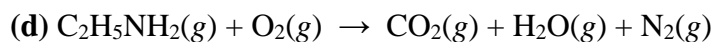
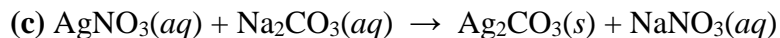
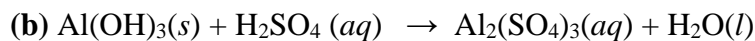
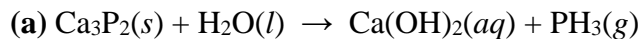


### CHAPTER 3 PROBLEM SET

1. Balance the following equations:



2. Calculate the percentage by mass of the indicated element in the following compounds:

(a) carbon in acetylene,  $\text{C}_2\text{H}_2$ , a gas used in welding;

(b) hydrogen in ascorbic acid,  $\text{HC}_6\text{H}_7\text{O}_6$ , also known as vitamin C;

(c) hydrogen in ammonium sulfate,  $(\text{NH}_4)_2\text{SO}_4$ , a substance used as a nitrogen fertilizer;

(d) platinum in  $\text{PtCl}_2(\text{NH}_3)_2$ , a chemotherapy agent called cisplatin;

(e) oxygen in the female sex hormone estradiol,  $\text{C}_{18}\text{H}_{24}\text{O}_2$ ;

(f) carbon in capsaicin,  $\text{C}_{18}\text{H}_{27}\text{NO}_3$ , the compound that gives the hot taste to chili peppers.

3. (a) What is the mass, in grams, of 1.223 mol of iron (III) sulfate?

(b) How many moles of ammonium ions are in 6.955 g of ammonium carbonate?

(c) What is the mass, in grams, of  $1.50 \times 10^{21}$  molecules of aspirin,  $\text{C}_9\text{H}_8\text{O}_4$ ?

(d) What is the molar mass of diazepam (Valium®) if 0.05570 mol has a mass of 15.86 g?

4. The molecular formula of aspartame, the artificial sweetener marketed as NutraSweet®, is  $\text{C}_{14}\text{H}_{18}\text{N}_2\text{O}_5$ . (a) What is the molar mass of aspartame? (b) How many moles of aspartame are present in 1.00 mg of aspartame? (c) How many molecules of aspartame are present in 1.00 mg of aspartame? (d) How many hydrogen atoms are present in 1.00 mg of aspartame?

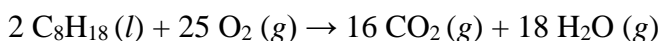
5. The allowable concentration level of vinyl chloride,  $\text{C}_2\text{H}_3\text{Cl}$ , in the atmosphere in a chemical plant is  $2.0 \times 10^{-6}$  g/L. How many moles of vinyl chloride in each liter does this represent? How many molecules per liter?

6. (a) The characteristic odor of pineapple is due to ethyl butyrate, a compound containing carbon, hydrogen, and oxygen. Combustion of 2.78 mg of ethyl butyrate produces 6.32 mg of  $\text{CO}_2$  and 2.58 mg of  $\text{H}_2\text{O}$ . What is the empirical formula of the compound?

(b) Nicotine, a component of tobacco, is composed of C, H, and N. A 5.250-mg sample of nicotine was combusted, producing 14.242 mg of CO<sub>2</sub> and 4.083 mg of H<sub>2</sub>O. What is the empirical formula for nicotine? If nicotine has a molar mass of 160 ± 5 g/mol, what is its molecular formula?

7. Epsom salts, a strong laxative used in veterinary medicine, is a hydrate, which means that a certain number of water molecules are included in the solid structure. The formula for Epsom salts can be written as MgSO<sub>4</sub> · xH<sub>2</sub>O, where *x* indicates the number of moles of H<sub>2</sub>O per mole of MgSO<sub>4</sub>. When 5.061 g of this hydrate is heated to 250 °C, all the water of hydration is lost, leaving 2.472 g of MgSO<sub>4</sub>. What is the value of *x*?

8. The complete combustion of octane, C<sub>8</sub>H<sub>18</sub>, a component of gasoline, proceeds as follows:



(a) How many moles of O<sub>2</sub> are needed to burn 1.50 mol of C<sub>8</sub>H<sub>18</sub>?

(b) How many grams of O<sub>2</sub> are needed to burn 10.0 g of C<sub>8</sub>H<sub>18</sub>?

(c) Octane has a density of 0.692 g/mL at 20 °C. How many grams of O<sub>2</sub> are required to burn 15.0 gal of C<sub>8</sub>H<sub>18</sub> (the capacity of an average fuel tank)?

(d) How many grams of CO<sub>2</sub> are produced when 15.0 gal of C<sub>8</sub>H<sub>18</sub> are combusted?

9. Solutions of sulfuric acid and lead(II) acetate react to form solid lead(II) sulfate and a solution of acetic acid. If 5.00 g of sulfuric acid and 5.00 g of lead(II) acetate are mixed, calculate the number of grams of sulfuric acid, lead(II) acetate, lead(II) sulfate, and acetic acid present in the mixture after the reaction is complete.

10. When ethane (C<sub>2</sub>H<sub>6</sub>) reacts with chlorine (Cl<sub>2</sub>), the main product is C<sub>2</sub>H<sub>5</sub>Cl, but other products containing Cl, such as C<sub>2</sub>H<sub>4</sub>Cl<sub>2</sub>, are also obtained in small quantities. The formation of these other products reduces the yield of C<sub>2</sub>H<sub>5</sub>Cl.

(a) Calculate the theoretical yield of C<sub>2</sub>H<sub>5</sub>Cl when 125 g of C<sub>2</sub>H<sub>6</sub> reacts with 255 g of Cl<sub>2</sub>, assuming that C<sub>2</sub>H<sub>6</sub> and Cl<sub>2</sub> react only to form C<sub>2</sub>H<sub>5</sub>Cl and HCl.

(b) Calculate the percent yield of C<sub>2</sub>H<sub>5</sub>Cl if the reaction produces 206 g of C<sub>2</sub>H<sub>5</sub>Cl.

11. An organic compound was found to contain only C, H, and Cl. When a 1.50-g sample of the compound was completely combusted in air, 3.52 g of CO<sub>2</sub> was formed. In a separate experiment the chlorine in a 1.00-g sample of the compound was converted to 1.27 g of AgCl. Determine the empirical formula of the compound.