Instructor Solutions Manual to accompany

Guinn's *Essentials of General, Organic, and Biochemistry*

Third Edition

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Chapter 1
Matter, Energy, and Measurement

37 Bone strength is assessed with a bone mineral density (BMD) measurement.
38 A strong bone has more bone mineral per volume than a weak one.
39 A DEXA (dual energy x-ray absorptiometry) scan is used to estimate BMD.
40 A T-score is assigned by how much a patient's BMD deviates from the average BMD of healthy people of the same gender and ethnicity.
41 The patient has osteopenia.
42 Her bone is normal.
43 The three physical states of matter are solid (s), liquid (l), and gas (g).
44 The particles interact with other particles in the liquid and solid states.
45 The particles are farther apart in the liquid and gas states.
46 Temperature is a measure of the average kinetic energy of particles.
47 Work is involved in moving an object.
48 A ball sitting at the top of a hill has stored energy, so it has potential energy.
49 A ball rolling downhill has kinetic energy.
50 **a.** kinetic energy (The water is moving.) **b.** potential energy (The skier is at the top of a hill.) **c.** kinetic energy (The dancer is moving.) **d.** potential energy (The atoms in the sandwich have stored energy in their bonds.)
51 **a**. kinetic energy (The biker is moving.) **b.** potential energy (The hiker is at the top of a mountain.)
c. kinetic energy (The helium atoms are moving within the balloon.)
d. potential energy (Energy is stored in the bonds of the molecules that make up candle wax.)
52 **a.** Molecules have the least amount of kinetic energy in the solid state.
53 **c.** Molecules have the greatest amount of kinetic energy in the gas state.
54 Steam. The water molecules are in the gas state.
55 **a.** A hospital is on the macroscopic scale. (You can see it.) **b.** A skin cell is on the microscopic scale. (You need a microscope to see it.) **c.** DNA is on the atomic scale. (DNA is too small to be seen.) **d.** A red blood cell is on the microscopic scale. (You need a microscope to see it.)
56 **a.** A lead atom is on the atomic scale. (It is too small to be seen.) **b**. The human body is on the macroscopic scale. (You can see it.) **c**. A grain of sand is on the macroscopic scale. (You can see it.) **d**. A virus is on the atomic scale. (It is too small to be seen.)
57 The SI system is an international system of units and was created by an international group of scientists to establish a uniform set of units, selecting one standard metric unit for each quantity of measurement.
58 the gram

59 mass and weight
60 length and distance
61 the liter
62 the second
63 *pico* (10^{12} in a base unit); *nano* (10^{9} in a base unit); *micro* (10^{6} in a base unit); and *kilo* (10^{-3} in a base unit)
64 *milli* (10^{3} in a base unit); *centi* (10^{2} in a base unit); *deci* (10 in a base unit); and *giga* (10^{-9} in a base unit)
65 **a.** mm is a metric unit of length. **b.** in. is an English unit of length.
c. oz is an English unit of volume. **d.** g is a metric unit of mass.
66 **a.** kg is a metric unit of mass. **b.** lb is an English unit of mass.
c. mL is a metric unit of volume. **d.** ft is an English unit of length.
67 $1\text{ cm} = 10^{-2}\text{ m}$
68 $1\text{ ps} = 10^{-12}\text{ s}$
69 $1\text{ mB} = 10^{6}\text{ B}$
70 $1\text{ kW} = 10^{3}\text{ W}$
71 $4.5\times10^{2}\ \mu\text{g}$ is larger. The microgram is a measure of mass.
72 6.3×10^{-3} mm is smaller. The millimeter is a measure of length.
73 a graduated cylinder, a pipette, and a syringe
74 A meniscus is a curved surface of a liquid that forms when it is in a graduated cylinder.
75 **c.** at the bottom of the meniscus
76 $V_{\text{lead}} = 16.5\text{ mL} - 15.0\text{ mL} = 1.5\text{ mL}$
77 $V_{\text{metal}} = 203.5\text{ mL} - 200.\text{ mL} = 3.5\text{ mL}$
78 Volume = 24 cm × 24 cm ×24 cm = 14,000 cm^3 = 14,000 mL
79 Volume = 5.21 cm × 5.21 cm × 5.21 cm = 141 cm^3
80 **a.** $5\underline{7},000$ m measured value because it is a length; two significant figures
b. $4.6\underline{0}$ mL measured value because it a volume; three significant figures
c. $0.0001\underline{1}$ g measured value because it is a mass; two significant figures
d. $23,304.6\underline{0}$ s measured value because it is time; seven significant figures
e. exact number because $25\underline{6}$ nurses is a number obtained by counting the number of nurses
81 **a.** $30\underline{4}$ mm measured value because it is a length; three significant figures; a zero between nonzero digits is significant. **b.** exact number because 429 bees is a number obtained by counting the number of bees **c.** $5,1\underline{1}0$ minutes measured value because it is time; three significant figures **d.** $0.00033\underline{0}$ kg measured value because it is a weight; three significant figures; the zeros between the decimal and the first digit, 3, are not significant, they are placeholders. The zero after the last digit, 3, is significant and the uncertain digit.
e. $5,00\underline{0}.$ g measured value because it is a weight; four significant figures
82 **a.** 2.31 μg **b.** 9,3100 mm **c.** 1.56 L **d.** 5680 s
83 **a.** 1.8 nm **b.** 4.3 mL **c.** 28 pg **d.** 360 m
84 **c.** 0.63
85 **b.** 79.88

