41. An ancient unit of length called the cubit was equal to approximately 50 centimeters, which is, of course, approximately 0.50 meters. It has been said that Noah's ark was 300 cubits long, 50 cubits wide, and 30 cubits high. Estimate the volume of the ark in cubic meters. Also estimate the volume of a typical home, and compare it with the ark's volume.

42. If one micrometeorite (a sphere with a diameter of 1.0×10^{-6} m) struck each square meter of the moon each second, it would take many years to cover the moon with micrometeorites to a depth of 1.0 m. Consider a cubic box, 1.0 m on a side, on the moon. Estimate how long it would take to completely fill the box with micrometeorites.

43. One cubic centimeter ($1.0\ cm^3$) of water has a mass of 1.0×10^{-3} kg at 25°C. Determine the mass of $1.0\ m^3$ of water at 25°C.

44. Assuming biological substances are 90 percent water and the density of water is $1.0 \times 10^3\ kg/m^3$, estimate the masses (density multiplied by volume) of the following:

- **a.** a spherical cell with a diameter of 1.0 μm (volume $= \frac{4}{3}\pi r^3$)
- **b.** a fly, which can be approximated by a cylinder 4.0 mm long and 2.0 mm in diameter (volume $= \ell \pi r^2$)

45. The radius of the planet Saturn is 6.03×10^7 m, and its mass is 5.68×10^{26} kg.

- **a.** Find the density of Saturn (its mass divided by its volume) in grams per cubic centimeter. (The volume of a sphere is given by $\frac{4}{3}\pi r^3$.)
- **b.** Find the surface area of Saturn in square meters. (The surface area of a sphere is given by $4\pi r^2$.)

Alternative Assessment

1. Imagine that you are a member of your state's highway board. In order to comply with a bill passed in the state legislature, all of your state's highway signs must show distances in miles and kilometers. Two plans are before you. One plan suggests adding metric equivalents to all highway signs as follows: Dallas 300 mi (483 km). Proponents of the other plan say that the first plan makes the metric system seem more cumbersome, so they propose replacing the old signs with new signs every 50 km as follows: Dallas 300 km (186 mi). Participate in a class debate about which plan should be followed.

2. Can you measure the mass of a five-cent coin with a bathroom scale? Record the mass in grams displayed by your scale as you place coins on the scale, one at a time. Then, divide each measurement by the number of coins to determine the approximate mass of a single five-cent coin, but remember to follow the rules for significant figures in calculations. Which estimate do you think is the most accurate? Which is the most precise?

3. Find out who were the Nobel laureates for physics last year, and research their work. Alternatively, explore the history of the Nobel Prizes. Who founded the awards? Why? Who delivers the award? Where? Document your sources and present your findings in a brochure, poster, or presentation.

4. You have a clock with a second hand, a ruler marked in millimeters, a graduated cylinder marked in milliliters, and scales sensitive to 1 mg. How would you measure the mass of a drop of water? How would you measure the period of a swing? How would you measure the volume of a paper clip? How can you improve the accuracy of your measurements? Write the procedures clearly so that a partner can follow them and obtain reasonable results.

5. Create a poster or other presentation depicting the possible ranges of measurement for a dimension, such as distance, time, temperature, speed, or mass. Depict examples ranging from the very large to the very small. Include several examples that are typical of your own experiences.

1 REVIEW

41. The ark ($6 \times 10^4\ m^3$) was about 100 times as large as a typical house ($6 \times 10^2\ m^3$).
42. 3.2×10^{10} years
43. 1.0×10^3 kg
44. **a.** 5×10^{-16} kg
b. 1×10^{-5} kg
45. **a.** $0.618\ g/cm^3$
b. $4.57 \times 10^{16}\ m^2$

Alternative Assessment ANSWERS

1. Students should recognize that preferences for one scheme or the other have nothing to do with the accuracy of the measurements.
2. Students should recognize that their approximation of the mass of a single coin becomes both more accurate and more precise as they increase the number of coins.
3. Students' presentations will vary depending on which scientists they choose. Alfred Nobel (1833–1896), inventor of dynamite, left a fund for the establishment of annual prizes in several fields.
4. Students' procedures should be safe and thoroughly explained. In some cases, they will need to measure several objects together.
5. Students' presentations will vary but should include references for sources of information. Check that all examples are within a reasonable order of magnitude.