Questions

1. What are the merits and drawbacks of using a person's foot as a standard? Consider both (*a*) a particular person's foot, and (*b*) any person's foot. Keep in mind that it is advantagous that fundamental standards be accessible (easy to compare to), invariable (do not change), indestructible, and reproducible.
2. When traveling a highway in the mountains, you may see elevation signs that read "914 m (3000 ft)." Critics of the metric system claim that such numbers show the metric system is more complicated. How would you alter such signs to be more consistent with a switch to the metric system?
3. Why is it incorrect to think that the more digits you represent in your answer, the more accurate it is?
4. What is wrong with this road sign:
   Memphis 7 mi (11.263 km)?
5. For an answer to be complete, the units need to be specified. Why?
6. Discuss how the notion of symmetry could be used to estimate the number of marbles in a 1-liter jar.
7. You measure the radius of a wheel to be 4.16 cm. If you multiply by 2 to get the diameter, should you write the result as 8 cm or as 8.32 cm? Justify your answer.
8. Express the sine of 30.0° with the correct number of significant figures.
9. A recipe for a soufflé specifies that the measured ingredients must be exact, or the soufflé will not rise. The recipe calls for 6 large eggs. The size of "large" eggs can vary by 10%, according to the USDA specifications. What does this tell you about how exactly you need to measure the other ingredients?
10. List assumptions useful to estimate the number of car mechanics in (*a*) San Francisco, (*b*) your hometown, and then make the estimates.

Problems

[The Problems at the end of each Chapter are ranked I, II, or III according to estimated difficulty, with (I) Problems being easiest. Level (III) Problems are meant mainly as a challenge for the best students, for "extra credit." The Problems are arranged by Sections, meaning that the reader should have read up to and including that Section, but not only that Section—Problems often depend on earlier material. Each Chapter also has a group of General Problems that are not arranged by Section and not ranked.]

1–4 Measurement, Uncertainty, Significant Figures

(*Note:* In Problems, assume a number like 6.4 is accurate to ±0.1; and 950 is ±10 unless 950 is said to be "precisely" or "very nearly" 950, in which case assume 950 ± 1.)

1. (I) The age of the universe is thought to be about 14 billion years. Assuming two significant figures, write this in powers of ten in (*a*) years, (*b*) seconds.
2. (I) How many significant figures do each of the following numbers have: (*a*) 214, (*b*) 81.60, (*c*) 7.03, (*d*) 0.03, (*e*) 0.0086, (*f*) 3236, and (*g*) 8700?
3. (I) Write the following numbers in powers of ten notation: (*a*) 1.156, (*b*) 21.8, (*c*) 0.0068, (*d*) 27.635, (*e*) 0.219, and (*f*) 444.
4. (I) Write out the following numbers in full with the correct number of zeros: (*a*) 8.69×10^4, (*b*) 9.1×10^3, (*c*) 8.8×10^{-1}, (*d*) 4.76×10^2, and (*e*) 3.62×10^{-5}.
5. (II) What, approximately, is the percent uncertainty for the measurement given as 1.57 m^2?
6. (II) What is the percent uncertainty in the measurement 3.76 ± 0.25 m?
7. (II) Time intervals measured with a stopwatch typically have an uncertainty of about 0.2 s, due to human reaction time at the start and stop moments. What is the percent uncertainty of a handtimed measurement of (*a*) 5 s, (*b*) 50 s, (*c*) 5 min?
8. (II) Add $(9.2 \times 10^3\ \text{s}) + (8.3 \times 10^4\ \text{s}) + (0.008 \times 10^6\ \text{s})$.
9. (II) Multiply 2.079×10^2 m by 0.082×10^{-1}, taking into account significant figures.
10. (III) What is the area, and its approximate uncertainty, of a circle of radius 3.8×10^4 cm?
11. (III) What, roughly, is the percent uncertainty in the volume of a spherical beach ball whose radius is $r = 2.86 \pm 0.09$ m?

1–5 and 1–6 Units, Standards, SI, Converting Units

12. (I) Write the following as full (decimal) numbers with standard units: (*a*) 286.6 mm, (*b*) 85 μV, (*c*) 760 mg, (*d*) 60.0 ps, (*e*) 22.5 fm, (*f*) 2.50 gigavolts.
13. (I) Express the following using the prefixes of Table 1–4: (*a*) 1×10^6 volts, (*b*) 2×10^{-6} meters, (*c*) 6×10^3 days, (*d*) 18×10^2 bucks, and (*e*) 8×10^{-9} pieces.
14. (I) Determine your own height in meters, and your mass in kg.
15. (I) The Sun, on average, is 93 million miles from Earth. How many meters is this? Express (*a*) using powers of ten, and (*b*) using a metric prefix.
16. (II) What is the conversion factor between (*a*) ft^2 and yd^2, (*b*) m^2 and ft^2?
17. (II) An airplane travels at 950 km/h. How long does it take to travel 1.00 km?
18. (II) A typical atom has a diameter of about 1.0×10^{-10} m. (*a*) What is this in inches? (*b*) Approximately how many atoms are there along a 1.0-cm line?
19. (II) Express the following sum with the correct number of significant figures: 1.80 m + 142.5 cm + 5.34×10^5 μm.
20. (II) Determine the conversion factor between (*a*) km/h and mi/h, (*b*) m/s and ft/s, and (*c*) km/h and m/s.
21. (II) How much longer (percentage) is a one-mile race than a 1500-m race ("the metric mile")?
22. (II) A *light-year* is the distance light travels in one year (at speed = 2.998×10^8 m/s). (*a*) How many meters are there in 1.00 light-year? (*b*) An astronomical unit (AU) is the average distance from the Sun to Earth, 1.50×10^8 km. How many AU are there in 1.00 light-year? (*c*) What is the speed of light in AU/h?
23. (III) The diameter of the Moon is 3480 km. (*a*) What is the surface area of the Moon? (*b*) How many times larger is the surface area of the Earth?