Chapter 1 Keys to the Study of Chemistry

1. Which one of the following is a "substance" in the sense of the word as used in your textbook?
   A) air B) tap water C) sea water D) water E) toothpaste
   Ans: D

2. Select the best statement.
   A) Physical changes may be reversed by changing the temperature.
   B) Physical changes alter the composition of the substances involved.
   C) Physical properties are not valid characteristics for identifying a substance.
   D) Physical properties are mostly extensive in nature.
   E) Physical changes are usually accompanied by chemical changes.
   Ans: A

3. Select the best statement.
   A) Chemical changes provide the only valid basis for identification of a substance.
   B) Chemical changes are easily reversed by altering the temperature of the system.
   C) Chemical changes always produce substances different from the starting materials.
   D) Chemical changes are associated primarily with extensive properties.
   E) Chemical changes are accompanied by changes in the total mass of the substances involved.
   Ans: C

4. Which of the following is a chemical change?
   A) boiling of water
   B) melting wax
   C) broiling a steak on a grill
   D) condensing water vapor into rainfall
   E) carving a piece of wood
   Ans: C

5. Water vapor is less dense than ice because
   A) molecules in the gas phase are in constant motion.
   B) molecules in the gas phase have more potential energy than in solids.
   C) molecules in the gas phase have more kinetic energy than in solids.
   D) gaseous molecules have less mass.
   E) molecules in the gas phase have more space between them than in solids.
   Ans: E

6. During the swing of a frictionless pendulum, what energy form(s) remain constant?
   A) kinetic energy only
   B) potential energy only
   C) both kinetic energy and potential energy
   D) kinetic plus potential energy
   E) None of these forms remains constant.
   Ans: D

7. Which of the following activities is not a part of good science?
   A) proposing a theory
   B) developing a hypothesis
   C) making quantitative observations
   D) designing experiments
   E) indulging in speculation
   Ans: E

8. The distance between carbon atoms in ethylene is 134 picometers. Which of the following expresses that distance in meters?
   A) 1.34×10^{-13} m
   B) 1.34×10^{-12} m
   C) 1.34×10^{-10} m
   D) 1.34×10^{-7} m
   E) 1.34×10^{-6} m
   Ans: C

9. The average distance from Earth to the Sun is 150 megameters. What is that distance in meters?
   A) 1.5×10^{8} m
   B) 1.5×10^{6} m
   C) 1.5×10^{5} m
   D) 1.5×10^{3} m
   E) 1.5×10^{-6} m
   Ans: A

10. The mass of a sample is 550 milligrams. Which of the following expresses that mass in kilograms?
   A) 5.5×10^{8} kg
   B) 5.5×10^{5} kg
   C) 5.5×10^{-4} kg
   D) 5.5×10^{-6} kg
   E) 5.5×10^{-1} kg
   Ans: C

11. A dose of medication was prescribed to be 35 microliters. Which of the following expresses that volume in centiliters?
   A) 3.5×10^{5} cL
   B) 3.5×10^{4} cL
   C) 3.5 cL
   D) 3.5×10^{-4} cL
   E) 3.5×10^{-3} cL
   Ans: E

12. Which of the following represents the largest volume?
   A) 10,000 µL B) 1000 pL C) 100 mL D) 10 nL E) 10 cm^3
   Ans: C

13. You prepare 1000. mL of tea and transfer it to a 1.00 quart pitcher for storage. Which of the following statements is true?
    A) The pitcher will be filled to 100% of its capacity with no tea spilled.
    B) The pitcher will be filled to about 95% of its capacity.
    C) The pitcher will be filled to about 50% of its capacity.
    D) The pitcher will be completely filled and a small amount of tea will overflow.
    E) The pitcher will be completely filled and most of the tea will overflow.
    Ans: D

14. In an average year the American chemical industry produces more than 9.5 million metric tons of sodium carbonate. Over half of this is used in the manufacture of glass while another third is used in the production of detergents and other chemicals. How many pounds of sodium carbonate are produced annually?
    A) 2.1×10^{10} lb
    B) 4.3×10^{9} lb
    C) 1.1×10^{7} lb
    D) 2.2×10^{6} lb
    E) 2.1×10^{4} lb
    Ans: A

15. A large pizza has a diameter of 15 inches. Express this diameter in centimeters.
    A) 38 cm B) 24 cm C) 18 cm D) 9.3 cm E) 5.9 cm
    Ans: A

16. The average distance between the Earth and the Moon is 240,000 miles. Express this distance in kilometers.
    A) 6.1×10^{5} km
    B) 5.3×10^{5} km
    C) $3.9 \times l0^{5}$ km
    D) 1.5×10^{5} km
    E) 9.4×10^{4} km
    Ans: C