86 **a.** $3.2 \times 8.54 = 27$ **b.** $3.2 + 8.54 = 11.7$

87 **a.** $2.26 + 8.1 = 10.4$ **b.** $2.26 \times 8.1 = 18$

88 **a.** $56.33\text{ cm} \times 2.50\text{ cm} = 140\text{ cm}^2$

b. $3.4\text{ cm} + 2.2\text{ cm} + 5.11\text{ cm} + 8.777\text{ cm} = 19.5\text{ cm}$

c. $\frac{33.22\text{ g}}{39.0\text{ mL}} = 0.852\text{ g/mL}$

89 **a.** $33{,}000. + 910. = 33{,}910.$ **b.** $0.333 \times 0.22 = 0.073$

c. $(37.55\text{ mL} + 22.2\text{ mL}) \times 5.666 = 339\text{ mL}$

90 **a.** $50{,}000\ \cancel{m} \times \frac{1\ \cancel{\text{km}}}{1000\ \cancel{\text{m}}} = 50\text{ km}$

b. $0.66\ \cancel{\text{g}} \times \frac{1\ \mu\text{g}}{10^{-6}\ \cancel{\text{g}}} = 6.6 \times 10^5\ \mu\text{g}$

91 **a.** . $6.0\ \cancel{\text{L}} \times \frac{1\text{ mL}}{10^{-3}\ \cancel{\text{L}}} = 6.0 \times 10^3\text{ mL}$

b. $2.0 \times 10^6\ \cancel{\text{m}} \times \frac{1\text{km}}{1000\ \cancel{\text{m}}} = 2.0 \times 10^3\text{km}$

92 **c.** 1,000 mm is equivalent to 1 m.

93 **b.** 0.001 kg is equivalent to 1 g.

94 $1\text{ m} = 10^{-3}\text{ km}$

95 $2.5\ \cancel{\text{cm}} \times \frac{10^{-2}\text{ m}}{1\ \cancel{\text{cm}}} = 0.025\text{ m}$

96 $200\ \cancel{\text{mg}} \times \frac{10^{-3}\text{ g}}{1\ \cancel{\text{mg}}} = 0.2\text{ g}$

97 $500.\ \cancel{\text{mg}} \times \frac{10^{-3}\text{ g}}{1\ \cancel{\text{mg}}} = 0.500\text{ g}$

$0.500\ \cancel{\text{g}} \times \frac{1\mu\text{g}}{10^{-6}\ \cancel{\text{g}}} = 5.00 \times 10^5\ \mu\text{g}$

98 $1\text{ mm} = 10^{-3}\text{ m}$ and $1\text{ pm} = 10^{-15}\text{ m}$

99 $75.6\ \cancel{\mu\text{L}} \times \frac{10^{-6}\ \cancel{\text{L}}}{1\ \cancel{\mu\text{L}}} \times \frac{1\text{mL}}{10^{-3}\ \cancel{\text{L}}} = 0.0756\text{ mL}$

100 $150\ \cancel{\text{kg}} \times \frac{2.205\text{ lb}}{1\ \cancel{\text{kg}}} = 330\text{ lb}$

