

# Empirical Formula by Combustion

- 3.45 g of an organic compound containing carbon, hydrogen and oxygen is combusted in air producing 6.60 g of carbon dioxide and 4.05 g of water.
  - Calculate the empirical formula
  - Determine the molecular formula if the molecular formula mass is  $138.1 \text{ g mol}^{-1}$ .
- Butyric acid, containing C, H, and O, is a component of rancid butter and has a vile stench. Burning 0.440 g of butyric acid in excess oxygen yields 0.882 g of  $\text{CO}_2$  and 0.360 g of  $\text{H}_2\text{O}$  as the only products. What is the empirical formula and the molecular formula of butyric acid (molar mass equals  $88 \text{ g mol}^{-1}$ )?
- Formaldehyde,  $\text{CH}_2\text{O}$ , is unstable as a pure gas, readily forming a mixture of a substance called trioxane and a polymer called paraformaldehyde. That is why formaldehyde is dissolved in a solvent, like water, before it is sold and used. The molecular formula of trioxane, which contains carbon, hydrogen, and oxygen, can be determined using the data from two different experiments. In the first experiment, 17.471 g of trioxane is burned in the apparatus shown above, and 10.477 g  $\text{H}_2\text{O}$  and 25.612 g  $\text{CO}_2$  are formed. In the second experiment, the molecular mass of trioxane is found to be  $90.079 \text{ g mol}^{-1}$ . Determine the molecular formula of trioxane.
- Dianabol is one of the anabolic steroids that has been used by some athletes to increase the size and strength of their muscles. It is similar to the male hormone testosterone. Some studies indicate that the desired effects of the drug are minimal, and the side effects, which include sterility and increased risk of liver cancer and heart disease, keep most people from using it. The molecular formula of Dianabol, which consists of carbon, hydrogen, and oxygen, can be determined using the data from two different experiments. In the first experiment, 14.765 g of Dianabol is burned, and 43.257 g  $\text{CO}_2$  and 12.395 g  $\text{H}_2\text{O}$  are formed. In the second experiment, the molecular mass of Dianabol is found to be  $300.44 \text{ g mol}^{-1}$ . What is the molecular formula for Dianabol?
- Challenge Question: Dimethyl hydrazine, the fuel used in Apollo lunar module has a molar mass of  $60.10 \text{ g mol}^{-1}$ . It is made up of carbon, hydrogen and nitrogen atoms. The combustion of 2.859 g of the fuel in excess oxygen yields 4.190 g of  $\text{CO}_2$  and 3.428 g of  $\text{H}_2\text{O}$ . What are the empirical and molecular formulae for dimethyl hydrazine?

**Answers:** 1. a)  $\text{C}_2\text{H}_6\text{O}$ , b)  $\text{C}_6\text{H}_{18}\text{O}_3$  2.  $\text{C}_2\text{H}_4\text{O}$ ,  $\text{C}_4\text{H}_8\text{O}_2$  3.  $\text{CH}_2\text{O}$ ,  $\text{C}_3\text{H}_6\text{O}_3$  4.  $\text{C}_{10}\text{H}_{14}\text{O}$ ,  $\text{C}_{20}\text{H}_{28}\text{O}_2$   
5.  $\text{CH}_4\text{N}$ ,  $\text{C}_2\text{H}_8\text{N}_2$