17. The area of a 15-inch pizza is 176.7 in^2. Express this area in square centimeters.
    A) 1140. cm^2 B) 448.8 cm^2 C) 96.8 cm^2 D) 69.57 cm^2 E) 27.39 cm^2
    Ans: A

18. The speed needed to escape the pull of Earth's gravity is 11.3 km/s. What is this speed in mi/h?
    A) 65,500 mi/h
    B) 25,300 mi/h
    C) 18,200 mi/h
    D) 1,090 mi/h
    E) 5.02×10^{-3} mi/h
    Ans: B

19. The density of mercury, the only metal to exist as a liquid at room temperature, is 13.6 g/cm^3. What is that density in pounds per cubic inch?
A) 849 lb/in^3
B) 491 lb/in^3
C) 376 lb/in^3
D) 0.491 lb/in^3
E) 1.83×10^{-3} lb/in^3
Ans: D

20. Given that 1 inch = 2.54 cm, 1 cm^3 is equal to
A) 16.4 in^3 B) 6.45 in^3 C) 0.394 in^3 D) 0.155 in^3 E) 0.0610 in^3
Ans: E

21. At a pressure of one billionth (10^{-9}) of atmospheric pressure, there are about 2.7×10^{10} molecules in one cubic centimeter of a gas. How many molecules is this per cubic meter?
A) 2.7×10^{16} B) 2.7×10^{14} C) 2.7×10^{12} D) 2.7×10^{8} E) 2.7×10^{4}
Ans: A

22. If the price of gold at the morning fixing in London was $5310 per lb, what would a kilogram of gold have cost in £ (pounds)? (Assume an exchange rate of $1.00 = £0.545)
A) £1310 B) £3510 C) £6370 D) £10400 E) £17100
Ans: C

23. Which of the following is not an S.I. base unit?
A) meter B) ampere C) second D) gram E) kelvin
Ans: D

24. The S.I. base unit of mass is
A) mg B) g C) kg D) metric ton E) lb
Ans: C

25. The S.I. prefix mega- (M) means
A) 10^{-6} B) 10^{-3} C) 10^{3} D) 10^{6} E) 10^{9}
Ans: D

26. The S.I. unit of speed (velocity) is
A) km/h B) km/s C) m/h D) m/s E) none of these choices is correct
Ans: D

27. Which of the following is an extensive property of oxygen?
A) boiling point
B) temperature
C) average kinetic energy of molecules
D) density
E) mass
Ans: E

28. A flask has a mass of 78.23 g when empty and 593.63 g when filled with water. When the same flask is filled with concentrated sulfuric acid, H_2SO_4, its mass is 1026.57 g. What is the density of concentrated sulfuric acid? (Assume water has a density of 1.00 g/cm^3 at the temperature of the measurement.)
A) 1.992 g/cm^3
B) 1.840 g/cm^3
C) 1.729 g/cm^3
D) 1.598 g/cm^3
E) 0.543 g/cm^3
Ans: B

29. Talc is a mineral that has low conductivity for heat and electricity and that is not attacked by acid. It is used as talcum powder and face powder. A sample of talc weighs 35.97 g in air and 13.65 g in mineral oil (d = 1.75 g/cm^3). What is the density of talc?
A) 4.61 g/cm^3 B) 2.82 g/cm^3 C) 2.63 g/cm^3 D) 2.44 g/cm^3 E) 1.61 g/cm^3
Ans: B

30. Acetone, which is used as a solvent and as a reactant in the manufacture of Plexiglas®, boils at 56.1°C. What is the boiling point in degrees Fahrenheit?
A) 159°F B) 133°F C) 101°F D) 69.0°F E) 43.4°F
Ans: B

31. Isopropyl alcohol, commonly known as rubbing alcohol, boils at 82.4°C. What is the boiling point in kelvins?
A) 387.6 K B) 355.6 K C) 323.6 K D) 190.8 K E) -190.8 K
Ans: B

32. Acetic acid boils at 244.2°F. What is its boiling point in degrees Celsius?
A) 382.0°C B) 167.7°C C) 153.4°C D) 117.9°C E) 103.7°C
Ans: D

33. Select the answer that expresses the result of this calculation with the correct number of significant figures.

$$\frac{13.602 \times 1.90 \times 3.06}{4.2 \times 1.4097} =$$

A) 13.3568 B) 13.357 C) 13.36 D) 13.4 E) 13
Ans: E

34. Select the answer that expresses the result of this calculation with the correct number of significant figures and with correct units.

$$16.18\,cm \times 9.6114\,g \div 1.4783\,cm^2 =$$

A) 105.2 g/cm^3
B) 105.2 g/cm^2
C) 105.2 g/cm
D) 72.13 g/cm^2
E) 72.13 g/cm
Ans: C

