Problem Set Chapter 3, Part 2

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1. Balance the following:

   (a) $Zn(C_2H_3O_2)_2 + Na_3PO_4 \rightarrow NaC_2H_3O_2 + Zn_3(PO_4)_2$

   $$3Zn(C_2H_3O_2)_2 + 2Na_3PO_4 \rightarrow 6NaC_2H_3O_2 + Zn_3(PO_4)_2$$

   (b) $Ca_{10}F_2(PO_4)_6 + H_2SO_4 \rightarrow HF + Ca(H_2PO_4)_2 + CaSO_4$

   $$Ca_{10}F_2(PO_4)_6 + 7H_2SO_4 \rightarrow 2HF + 3Ca(H_2PO_4)_2 + 7CaSO_4$$

   (c) $C_2H_6 + O_2 \rightarrow CO_2 + H_2O$

   $$2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$$

2. Calculate the number of grams of both products when 17.8[g] of C_3H_8 is combusted.

   (a) $C_3H_8 + 5O_2 \rightarrow 4H_2O + 3CO_2$

   $$\frac{17.8[\text{g}]}{44[\text{g mol}^{-1}]} = .4[\text{mol}_{C_3H_8}] \rightarrow 2[\text{mol}_{O_2}],\ 1.6[\text{mol}_{H_2O}],\ 1.2[\text{mol}_{CO_2}]$$

   $$1.6[\text{mol}] \cdot 18[\text{g mol}^{-1}] = 28.8[\text{g}]$$
   $$1.2[\text{mol}] \cdot 44[\text{g mol}^{-1}] = 52.8[\text{g}]$$

3. A 0.1204[g] sample of carboxylic acid (containing C, O, and H) is burned in oxygen to yield 0.2147[g] of carbon dioxide and 0.0884[g] of water. Calculate the empirical formula.

   $$.2147 \cdot \frac{12}{44} = .059[\text{g}_C],\ .0884 \cdot \frac{2}{18} = .0098[\text{g}_H],\ .1204 - .0098 - .059 = .0516[\text{g}_O]$$
   $$\frac{.059}{12} = .0049[\text{mol}_C],\ \frac{.0098}{1} = .0098[\text{mol}_H],\ \frac{.0516}{16} = .0032[\text{mol}_O]$$

   $$C_3H_6O_2$$

4. Phenol contains C, H, and O. Combustion of 2.136[mg] of phenol gives 5.993[mg] of CO_2 and 1.227[mg_{H_2O}]. What is the simplest formula?

$$.5993 \cdot \frac{12}{44} = .163[\text{g}_C],\ .1227 \cdot \frac{2}{18} = .0136[\text{g}_H],\ .2136 - .163 - .0136 = .0773[\text{g}_O]$$

$$\frac{.163}{12} = .0136[\text{mol}_C],\ \frac{.0136}{1} = .0136[\text{mol}_H],\ \frac{.037}{16} = .00231[\text{mol}_O]$$

$$C_6H_6O$$

5. Kerosene ($C_{14}H_{30}$) has a density of 0.763[g mL^{-1}]. How many grams of carbon dioxide are produced by the combustion of 3.785[L] of kerosene?

$$.763[\text{g mL}^{-1}] = .763[\text{kg L}^{-1}]$$

$$.763 \cdot 3.785 = 2.89[\text{kg}] = 2890[\text{g}]$$

$$2890 \cdot \frac{168}{198} = 2452[\text{g}_C]$$

$$\frac{2452}{12} = 204.33[\text{mol}_C] \rightarrow 408.66[\text{mol}]$$

$$408.66 \cdot 16 = 6538.6[\text{g}_O] + 2452[\text{g}_C] = 8990.6[\text{g}_{CO_2}]$$

6. How many liters of CH_3CH_2OH (density = 0.789[g mL^{-1}]) must be consumed to produce 25[L] of CH_3CHO (density = 0.788[g mL^{-1}])?

$$CH_3CH_2OH + O_2 \rightarrow CH_3CHO + H_2O$$

$$2CH_3CH_2OH + O_2 \rightarrow 2CH_3CHO + 2H_2O$$

$$.788[\text{g mL}^{-1}] = .788[\text{kg L}^{-1}]$$

$$.788 \cdot 25 = 19.7[\text{kg}] \rightarrow 19700[\text{g}] \cdot \frac{1}{44} = 447.73[\text{mol}_{CH_3CHO}] \rightarrow 447.73[\text{mol}]$$

$$447.73[\text{mol}_{CH_3CH_2OH}] \cdot 46 = 20595[\text{g}] = 20.595[\text{kg}]$$

$$V = \frac{m}{\rho} = \frac{20.595}{.789} = 26[\text{L}]$$