Appendix B
Extra Practice Problems

Appendix B

Chapter 2

1. Express the following numbers in scientific notation.
   a. 810 000 g
   b. 0.000634 g
   c. 60 000 000 g
   d. 0.0000010 g
2. Convert each of the following time measurements to its equivalent in seconds.
   a. 58 ns
   b. 0.046 Gs
   c. 9270 ms
   d. 12.3 ks
3. Solve the following problems. Express your answers in scientific notation.
   a. 6.2×10^{-4} m + 5.7×10^{-3} m
   b. 8.7×10^{8} km − 3.4×10^{7} m
   c. $(9.21 \times 10^{-5}$ cm$)(1.83 \times 10^{8}$ cm$)$
   d. $(2.63 \times 10^{-6}$ m$) \div (4.08 \times 10^{6}$ s$)$
4. State the number of significant digits in the following measurements.
   a. 3218 kg
   b. 60.080 kg
   c. 801 kg
   d. 0.000534 kg
5. State the number of significant digits in the following measurements.
   a. 5.60×10^{8} m
   b. 3.0005×10^{-6} m
   c. 8.0×10^{10} m
   d. 9.204×10^{-3} m
6. Add or subtract as indicated and state the answer with the correct number of significant digits.
   a. 85.26 g + 4.7 g
   b. 1.07 km + 0.608 km
   c. 186.4 kg − 57.83 kg
   d. 60.08 s − 12.2 s
7. Multiply or divide as indicated using significant digits correctly.
   a. $(5 \times 10^{8}$ m$)(4.2 \times 10^{7}$ m$)$
   b. $(1.67 \times 10^{-2}$ km$)(8.5 \times 10^{-6}$ km$)$
   c. $(2.6 \times 10^{4}$ kg$) \div (9.4 \times 10^{3}$ m$^{3})$
   d. $(6.3 \times 10^{-1}$ m$) \div (3.8 \times 10^{2}$ s$)$
8. A rectangular room is 8.7 m by 2.41 m.
   a. What length of baseboard molding must be purchased to go around the perimeter of the floor?
   b. What area must be covered if floor tiles are laid?
9. The following data table was established to show the total distances an object fell during various lengths of time.

Time (s)	Distance (m)
1.0	5
2.0	20
3.0	44
4.0	78
5.0	123

   a. Plot distance versus time from the values given in the table and draw a curve that best fits all points.
   b. Describe the resulting curve.
   c. According to the graph, what is the relationship between distance and time for a free-falling object?

10. The total distance a lab cart travels during specified lengths of time is given in the following table.

Time (s)	Distance (m)
0.0	0.500
1.0	0.655
2.0	0.765
3.0	0.915
4.0	1.070

a. Plot distance versus time from the values given in the table and draw the curve that best fits all points.

b. Describe the resulting curve.

c. According to the graph, what type of relationship exists between the total distance traveled by the lab cart and the time?

d. What is the slope of this graph?

e. Write an equation relating distance and time for these data.

11. A cube has an edge of length 5.2 cm.

a. Find its surface area.

b. Find its volume.

12. A truck is traveling at a constant velocity of 70 km/h. Convert the velocity to m/s.

13. The density of gold is 19.3 g/cm^3. A gold washer has an outside radius of 4.3 cm and an inside radius of 2.1 cm. Its thickness is 0.14 cm. What is the mass of the washer?

Chapter 3

Create pictorial and physical models for the following problems. Do not solve the problems.

1. A sailboat moves at a constant speed of 2 m/s. How far does it travel every ten seconds?

2. The putter strikes a golf ball 3.2 m from the hole. After 1.8 s, the ball comes to rest 15 cm from the hole. Assuming constant acceleration, find the initial velocity of the ball.

3. How far above the floor would you need to drop a pencil to have it land in 1 s?

4. Two bikes 24 m apart are approaching each other at a constant speed. One bike is traveling at twice the speed of the other. If they pass each other in 4.3 s, how fast are they going?