35. Which measurement is expressed to 4 significant figures?
A) 0.00423 kg B) 24.049 cm C) 1300 K D) 82,306 m E) 62.40 g
Ans: E

36. Express 96,342 m using 2 significant figures.
A) 9.60×10^4 m
B) 9.6×10^4 m
C) 9.60×10^{-4} m
D) 9.6×10^{-4} m
E) 96,000. m
Ans: B

37. Select the answer with the correct number of decimal places for the following sum:
$13.914\ cm + 243.1\ cm + 12.00460\ cm =$
A) 269.01860 cm
B) 269.0186 cm
C) 269.019 cm
D) 269.02 cm
E) 269.0 cm
Ans: E

38. The appropriate number of significant figures in the result of 15.234×15.208 is
A) 2 B) 3 C) 4 D) 5 E) 6
Ans: D

39. The appropriate number of significant figures in the result of 15.234 - 15.208 is
A) 1 B) 2 C) 3 D) 4 E) 5
Ans: B

40. The result of $(3.8621 \times 1.5630) - 5.98$ is properly written as
A) 0.06 B) 0.056 C) 0.0565 D) 0.05646 E) 0.056462
Ans: A

41. As chief chemist at Superior Analytical Products (SAP) you must design an experiment to determine the density of an unknown liquid to three (3) significant figures. The density is of the order of 1 g/cm^3. You have approximately 7 mL of the liquid and only graduated cylinders and balances are available for your use. Which of the following combinations of equipment will allow you to meet but not exceed your goal?
A) Graduated cylinder with ±0.1 mL uncertainty; balance with ±0.1 g uncertainty
B) Graduated cylinder with ±0.01 mL uncertainty; balance with ±0.1 g uncertainty
C) Graduated cylinder with ±0.01 mL uncertainty; balance with ±0.01 g uncertainty
D) Graduated cylinder with ±0.001 mL uncertainty; balance with ±0.001 g uncertainty
E) Graduated cylinder with ±0.1 mL uncertainty; balance with ±0.001 g uncertainty
Ans: C

42. Bud N. Chemist must determine the density of a mineral sample. His four trials yield densities of 4.77 g/cm^3, 4.67 g/cm^3, 4.69 g/cm^3, and 4.81 g/cm^3. Independent studies found the correct density to be 4.75 g/cm^3. Which of the following statements represents the best analysis of the data?
    A) Bud's results have much greater accuracy than precision.
    B) Bud's results have much greater precision than accuracy.
    C) Bud's results have high accuracy and high precision.
    D) Bud's results have low accuracy and low precision.
    E) Bud's equipment is faulty.
    Ans: A

43. As part of an experiment to determine the density of a new plastic developed in her laboratory, Sara Ann Dippity measures the volume of a solid sample. Her four trials yield volumes of 12.37 cm^3, 12.41 cm^3, 12.39 cm^3, and 12.38 cm^3. Measurements of other scientists in the lab give an average volume of 12.49 cm^3. Which of the following statements represents the best analysis of the data?
    A) Sara's results have low precision and high accuracy.
    B) Sara's results have high precision and high accuracy.
    C) Sara's results have greater precision than accuracy.
    D) Sara's results have greater accuracy than precision.
    E) Sara has been using a faulty instrument to measure the volume.
    Ans: C

44. Which of the following correctly expresses 52,030.2 m in scientific notation?
    A) 5.20302×10^4 m
    B) 5.20302×10^5 m
    C) 5.203×10^4 m
    D) 5.20×10^4 m
    E) 5.2×10^4 m
    Ans: A

45. Which of the following correctly expresses 0.000007913 g in scientific notation?
    A) 7.913×10^6 g
    B) 7.913×10^5 g
    C) 7.913×10^{-5} g
    D) 7.913×10^{-6} g
    E) 7.913×10^{-9} g
    Ans: D

46. Give an example of a physical property and a chemical property of each of the following:
    a. oxygen gas
    b. octane
    c. copper
    Ans: Answers could all be the same, but some possibilities are
    a. boiling point, reaction with sodium
    b. boiling point, reaction with oxygen
    c. electrical conductivity, reaction with nitric acid

47. Briefly explain the relationship between hypothesis and experiment in the scientific method.
    Ans: A hypothesis should be capable of leading to a prediction which is testable by experiment. If the experimental result differs from the prediction, the hypothesis should be modified.