101 $68.2\ \cancel{\text{miles}} \times \frac{5280\ \cancel{\text{ft}}}{1\ \cancel{\text{mile}}} \times \frac{12\ \cancel{\text{in}}}{1\ \cancel{\text{ft}}} \times \frac{1\ \cancel{\text{m}}}{39.37\ \cancel{\text{in}}} \times \frac{1\text{ km}}{10^3\ \cancel{\text{m}}} = 110.\text{ km}$

102 $86\ \cancel{\text{gallons}} \times \frac{4\ \cancel{\text{qt}}}{1\ \cancel{\text{gallon}}} \times \frac{1\text{ L}}{1.057\ \cancel{\text{qt}}} = 330\text{ L}$

103 **b.** $26.7\ \cancel{\text{mm}} \times \frac{10^{-3}\ \cancel{\text{m}}}{1\ \cancel{\text{mm}}} \times \frac{39.37\text{ in.}}{1\ \cancel{\text{m}}} = 1.05\text{ in.}$

104 **d.** $14.3\ \cancel{\text{cm}}^3 \times \frac{10^{-3}\text{ L}}{1\ \cancel{\text{cm}}^3} = 0.0143\text{ L}$

105 **a.** $1\ \cancel{\text{km}} \times \frac{10^{3}\ \cancel{\text{m}}}{1\ \cancel{\text{km}}} \times \frac{1\text{ mm}}{10^{-3}\ \cancel{\text{m}}} = 1 \times 10^6\text{ mm}$

b. $1\ \cancel{\text{cm}} \times \frac{10^{-2}\ \cancel{\text{m}}}{1\ \cancel{\text{cm}}} \times \frac{1\text{ mm}}{10^{-3}\ \cancel{\text{m}}} = 10\text{ mm}$

c. $1\ \cancel{\text{dm}} \times \frac{10^{-1}\ \cancel{\text{m}}}{1\ \cancel{\text{dm}}} \times \frac{1\text{ mm}}{10^{-3}\ \cancel{\text{m}}} = 100\text{ mm}$

d. $1\ \cancel{\text{nm}} \times \frac{10^{-9}\ \cancel{\text{m}}}{1\ \cancel{\text{nm}}} \times \frac{1\text{ mm}}{10^{-3}\ \cancel{\text{m}}} = 1 \times 10^{-6}\text{ mm}$

106 **a.** $1\ \cancel{\text{g}} \times \frac{1\ \text{kg}}{10^{3}\ \cancel{\text{g}}} = 1 \times 10^{-3}\ \text{kg}$

b. $1\ \cancel{\text{ng}} \times \frac{10^{-9}\cancel{\text{g}}}{1\ \cancel{\text{ng}}} \times \frac{1\ \text{kg}}{10^{3}\ \cancel{\text{g}}} = 1 \times 10^{-12}\ \text{kg}$

c. $100\ \cancel{\text{mcg}} \times \frac{10^{-6}\cancel{\text{g}}}{1\cancel{\text{mcg}}} \times \frac{1\ \text{kg}}{10^{3}\ \cancel{\text{g}}} = 1 \times 10^{-7}\ \text{kg}$

d. $10\ \cancel{\mu\text{g}} \times \frac{10^{-6}\cancel{\text{g}}}{1\ \cancel{\mu\text{g}}} \times \frac{1\ \text{kg}}{10^{3}\ \cancel{\text{g}}} = 1 \times 10^{-8}\ \text{kg}$

107 **a.** $5\ \cancel{\text{mL}} \times \frac{10^{-3}\cancel{\text{L}}}{1\ \cancel{\text{mL}}} \times \frac{1\ \mu\text{L}}{10^{-6}\ \cancel{\text{L}}} = 5 \times 10^{3}\ \mu\text{L}$

b. $0.5\ \cancel{\text{L}} \times \frac{1\ \mu\text{L}}{10^{-6}\ \cancel{\text{L}}} = 5 \times 10^{5}\ \mu\text{L}$

c. $250\ \cancel{\text{cm}^3} \times \frac{10^{-3}\cancel{\text{L}}}{1\ \cancel{\text{cm}^3}} \times \frac{1\ \mu\text{L}}{10^{-6}\ \cancel{\text{L}}} = 2.5 \times 10^{5}\ \mu\text{L}$

d. $80\ \cancel{\text{dL}} \times \frac{10^{-1}\cancel{\text{L}}}{1\ \cancel{\text{dL}}} \times \frac{1\ \mu\text{L}}{10^{-6}\ \cancel{\text{L}}} = 8 \times 10^{6}\ \mu\text{L}$

108 **c.** 150 μg is equivalent to 1.5×10^{-7} kg.