5. A sprinter accelerates from 0.0 m/s to 5.4 m/s in 1.2 s, then continues at this constant speed until the end of the 100-m dash. What time did the sprinter achieve for the race?

6. Toss your keys straight up at 1 m/s. How long will they stay aloft before you catch them?

Chapter 4

1. Bob walks 81 m and then he walks 125 m.

a. What is Bob's displacement if he walks east both times?

b. What is Bob's displacement if he walks east then west?

c. What distance does Bob walk in each case?

2. A cross-country runner runs 5.0 km east along the course, then turns around and runs 5.0 km west along the same path. She returns to the starting point in 45 min. What is her average speed? her average velocity?

3. Car A is traveling at 85 km/h while car B is at 64 km/h. What is the relative velocity of car A to car B

a. if they both are traveling in the same direction?

b. if they are headed toward each other?

4. Find θ for each of the following.

a. $\tan\theta = 9.5143$

b. $\sin\theta = 0.4540$

c. $\cos\theta = 0.8192$

d. $\tan\theta = 0.1405$

e. $\sin\theta = 0.7547$

f. $\cos\theta = 0.9781$

5. Find the value of each of the following.

a. tan 28°

b. sin 86°

c. cos 2°

d. tan 58°

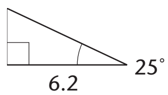
e. sin 40°

f. cos 71°

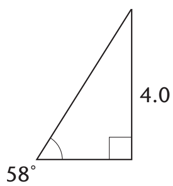
6. You walk 30 m south and 30 m east. Draw and add vectors representing these two displacements.

7. Solve for all sides and all angles for the following right triangles.

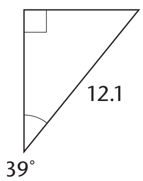
a.



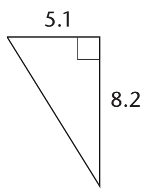
b.



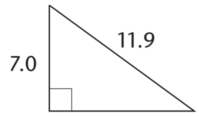
c.



d.

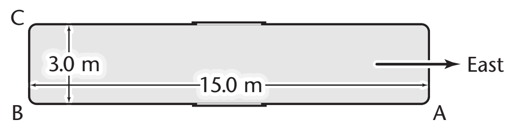


e.



8. A plane flying at 90° at 1.00×10^2 m/s is blown toward 180° at 5.0×10^1 m/s by a strong wind. Find the plane's resultant velocity and direction.

9. A man hops a freight car 15.0 m long and 3.0 m wide. The car is moving east at 2.5 m/s. Exploring the surroundings, the man walks from corner A to corner B in 20.0 s; then from corner B to corner C in 5.0 s as shown. With the aid of a vector diagram, compute the man's displacement relative to the ground.



10. A plane travels on a heading of 40.0° for a distance of 3.00×10^2 km. How far north and how far east does the plane travel?

11. What are the x and y components of a velocity vector of magnitude 1.00×10^2 km/h and direction of 240°?

12. You are a pilot on an aircraft carrier. You must fly to another aircraft carrier, now 1.450×10^3 km at 45° of your position, moving at 56 km/h due east. The wind is blowing from the south at 72 km/h. Calculate the heading and air speed needed to reach the carrier 2.5 h after you take off. **Hint:** Draw a displacement vector diagram.

13. An 80-N and a 60-N force act concurrently on a point. Find the magnitude of the vector sum if the forces pull

a. in the same direction.

b. in opposite directions.

c. at a right angle to each other.

14. One force of 60.0 N and a second of 30.0 N act on an object at point **P.** Graphically add the vectors and find the magnitude of the resultant when the angle between them is as follows.

a. 0°

b. 30°

c. 45°

d. 60°

e. 90°

f. 180°

15. In tackling a running back from the opposing team, a defensive lineman exerts a force of 510 N at 180°, while a linebacker simultaneously applies a force of 650 N at 270°. What is the resultant force on the ball carrier?

16. A water skier is towed by a speedboat. The skier moves to one side of the boat in such a way that the tow rope forms an angle of 55° with the direction of the boat. The tension on the rope is 350 N. What would be the tension on the rope if the skier were directly behind the boat?

