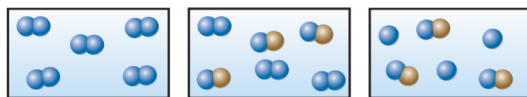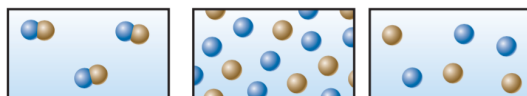# Matter and Measurement
Problem Set

1.1 Which of the following figures represents (**a**) a pure element, (**b**) a mixture of two elements, (**c**) a pure compound, (**d**) a mixture of an element and a compound? (More than one picture might fit each description.) [Section 1.2]
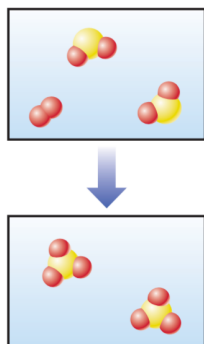

(i) (ii) (iii)

(iv) (v) (vi)

1.2 Does the following diagram represent a chemical or physical change? How do you know? [Section 1.3]


1.5 (**a**) Three spheres of equal size are composed of aluminum (density = 2.70 g/cm^3), silver (density = 10.49 g/cm^3), and nickel (density = 8.90 g/cm^3). List the spheres from lightest to heaviest. (**b**) Three cubes of equal mass are composed of gold (density = 19.32 g/cm^3), platinum (density = 21.45 g/cm^3), and lead (density = 11.35 g/cm^3). List the cubes from smallest to largest. [Section 1.4]

1.6 The following dartboards illustrate the types of errors often seen when one measurement is repeated several times. The bull's-eye represents the "true value," and the darts represent the experimental measurements. Which board best represents each of the following scenarios: (**a**) measurements both accurate and precise, (**b**) measurements precise but inaccurate, (**c**) measurements imprecise but yielding an accurate average? [Section 1.5]


(i) (ii) (iii)

1.7 (**a**) What is the length of the pencil in the following figure if the ruler reads in centimeters? How many significant figures are there in this measurement?
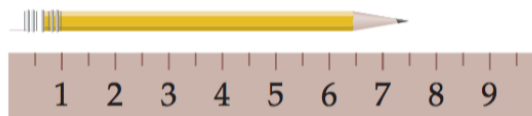
1.8 (**a**) How many significant figures should be reported for the volume of the metal bar shown here? (**b**) If the mass of the bar is 104.72 g, how many significant figures should be reported when its density is determined using the calculated volume? [Section 1.5]

2.5 cm

1.25 cm

5.30 cm
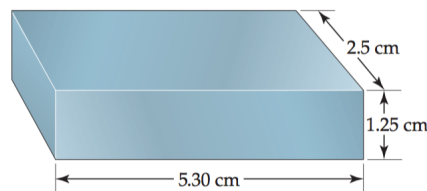
1.16 You are hiking in the mountains and find a shiny gold nugget. It might be the element gold, or it might be "fool's gold," which is a nickname for iron pyrite, FeS$_2$. What kinds of experiments could be done to determine if the shiny nugget is really gold?

1.18 Read the following description of the element zinc and indicate which are physical properties and which are chemical properties. Zinc is a silver-gray–colored metal that 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 7.13 g/cm^3 at 25 °C. It reacts slowly with oxygen gas at elevated temperatures to form zinc oxide, ZnO.

1.20 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 What exponential notation do the following abbreviations represent: (**a**) d, (**b**) c, (**c**) f, (**d**) μ, (**e**) M, (**f**) k, (**g**) n, (**h**) m, (**i**) p?

1.24 Use appropriate metric prefixes to write the following measurements without use of exponents: (**a**) 2.3 × 10^{-10} L, (**b**) 4.7 × 10^{-6} g, (**c**) 1.85 × 10^{-12} m, (**d**) 16.7 × 10^6 s; (**e**) 15.7 × 10^3 g, (**f**) 1.34 × 10^{-3} m, (**g**) 1.84 × 10^2 cm.

1.26 (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.

1.28 (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^3 at this temperature? (b) The density of titanium metal is 4.51 g/cm^3 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 0.8787 g/mL. Calculate the mass of 0.1500 L of benzene at this temperature.

1.32 Silicon for computer chips is grown in large cylinders called "boules" that are 300 mm in diameter and 2 m in height. The density of silicon is 2.33 g/cm^3. Silicon wafers for making integrated circuits are sliced from a 2.0 m boule and are typically 0.75 mm thick and 300 mm in diameter. (a) How many wafers can be cut from a single boule? (b) What is the mass of a silicon wafer? (The volume of a cylinder is given by $\pi r^2 h$, where r is the radius and h is its height.)

1.35 What is the number of significant figures in each of the following measured quantities? (a) 601 kg, (b) 0.054 s, (c) 6.3050 cm, (d) 0.0105 L, (e) 7.0500×10^{-3} m^3, (f) 400 g.

1.39 Carry out the following operations, and express the answers with the appropriate number of significant figures.
(a) $14.3505 + 2.65$
(b) $952.7 - 140.7389$
(c) $(3.29 \times 10^4)(0.2501)$
(d) $0.0588/0.677$

1.40 Carry out the following operations, and express the answer with the appropriate number of significant figures.
(a) $320.5 - (6104.5/2.3)$
(b) $[(285.3 \times 10^5) - (1.200 \times 10^3)] \times 2.8954$
(c) $(0.0045 \times 20,000.0) + (2813 \times 12)$
(d) $863 \times [1255 - (3.45 \times 108)]$

1.42 You have a graduated cylinder that contains a liquid (see photograph). Write the volume of the liquid, in milliliters, using the proper number of significant figures.

1.47 Perform the following conversions: (a) 5.00 days to s, (b) 0.0550 mi to m, (c) $1.89/gal to dollars per liter, (d) 0.510 in./ms to km/hr, (e) 22.50 gal/min to L/s, (f) 0.02500 ft^3 to cm^3.

1.56 A copper refinery produces a copper ingot weighing 150 lb. If the copper is drawn into wire whose diameter is 7.50 mm, how many feet of copper can be obtained from the ingot? The density of copper is 8.94 g/cm^3. (Assume that the wire is a cylinder whose volume $V = \pi r^2 h$, where r is its radius and h is its height or length.)

1.50 (a) If an electric car is capable of going 225 km on a single charge, how many charges will it need to travel from Seattle, Washington, to San Diego, California, a distance of 1257 mi, assuming that the trip begins with a full charge? (b) If a migrating loon flies at an average speed of 14 m/s, what is its average speed in mi/hr? (c) What is the engine piston displacement in liters of an engine whose displacement is listed as 450 $in.^3$? (d) In March 1989 the *Exxon Valdez* ran aground and spilled 240,000 barrels of crude petroleum off the coast of Alaska. One barrel of petroleum is equal to 42 gal. How many liters of petroleum were spilled?