Chapter 1

Units and Unit Conversions

Many aspects of chemistry are quantitative, and you use units to measure these quantities. In many cases, you have to convert from one unit to another. Most people in the United States initially learn the English system of units, but most chemists use the *Système international d'unités* (the SI system), derived from the older metric system. Unit conversions relate these two systems. Dimensional analysis provides a systematic means to not only perform these conversions but also to work many of the other problems in this book. Dimensional analysis lets the units solve the problem for you.

The Problems You'll Work On

In this chapter, you work with units and unit conversions in the following ways:

- Choosing appropriate units
- Interpreting metric prefixes
- Converting metric and English units
- Solving problems with dimensional analysis

What to Watch Out For

Don't let common mistakes trip you up; remember the following when working on units and unit conversions:

- Always include your units when setting up equations and answering questions.
- Set up your problem so that units cancel to leave the desired units.
- Make sure your answer looks reasonable and the final units match what they describe. For example, s^{-1} represents 1/seconds, which is frequency, not time.
- When rounding your answer for significant figures, remember that many, but not all, conversions are exact numbers and therefore don't affect the number of significant figures in the answer.

Understanding Metric Prefixes and Units

1–10 *Answer the questions on metric prefixes and metric units used in the laboratory.*

1. What is a common metric unit of mass used in the laboratory?

2. What is a common metric unit of length used for measuring small objects in the laboratory?

3. What is a common metric unit of volume used in the laboratory?

4. What is a common metric unit of pressure used in the laboratory?

5. What is a common metric unit of energy?

6. What is the metric prefix that represents 1,000?

7. What is the metric prefix that represents $\frac{1}{1{,}000}$?

8. What is the metric prefix that represents $\frac{1}{100}$?

9. What is the metric prefix that represents 10^{-9}?

10. What is the metric prefix that represents 10^{6}?

Choosing Appropriate Units

11–20 *Choose appropriate metric or English units for measuring everyday objects.*

11. Which metric unit is most appropriate for expressing the mass of an adult human?

12. Which metric unit is most appropriate for recording the volume of a child's wooden block?

13. Which metric unit would a scientist use to measure the temperature on a warm autumn day?

14. Which metric unit is most often used for small doses of solid medications?

15. Which SI base unit is named after a person?

16. Which English unit is most similar in volume to a liter?

17. Which English unit is most similar in length to a meter?

18. How many fluid ounces are in a cup?

19. An Olympic swimmer competes in the 100-meter freestyle. What is the comparable English unit?

20. If a wooden board's width is 6 in., what is an appropriate metric unit to express this width?

Doing Metric Conversions

21–32 *Complete the conversion between metric units.*

21. How many milligrams are in 1 dg?

22. How many deciliters are in 1 L?

23. How many kilometers are in 1 m?

24. How many centimeters are in 1 m?

25. How many grams are in 1 hg?

26. How many milliliters are in 2.5 daL?

27. How many centigrams are in 49 kg?

28. How many gigawatts are in 370,000 W?

29. How many micrograms are in 0.126 Mg?

30. How many kilometers are in 80. pm?

31. How many cubic meters are in 2 L?

32. How many milliliters are in 0.64 m^3?

Converting between Systems of Measurement

33–59 *Convert between metric and English units.*

33. How many miles are in 35 km?

34. How many inches are in 0.20 cm?

35. How many yards are in 202 m?

36. How many pounds are in 58 kg?

37. How many quarts are in 7.54 L?

38. How many centimeters are in 0.087 in.?

39. How many kilometers are in 463 mi.?

40. How many grams are in 91 lb.?

41. How many liters are in 525 gal.?

42. How many atmospheres are in 44 psi?

43. How many cups are in 2.00 L?

44. How many pounds are in 164 hg?

45. How many gallons are in 587 mL?

46. How many centimeters are in 6.02 mi.?

47. How many decigrams are in 225 lb.?

48. How many milliliters are in 6.8 qt.?

49. How many centimeters are in 15.3 ft.?

50. How many liters are in 99 pt.?

51. How many kilograms are in 1.00 short ton? (1 short ton = 2,000 lb.)

52. How many centimeters are in 6.04 yd.?

53. How many cups are in 15 cc?

54. How many millimeters are in 1,760 yd.?

55. How many pints are in 250 hL?

56. How many grams are in 0.35 slugs? (1 slug = 32.2 lb.)

57. How many kilometers are in 9,999 in.?

58. How many ounces are in 0.734 kg?

59. How many microliters are in 55 oz.?

Using Dimensional Analysis

60–75 *Solve the word problem using a setup similar to those used in unit conversions.*

60. How many dozen eggs are in 17,981 eggs?

61. How many years are in 6,250 days? (1 yr. = 365.25 days)

62. How many weeks are in 2.5 centuries? (1 yr. = 52 weeks)

63. If the average penny has a mass of 3.16 g, what is the dollar value of 1.00 short ton of pennies? (1 short ton = 2,000 lb.)

64. If an athlete runs the 100-yard dash in 10.0 s, how long will it take for the athlete to run 400 m?

65. You're planning a party and need enough soda for 60 guests. How many liters will you need, assuming each guest drinks 10. fl. oz. of soda?

66. You plan to serve sub sandwiches at a party. How many 6.0-foot subs will you need to feed the 60 guests if each person eats a 25.4-cm length of sandwich?

67. A textbook measures 230. mm long, 274 mm wide, and 60.0 mm thick. What is the volume in cubic centimeters?

68. A textbook measures 230. mm long, 274 mm wide, and 60.0 mm thick. What is the surface area of the front cover in square meters?

69. A hallway measures 10.0 ft. by 5.0 ft. How many square tiles, measuring 10.0 in. on each side, are necessary to cover the floor?

70. If a car is going 20. mph through a school zone, how many centimeters per minute is it traveling?

71. A solid sphere made of pure gold has a volume of 2.0 L. What is the mass of the sphere, in pounds, if 1.00 cm^3 of gold has a mass of 19.3 g?

72. How many minutes does it take a horse to run 12 furlongs at 35.3 mph? (1 furlong = 40 rods, and 1 rod = 5.5 yd.)

73. If a pitcher throws a 96-mph fastball, how many seconds will it take to travel the 60.5 ft. from the pitcher's mound to home plate?

74. Pure gold can be made into extremely thin sheets called gold leaf. Suppose that 25 kg of gold is made into gold leaf having a surface area of 1,810 m^2. How thick is the gold leaf in millimeters? The density of gold is 19.3 g/cm^3.

75. Radio waves travel at 300,000,000 m/s. If you asked a question of someone who was on the moon, 239,000 mi. from the Earth, what is the minimum time that you would have to wait for a reply?