109 density $= \frac{9.22\ \text{g}}{8.7\ \text{mL}} = 1.1\ \text{g/mL}$

110 density $= \frac{3.8\ \text{g}}{2.0\ \cancel{\text{cm}}^3} \times \frac{1\cancel{\text{cm}}^3}{1\ \text{mL}} = 1.9\ \text{g/mL}$

111 Water has a density of 1.0 g/mL.

112 A liquid with a density greater than 1.0 g/mL will sink in water.

113 volume = 2.3 mL

$2.3\ \cancel{\text{mL}} \times \frac{19.32\ \text{g}}{1\ \cancel{\text{mL}}} = 44\ \text{g}$

114 volume = (length of side)^3

volume = (2.20 cm)^3

volume = 10.6 cm^3

$10.6\ \cancel{\text{cm}}^3 \times \frac{19.32\ \text{g}}{1\cancel{\text{cm}}^3} = 205\ \text{g}$

115 specific gravity $= \frac{1.025\ \cancel{\text{g/mL}}}{1.0\ \cancel{\text{g/mL}}} = 1.025$

Yes, the specific gravity is within the normal range.

116 specific gravity $= \frac{1.037\ \cancel{\text{g/mL}}}{1.0\ \cancel{\text{g/mL}}} = 1.037$

No, the specific gravity is not within the normal range.

117 density of urine $= 1.014 \times 1.0\ \text{g/mL} = 1.014\ \text{g/mL}$

The specific gravity of the urine sample is within the normal range.

118 density of urine $= 0.997 \times 1.0\ \text{g/mL} = 0.997\ \text{g/mL}$

The specific gravity of the urine sample is not within the normal range.

119 The abbreviation *q.d.* indicates that Accupril should be administered once a day. 10 mg should be given at every administration.

120 The abbreviation *b.i.d.* indicates that Retrovir should be administered twice a day. 300 mg should be given at every administration.

121 $34\ \cancel{\text{lb}} \times \frac{1\ \cancel{\text{kg}}}{2.205\ \cancel{\text{lb}}} \times \frac{25\ \text{mg}}{\cancel{\text{kg}}\cdot\text{day}} = 390\ \frac{\text{mg}}{\text{day}}$

122 $27\ \cancel{\text{kg}} \times \frac{2.205\ \cancel{\text{lb}}}{1\ \cancel{\text{kg}}} \times \frac{1\ \text{mg}}{\cancel{\text{lb}}\cdot\text{day}} = 60\ \frac{\text{mg}}{\text{day}}$

123 $12\ \cancel{\text{lb}} \times \frac{1\ \cancel{\text{kg}}}{2.205\ \cancel{\text{lb}}} \times \frac{20\ \text{mg}}{\cancel{\text{kg}\cdot\text{day}}} \times \frac{1\ \cancel{\text{day}}}{3\ \text{dose}} = 36\ \text{mg/dose}$

124 Tamiflu should be administered twice a day.

$16\ \cancel{\text{lb}} \times \frac{1\ \cancel{\text{kg}}}{2.205\ \cancel{\text{lb}}} \times \frac{3\ \text{mg}}{\cancel{\text{kg}\cdot\text{day}}} \times \frac{1\ \cancel{\text{day}}}{2\ \text{dose}} = 11\ \text{mg/dose}$

125 The freezing point of water is $0\ °\text{C}$ and $32\ °\text{F}$.

126 Normal body temperature is 37 °C and 98.6 °F.

127 **b.** in the refrigerator $(1.8 \times 2\ ℃) + 32 = 36\ °\text{F}$

$(1.8 \times 8\ ℃) + 32 = 46\ °\text{F}$

128 **c**. in a medicine cabinet $(1.8 \times 15\ ℃) + 32 = 59\ °\text{F}$

$(1.8 \times 30\ ℃) + 32 = 90\ °\text{F}$

129 $18\ ℃ + 273.15 = 291\ \text{K}$

$(1.8 \times 18\ ℃) + 32 = 64\ °\text{F}$

You are wearing summer clothes.