17. Two 15-N forces act concurrently on point **P.** Find the magnitude of their resultant when the angle between them is

a. 0.0°

b. 30.0°

c. 90.0°

d. 120.0°

e. 180.0°

18. Kim pushes a lawn spreader across a lawn by applying a force of 95 N along the handle that makes an angle of 60.0° with the horizontal.

a. What are the horizontal and vertical components of the force?

b. The handle is lowered so it makes an angle of 30.0° with the horizontal. Now what are the horizontal and vertical components of the force?

Chapter 5

1. 0.30 s after seeing a puff of smoke rise from the starter's pistol, the sound of the firing of the pistol is heard by the track timer 1.00×10^2 m away. What is the velocity of sound?

2. The tire radius on a particular vehicle is 0.62 m. If the tires are rotating 5 times per second, what is the velocity of the vehicle?

3. A bullet is fired with a speed of 720.0 m/s.

a. What time is required for the bullet to strike a target 324 m away?

b. What is the velocity in km/h?

4. Light travels at 3.0×10^8 m/s. How many seconds go by from the moment the starter's pistol is shot until the smoke is seen by the track timer 1.00×10^2 m away?

5. You drive your car from home at an average velocity of 82 km/h for 3 h. Halfway to your destination, you develop some engine problems, and for 5 h you nurse the car the rest of the way. What is your average velocity for the entire trip?

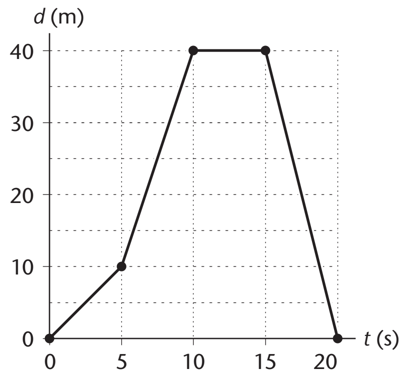
6. The total distance a ball is off the ground when thrown vertically is given for each second of flight shown in the following table.

Time (s)	Distance (m)
0.0	0.0
1.0	24.5
2.0	39.2
3.0	44.1
4.0	39.2
5.0	24.5
6.0	0.0

a. Draw a position-time graph of the motion of the ball.

b. How far off the ground is the ball at the end of 0.5 s? When would the ball again be this distance from the ground?

7. Use the following position-time graph to find how far the object travels between



a. $t = 0$ s and $t = 5$ s.

b. $t = 5$ s and $t = 10$ s.

c. $t = 10$ s and $t = 15$ s.

d. $t = 15$ s and $t = 20$ s.

e. $t = 0$ s and $t = 20$ s.

8. Use the position-time graph from problem 7 to find the object's velocity between

a. $t = 0$ s and $t = 5$ s.

b. $t = 5$ s and $t = 10$ s.

c. $t = 10$ s and $t = 15$ s.

d. $t = 15$ s and $t = 20$ s.

9. Two cars are headed in the same direction; the one traveling 60 km/h is 20 km ahead of the other traveling 80 km/h.

a. Draw a position-time graph showing the motion of the cars.

b. Use your graph to find the time when the faster car overtakes the slower one.

10. You head downstream on a river in an outboard. The current is flowing at a rate of 1.50 m/s. After 30.0 min, you find that you have traveled 24.3 km. How long will it take you to travel back upstream to your original point of departure?

11. Use your graph from problem 6 to calculate the ball's instantaneous velocity at

a. $t = 2$ s.

b. $t = 3$ s.

c. $t = 4$ s.

12. A plane flies in a straight line at a constant speed of +75 m/s. Assume that it is at the reference point when the clock reads $t = 0$.

a. Construct a table showing the position or displacement of the plane at the end of each second for a 10-s period.

b. Use the data from the table to plot a position-time graph.

c. Show that the slope of the line is the velocity of the plane. Use at least two different sets of points along the line.

d. Plot a velocity-time graph of the plane's motion for the first 6 s of the 10-s interval.

e. From the velocity-time graph, find the displacement of the plane between the second and the sixth period.