48. Calculate (to three significant figures) the numerical part of the conversion factors needed to carry out the following unit conversions:
    a. density in g/cm^3 to kg/m^3
    b. speed in mi/h to ft/s
    c. area in km^2 to mi^2
    d. area in km^2 to cm^2
    e. mass/area of aluminum foil in mg/cm^2 to g/m^2
    f. number of gas molecules per unit volume from $/m^3$ to $/ft^3$
    g. number of bacteria per unit area on a microscope slide from $/mm^2$ to $/in^2$
    Ans: a. 10^3 (exactly)
    b. 1.47
    c. 0.386
    d. 10^{10} (exactly)
    e. 10 (exactly)
    f. 0.0283
    g. 645

49. The S.I. unit of energy is the joule, J. 1 J = 1 $kg \cdot m^2/s^2$. Another energy unit, the erg, was once in widespread use. 1 erg = 1 $g \cdot cm^2/s^2$. Calculate the number of ergs in 1 J, showing all your work.
    Ans: 1 J = 10^7 erg

50. Classify the following properties of hydrogen gas as either intensive or extensive.
    a. the mass of the gas sample
    b. the average speed of a molecule in the sample
    c. temperature
    d. density
    e. number of molecules present
    Ans: a. E
    b. I
    c. I
    d. I
    e. E

51. An evacuated 276 mL glass bulb weighs 129.6375 g. Filled with an unknown gas, the bulb weighs 130.0318 g. Calculate the gas density in g/L, and express it with an appropriate number of significant figures.
    Ans: 1.43 g/L

52. Use the relationship between temperatures in Celsius and Fahrenheit to calculate the temperature at which
    a. the numerical value is the same on both scales.
    b. the Fahrenheit number is exactly twice the Celsius number.
    Ans: a. 40.°F = - 40.°C
    b. 320.°F = 160.°C

53. Write the following numbers and results in scientific notation, with appropriate significant figures.
    a. 654
    b. 1234560
    c. 0.000000673
    d. 0.002590
    e. 200.4
    f. 260.0
    g. πr^2, where $r = 8.7$ cm
    h. 23.24 + 18.6 - 5
    Ans: a. 6.54×10^2
    b. 1.23456×10^6
    c. 6.73×10^{-7}
    d. 2.590×10^{-3}
    e. 2.004×10^2
    f. 2.600×10^2
    g. 2.4×10^2 cm^2
    h. 3.7×10^1

54. Write the following numbers and results in standard notation, with appropriate significant figures.
    a. 7.85×10^{-3}
    b. 7.85×10^4
    c. 5.920×10^3
    d. $7.85 \times 10^{12} \div 10^{10}$
    e. 7.00×10^{-5}
    f. circumference of a circle, $2\pi r$, where r = 8.7 cm
    g. $\dfrac{6.626 \times 10^{-34} \times 6.02214 \times 10^{23} \times 2.9979 \times 10^8}{5.23 \times 10^{-6}}$
    Ans: a. 0.00785
    b. 78500
    c. 5920.
    d. 785
    e. 0.0000700
    f. 55 cm
    g. 22900

55. In each of the sets below, choose the one quantity or number which is exact.
    a. (i.) the human population
       (ii.) the distance in light years from the sun to Alpha Centauri, a nearby star
       (iii.) the winning time for the 100 m dash in the Olympic Games

    b. (i.) the weight of a particular one cent coin in g
       (ii.) the boiling point of lead, in °C
       (iii.) the number of cm in 1 yd

    c. (i.) the measured value of the speed of light ($2.998... \times 10^8$ m/s)
       (ii.) π (3.141...)
       (iii.) the volume of milk in a 1-gallon jug

    Ans: a. i
         b. iii
         c. ii

56. The ripening of fruit, once picked, is an example of physical change.
    Ans: False

57. An important aim in much chemical work is to use macroscopic measurements in order to gain an understanding of the microscopic world.
    Ans: True

58. The potential energy of a car moving on a level road does not depend on its speed.
    Ans: True

59. When a wooden match burns in air, chemical potential energy is converted to kinetic energy.
    Ans: True

60. When applying the scientific method, it is important to avoid any form of hypothesis.
    Ans: False

61. When applying the scientific method, a model or theory should be based on experimental data.
    Ans: True

62. The numerical value of any temperature expressed in Celsius is always different from the numerical value of the same temperature in Fahrenheit.
    Ans: False

63. The numerical value of any temperature expressed in Celsius is always different from the numerical value of the same temperature in kelvin.
    Ans: True

64. The number 6.0448, rounded to 3 decimal places, becomes 6.045.
    Ans: True

65. The number 6.0448, rounded to 2 decimal places, becomes 6.05.
    Ans: False

66. The weight of a coin measured as 1.96235 g on one balance is definitely more accurate than a weight measurement of 1.95 g on another balance.
    Ans: False