130 $31\ ℃ + 273.15 = 304\ \text{K}$

$(1.8 \times 31\ ℃) + 32 = 88\ °\text{F}$

You are wearing summer clothes.

131 $\frac{(105.2\ °\text{F} - 32)}{1.8} = 40.7\ ℃$

132 $\frac{(87.4\ °\text{F} - 32)}{1.8} = 30.8\ ℃$

133 $(1.8 \times 33\ ℃) + 32 = 91\ °\text{F}$

The patient has hypothermia.

134 $2.7\ \text{K} - 273.15 = -270.4\ ℃$

$(1.8 \times (-270.4\ ℃)) + 32 = -454.7\ °\text{F}$

135 $-78\ ℃ + 273.15 = 195\ \text{K}$

$(1.8 \times (-78\ ℃)) + 32 = -110\ °\text{F}$

136 $77\ \text{K} - 273.15 = -196\ ℃$

$(1.8 \times (-196\ ℃)) + 32 = -321\ °\text{F}$

137 Carbohydrates and fats provide us most of our energy.

138 Glucose is the most important source of energy for the body.

139 The body will convert muscle into glucose to produce energy.

140 Glucose is a high in potential energy.

141 Carbon dioxide is low in potential energy.

142 2 cm volume = length × width × height = 8 cm^3 $\sqrt[3]{8} = 2$

143 Convert all measurements to a common unit.

$5{,}000\ \cancel{\mu\text{L}} \times \frac{10^{-6}\ \cancel{\text{L}}}{1\ \cancel{\mu\text{L}}} \times \frac{1\ \text{mL}}{10^{-3}\ \cancel{\text{L}}} = 5\ \text{mL}$

$0.5000\ \cancel{\text{L}} \times \frac{1\ \text{mL}}{10^{-3}\ \cancel{\text{L}}} = 500.0\ \text{mL}$

$8.000\ \text{cm}^3 = 8.000\ \text{mL}$

Largest to smallest: 0.5000 L, 50.00 mL, 8.000 cm^3, 5,000 μL

144 **a.** 10 m **b.** the same length **c.** the same length **d.** 1 nm

145 **a.** 1 ng **b.** 100 mg **c.** the same mass **d.** 50 mcg

146 $2.5\ \cancel{\text{in.}} \times \frac{2.54\ \text{cm}}{1\ \cancel{\text{in.}}} = 6.4\ \text{cm}$

volume = length × width × height = 6.4 cm × 6.4 cm × 6.4 cm = 262 cm^3

mass = $\text{density} \times \text{volume} = 7.87 \frac{\text{g}}{\cancel{\text{cm}^3}} \times 262\ \cancel{\text{cm}^3} = 2.06 \times 10^3 \text{g}$

$2.06 \times 10^3\ \cancel{\text{g}} \times \frac{1\ \text{mg}}{10^{-3} \cancel{\text{g}}} = 2.06 \times 10^6\ \text{mg}$

147 **a.** twice daily

b. two times a day

c. $62\ \cancel{\text{lb}} \times \frac{1\ \cancel{\text{kg}}}{2.205\ \cancel{\text{lb}}} \times \frac{25\ \text{mg}}{\cancel{\text{kg}{\cdot}\text{day}}} \times \frac{1\ \cancel{\text{day}}}{2\ \text{dose}} = 350\ \text{mg/dose}$

d. $(1.8\ \times 20\ ℃) + 32 = 68$ °F It should be stored in the refrigerator.

e. The particles in the tablet are close together since they are in the solid state.

148 $3.2\ \cancel{\text{mm}}\ \times \frac{10^{\ -3} \cancel{\text{m}}}{1\ \cancel{\text{mm}}} \times \frac{1\ \text{cm}}{10^{\ -2}\ \cancel{\text{m}}} = 0.32\ \text{cm}$

volume = length × width × height = 0.32 cm × 0.32 cm × 0.32 cm = 0.033 cm^3 = 0.033 mL

149 volume = length × width × height = 147cm^3 $\sqrt[3]{147}$ = 5.27cm

$5.27\ \cancel{\text{cm}} \times \frac{1\ \text{in.}}{2.54\ \cancel{\text{cm}}} = 2.07\ \text{in.}$