{O: } 34.7\% \Rightarrow 34.7 \text{ g} \times \frac{1 \text{ mol O}}{16.00 \text{ g O}} = 2.17 \text{ mol O} \div 0.724 = 3.00$

$\boxed{K_2CO_3}$

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

$$\text{C: } 60.0\% \Rightarrow 60.0\text{ g} \times \frac{1\text{ mol C}}{12.01\text{ g C}} = 5.00\text{ mol C} \div 1.66 = 3.01 \approx 3$$
$$\text{H: } 13.4\% \Rightarrow 13.4\text{ g} \times \frac{1\text{ mol H}}{1.008\text{ g H}} = 13.3\text{ mol H} \div 1.66 = 7.98 \approx 8$$
$$\text{O: } 26.6\% \Rightarrow 26.6\text{ g} \times \frac{1\text{ mol O}}{16.00\text{ g O}} = 1.66\text{ mol O} \div 1.66 = 1$$

$\boxed{C_3H_8O}$

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.

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

$$\text{C: } 0.5555\text{ g} \times \frac{1\text{ mol C}}{12.01\text{ g C}} = 0.04625\text{ mol C} \div 0.04625 = 1$$
$$\text{H: } 0.0917\text{ g} \times \frac{1\text{ mol H}}{1.008\text{ g H}} = 0.0919\text{ mol H} \div 1.66 = 1.99 \approx 2$$

$\boxed{CH_2}$

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

$$\text{Al: } 35.98\% \Rightarrow 35.98\text{ g} \times \frac{1\text{ mol Al}}{26.98\text{ g Al}} = 1.334\text{ mol Al} \div 1.334 = 1 \times 2 = 2$$
$$\text{S: } 64.02\% \Rightarrow 64.02\text{ g} \times \frac{1\text{ mol S}}{32.07\text{ g S}} = 1.996\text{ mol S} \div 1.334 = 1.5 \times 2 = 3$$

$\boxed{Al_2S_3}$

11. *Propane is a hydrocarbon, a compound composed only of carbon and hydrogen. It is 81.82% carbon and 18.18% hydrogen.

$$\text{C: } 81.82\% \Rightarrow 81.82\text{ g} \times \frac{1\text{ mol C}}{12.01\text{ g C}} = 6.813\text{ mol C} \div 6.813 = 1 \times 3$$
$$\text{H: } 18.18\% \Rightarrow 18.18\text{ g} \times \frac{1\text{ mol H}}{1.008\text{ g H}} = 18.04\text{ mol H} \div 6.813 = 2.648 \times 3 = 7.944 \approx 8$$

$\boxed{C_3H_8}$