1–7 Order of Magnitude Estimating

(*Note:* Remember that for rough estimates, only round numbers are needed both as input to calculations and as final results.)

24. (I) Estimate the order of magnitude (power of ten) of: (*a*) 2800, (*b*) 86.30×10^2, (*c*) 0.0076, and (*d*) 15.0×10^8.

25. (II) Estimate how many books can be shelved in a college library with 3500 square meters of floor space. Assume 8 shelves high, having books on both sides, with corridors 1.5 m wide. Assume books are about the size of this one, on average.

26. (II) Estimate how many hours it would take a runner to run (at 10 km/h) across the United States from New York to California.

27. (II) Estimate how long it would take one person to mow a football field using an ordinary home lawn mower (Fig. 1–13). Assume the mower moves with a 1 km/h speed, and has a 0.5 m width.

FIGURE 1–13 Problem 27.

28. (II) Estimate the number of liters of water a human drinks in a lifetime.

29. (II) Make a rough estimate of the volume of your body (in cm^3).

30. (II) Make a rough estimate, for a typical suburban house, of the % of its outside wall area that consists of window area.

31. (III) The rubber worn from tires mostly enters the atmosphere as particulate pollution. Estimate how much rubber (in kg) is put into the air in the United States every year. To get started, a good estimate for a tire tread's depth is 1 cm when new, and the density of rubber is about 1200 kg/m^3.

* 1–8 Dimensions

* **32.** (II) The speed, v, of an object is given by the equation $v = At^3 - Bt$, where t refers to time. What are the dimensions of A and B?

* **33.** (II) Three students derive the following equations in which x refers to distance traveled, v the speed, a the acceleration (m/s^2), and t the time, and the subscript $(_0)$ means a quantity at time $t = 0$: (*a*) $x = vt^2 + 2at$, (*b*) $x = v_0 t + \frac{1}{2}at^2$, and (*c*) $x = v_0 t + 2at^2$. Which of these could possibly be correct according to a dimensional check?

General Problems

34. Global positioning satellites (GPS) can be used to determine positions with great accuracy. The system works by determining the distance between the observer and each of several satellites orbiting Earth. If one of the satellites is at a distance of 20,000 km from you, what percent accuracy in the distance is required if we desire a 2-meter uncertainty? How many significant figures do we need to have in the distance?

35. Computer chips (Fig. 1–14) are etched on circular silicon wafers of thickness 0.60 mm that are sliced from a solid

cylindrical silicon crystal of length 30 cm. If each wafer can hold 100 chips, what is the maximum number of chips that can be produced from one entire cylinder?
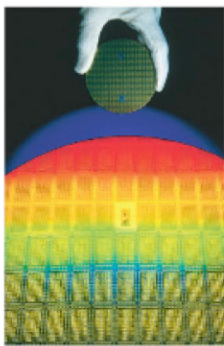
FIGURE 1–14 Problem 35. The wafer held by the hand (above) is shown below, enlarged and illuminated by colored light. Visible are rows of integrated circuits (chips).

36. (*a*) How many seconds are there in 1.00 year? (*b*) How many nanoseconds are there in 1.00 year? (*c*) How many years are there in 1.00 second?

37. A typical adult human lung contains about 300 million tiny cavities called alveoli. Estimate the average diameter of a single alveolus.

38. One hectare is defined as 10^4 m^2. One acre is $4 \times 10^4 \text{ ft}^2$. How many acres are in one hectare?

39. Use Table 1–3 to estimate the total number of protons or neutrons in (*a*) a bacterium, (*b*) a DNA molecule, (*c*) the human body, (*d*) our Galaxy.

40. Estimate the number of gallons of gasoline consumed by the total of all automobile drivers in the United States, per year.

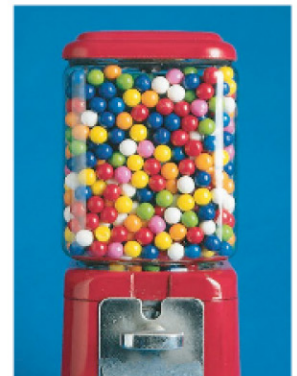**41.** Estimate the number of gumballs in the machine of Fig. 1–15.

FIGURE 1–15
Problem 41. Estimate the number of gumballs in the machine.