

## cal Formulas and Equations

3.19 Percent yield is defined as

$$\frac{\text{amount of product formed}}{\text{amount of reactant}} \times 100$$

### Problems and Short-Answer Questions

3.20 Balance the following equations:

- (a)  $\text{AgNO}_3(aq) + \text{CaCl}_2(aq) \rightarrow \text{AgCl}(s) + \text{Ca}(\text{NO}_3)_2(aq)$
- (b)  $\text{VO}(s) + \text{Fe}_2\text{O}_3(s) \rightarrow \text{FeO}(s) + \text{V}_2\text{O}_5(s)$
- (c)  $\text{Na}(s) + \text{H}_2\text{O}(l) \rightarrow \text{NaOH}(aq) + \text{H}_2(g)$
- (d)  $\text{NH}_4\text{NO}_3(s) \rightarrow \text{N}_2\text{O}(g) + \text{H}_2\text{O}(l)$
- (e)  $\text{MnO}_2(s) + \text{HCl}(aq) \rightarrow \text{Cl}_2(g) + \text{MnCl}_2(aq) + \text{H}_2\text{O}(l)$

3.21 Write balanced equations for the following reactions:

- (a) aqueous silver nitrate reacts with aqueous copper(II) chloride to form insoluble silver chloride and aqueous copper(II) nitrate;
- (b) metallic aluminum reacts with oxygen gas to form solid aluminum oxide;
- (c) aqueous barium chloride reacts with aqueous potassium sulfate to form solid barium sulfate and aqueous potassium chloride;
- (d) solid magnesium chloride reacts with aqueous sodium hydroxide to yield insoluble magnesium hydroxide and aqueous sodium chloride;
- (e) solid potassium chlorate decomposes to solid potassium chloride and oxygen gas.

3.22 Ethylene,  $\text{C}_2\text{H}_4$ , is used to make the plastic polyethylene.

- (a) What are its molecular weight and formula weight?
- (b) How many moles of  $\text{C}_2\text{H}_4$  are there in 5.50 g?
- (c) How many molecules of  $\text{C}_2\text{H}_4$  are there in 5.50 g?

3.23 If a certain quantity of  $\text{NO}(g)$  has a mass of 5.00 g, what is the quantity of  $\text{H}_2\text{O}$  containing the same number of molecules?

3.24 What is the density of  $\text{F}_2(g)$  in grams per cubic centimeter if at  $0^\circ\text{C}$  one mole of it occupies 22.4 L?

3.25 How many molecules of  $\text{CH}_4(g)$  are contained in 1.35 g?

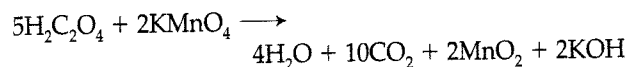
3.26 The main constituent of gallstones is cholesterol. Cholesterol may have a role in heart attacks and blood clot formation. Its elemental percentage composition is 83.87% C, 11.99% H, and 4.14% O. It has a molecular weight of 386.64 amu. Calculate its empirical and molecular formulas.

3.27 What is the empirical formula of compound such that 200.0 g of it contains 87.2 g of P and 112.8 g of O?

3.28 A stimulant of the nervous system found in coffee, tea, and cola is caffeine. Caffeine contains the following

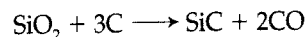
weight percentage of elements: 49.5% C; 28.9% N; 16.5% O; 5.2% H. What is the empirical formula of caffeine?

3.29  $\text{H}_2\text{C}_2\text{O}_4$  and  $\text{KMnO}_4$  react according to the equation



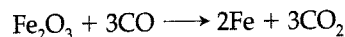
How many grams of  $\text{CO}_2$  are formed when 10.05 g of  $\text{H}_2\text{C}_2\text{O}_4$  and 26.72 g of  $\text{KMnO}_4$  are mixed together?

3.30 Silicon carbide,  $\text{SiC}$ , is an important industrial abrasive. It is formed by the reaction of  $\text{SiO}_2$  and carbon at high temperatures:



- (a) Calculate the number of moles of silicon carbide formed when 5.00 g of carbon reacts with an excess of  $\text{SiO}_2$ .
- (b) What is the minimum amount of carbon required to react with 25.0 g of  $\text{SiO}_2$ ?

3.31 The reaction for the production of iron from the reduction of the ore hematite,  $\text{Fe}_2\text{O}_3$ , is as follows:



- (a) If the reaction yields 4.52 g of  $\text{CO}_2$ , how many grams of Fe are also formed?
- (b) How many grams of Fe are formed from 7.25 g of  $\text{Fe}_2\text{O}_3$  and 6.00 g of  $\text{CO}$ ?

3.32 Bromine has two naturally occurring isotopes:  $^{79}\text{Br}$  (78.918 amu) and  $^{81}\text{Br}$  (80.916 amu). The atomic weight of Br is 79.904 amu. What are the fractional abundances of  $^{79}\text{Br}$  and  $^{81}\text{Br}$ ?

### Integrative Exercises

3.33 A 3.15 g sample of KCl contains chlorine-35 and chlorine-37. The fractional abundance of chlorine-35 is 0.75771. This sample is reacted with excess  $\text{AgNO}_3$  in water to form  $\text{AgCl}$  in a yield of 85.5%. (a) What is the mass of  $\text{AgCl}$ ? (b) What is the mass of the chlorine-35 atoms in the  $\text{AgCl}$ ?

3.34 A student prepared a sample of a unknown substance containing only nitrogen and oxygen. After studying the composition of the substance the student named it nitrogen (IV) oxide. Other students also studied the substance and found that it contained 30.45% N and 69.55% O and had a molar mass of 91.98 g. Did the original student properly name the compound? Explain.

3.35 Urea is an important compound because it is used as a fertilizer. It is commercially produced from two gases, each containing two different elements; water is the other product formed. The carbon-containing gas is colorless, a major component of exhaled air and extinguishes a flame. The percentage composition of urea is 20.0% C, 46.6% N, 26.6% O, and 6.7% H and it has a molar mass of 60.1 g. Given this information and your knowledge of gases