

- 1.19** In the process of attempting to characterize a substance, a chemist makes the following observations: The substance is a silvery white, lustrous metal. It melts at 649 °C and boils at 1105 °C. Its density at 20 °C is 1.738 g/cm<sup>3</sup>. The substance burns in air, producing an intense white light. It reacts with chlorine to give a brittle white solid. The substance can be pounded into thin sheets or drawn into wires. It is a good conductor of electricity. Which of these characteristics are physical properties, and which are chemical properties?
- 1.20** (a) Read the following description of the element zinc and indicate which are physical properties and which are chemical properties.



Zinc melts at 420 °C. When zinc granules are added to dilute sulfuric acid, hydrogen is given off and the metal dissolves. Zinc has a hardness on the Mohs scale of 2.5 and a density of 7.13g/cm<sup>3</sup> at 25 °C. It reacts slowly with oxygen gas at elevated temperatures to form zinc oxide, ZnO.

(b) Which properties of zinc can you describe from the photo? Are these physical or chemical properties?

- 1.21** Label each of the following as either a physical process or a chemical process: (a) rusting of a metal can, (b) boiling a cup of water, (c) pulverizing an aspirin, (d) digesting a candy bar, (e) exploding of nitroglycerin.
- 1.22** A match is lit and held under a cold piece of metal. The following observations are made: (a) The match burns. (b) The metal gets warmer. (c) Water condenses on the metal. (d) Soot (carbon) is deposited on the metal. Which of these occurrences are due to physical changes, and which are due to chemical changes?
- 1.23** Suggest a method of separating each of the following mixtures into two components: (a) sugar and sand, (b) oil and vinegar.
- 1.24** Three beakers contain clear, colorless liquids. One beaker contains pure water, another contains salt water, and another contains sugar water. How can you tell which beaker is which? (No tasting allowed!)

### Units and Measurement (Section 1.4)

- 1.25** What exponential notation do the following abbreviations represent? (a) d, (b) c, (c) f, (d)  $\mu$ , (e) M, (f) k, (g) n, (h) m, (i) p.
- 1.26** Use appropriate metric prefixes to write the following measurements without use of exponents: (a)  $2.3 \times 10^{-10}$  L, (b)  $4.7 \times 10^{-6}$  g, (c)  $1.85 \times 10^{-12}$  m, (d)  $16.7 \times 10^6$  s, (e)  $15.7 \times 10^3$  g, (f)  $1.34 \times 10^{-3}$  m, (g)  $1.84 \times 10^2$  cm.
- 1.27** Make the following conversions: (a) 72 °F to °C, (b) 216.7 °C to °F, (c) 233 °C to K, (d) 315 K to °F, (e) 2500 °F to K, (f) 0 K to °F.

- 1.28** (a) The temperature on a warm summer day is 87 °F. What is the temperature in °C? (b) Many scientific data are reported at 25 °C. What is this temperature in kelvins and in degrees Fahrenheit? (c) Suppose that a recipe calls for an oven temperature of 400 °F. Convert this temperature to degrees Celsius and to kelvins. (d) Liquid nitrogen boils at 77 K. Convert this temperature to degrees Fahrenheit and to degrees Celsius.
- 1.29** (a) A sample of tetrachloroethylene, a liquid used in dry cleaning that is being phased out because of its potential to cause cancer, has a mass of 40.55 g and a volume of 25.0 mL at 25 °C. What is its density at this temperature? Will tetrachloroethylene float on water? (Materials that are less dense than water will float.) (b) Carbon dioxide (CO<sub>2</sub>) is a gas at room temperature and pressure. However, carbon dioxide can be put under pressure to become a "supercritical fluid" that is a much safer dry-cleaning agent than tetrachloroethylene. At a certain pressure, the density of supercritical CO<sub>2</sub> is 0.469 g/cm<sup>3</sup>. What is the mass of a 25.0-mL sample of supercritical CO<sub>2</sub> at this pressure?
- 1.30** (a) A cube of osmium metal 1.500 cm on a side has a mass of 76.31 g at 25 °C. What is its density in g/cm<sup>3</sup> at this temperature? (b) The density of titanium metal is 4.51g/cm<sup>3</sup> at 25 °C. What mass of titanium displaces 125.0 mL of water at 25 °C? (c) The density of benzene at 15 °C is 0.8787g/mL. Calculate the mass of 0.1500 L of benzene at this temperature.
- 1.31** (a) To identify a liquid substance, a student determined its density. Using a graduated cylinder, she measured out a 45-mL sample of the substance. She then measured the mass of the sample, finding that it weighed 38.5 g. She knew that the substance had to be either isopropyl alcohol (density 0.785 g/mL) or toluene (density 0.866/mL). What are the calculated density and the probable identity of the substance? (b) An experiment requires 45.0 g of ethylene glycol, a liquid whose density is 1.114 g/mL. Rather than weigh the sample on a balance, a chemist chooses to dispense the liquid using a graduated cylinder. What volume of the liquid should he use? (c) Is a graduated cylinder such as that shown in Figure 1.19 likely to afford the accuracy of measurement needed? (d) A cubic piece of metal measures 5.00 cm on each edge. If the metal is nickel, whose density is 8.90 g/cm<sup>3</sup>, what is the mass of the cube?
- 1.32** (a) After the label fell off a bottle containing a clear liquid believed to be benzene, a chemist measured the density of the liquid to verify its identity. A 25.0-mL portion of the liquid had a mass of 21.95 g. A chemistry handbook lists the density of benzene at 15 °C as 0.8787 g/mL. Is the calculated density in agreement with the tabulated value? (b) An experiment requires 15.0 g of cyclohexane, whose density at 25 °C is 0.7781 g/mL. What volume of cyclohexane should be used? (c) A spherical ball of lead has a diameter of 5.0 cm. What is the mass of the sphere if lead has a density of 11.34 g/cm<sup>3</sup>? (The volume of a sphere is  $(4/3)\pi r^3$ , where  $r$  is the radius.)
- 1.33** In the year 2011, an estimated amount of 35 billion tons of carbon dioxide (CO<sub>2</sub>) was emitted worldwide due to fossil fuel combustion and cement production. Express this mass of CO<sub>2</sub> in grams without exponential notation, using an appropriate metric prefix.