13. Shonda jogs for 15 min at 240 m/min, walks the next 10 min at 90 m/min, rests for 5 min, and jogs back to where she started at –180 m/min.

a. Plot a velocity-time graph for Shonda's exercise run.

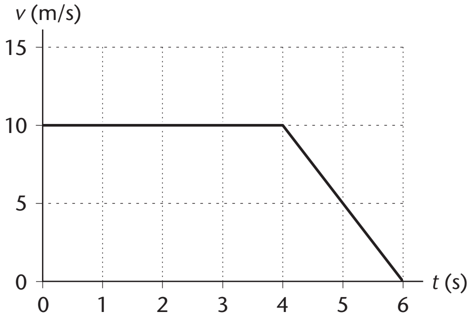
b. Find the area under the curve for the first 15 min. What does this represent?

c. What is the total distance traveled by Shonda?

d. What is Shonda's displacement from start to finish?

14. From the moment a 40.0 m/s fastball touches the catcher's mitt until it is completely stopped takes 0.012 s. Calculate the average acceleration of the ball as it is being caught.

15. The following velocity-time graph describes a familiar motion of a car traveling during rush-hour traffic.



a. Describe the car's motion from $t = 0$ s to $t = 4$ s.

b. Describe the car's motion from $t = 4$ s to $t = 6$ s.

c. What is the average acceleration for the first 4 s?

d. What is the average acceleration from $t = 4$ s to $t = 6$ s?

16. Given the following table:

Time (s)	Velocity (m/s)
0.0	0.0
1.0	5.0
2.0	20.0
3.0	45.0
4.0	80.0

a. Plot a velocity-time graph for this motion.

b. Is this motion constant velocity? Uniform acceleration?

c. Calculate the instantaneous acceleration at $t = 3.0$ s.

17. Top-fuel drag racers are able to uniformly accelerate at 12.5 m/s^2 from rest to 1.00×10^2 m/s before crossing the finish line. How much time elapses during the run?

18. A race car accelerates from rest at +7.5 m/s^2 for 4.5 s. How fast will it be going at the end of that time?

19. A race car starts from rest and is accelerated uniformly to +41 m/s in 8.0 s. What is the car's displacement?

20. A jet plane traveling at +88 m/s lands on a runway and comes to rest in 11 s.

a. Calculate its uniform acceleration.

b. Calculate the distance it travels.

21. A bullet accelerates at 6.8×10^4 m/s^2 from rest as it travels the 0.80 m of the rifle barrel.

a. How long was the bullet in the barrel?

b. What velocity does the bullet have as it leaves the barrel?

22. A car traveling at 14 m/s encounters a patch of ice and takes 5.0 s to stop.

a. What is the car's acceleration?

b. How far does it travel before stopping?

23. A motorcycle traveling at 16 m/s accelerates at a constant rate of 4.0 m/s^2 over 50.0 m. What is its final velocity?

24. A hockey player skating at 18 m/s comes to a complete stop in 2.0 m. What is the acceleration of the hockey player?

25. Police find skid marks 60.0 m long on a highway showing where a car made an emergency stop. Assuming that the acceleration was −10.0 m/s^2 (about the maximum for dry pavement), how fast was the car going? Was the car exceeding the 80 km/h speed limit?

26. An accelerating lab cart passes through two photo gate timers 3.0 m apart in 4.2 s. The velocity of the cart at the second timer is 1.2 m/s.

a. What is the cart's velocity at the first gate?

b. What is the acceleration?

27. A camera is accidentally dropped from the edge of a cliff and 6.0 s later hits the bottom.

    a. How fast was it going just before it hit?

    b. How high is the cliff?

28. A rock is thrown vertically upward with a velocity of 21 m/s from the edge of a bridge 42 m above a river. How long does the rock stay in the air?

29. A platform diver jumps vertically with a velocity of 4.2 m/s. The diver enters the water 2.5 s later. How high is the platform above the water?

Chapter 6

1. A tow rope is used to pull a 1750-kg car, giving it an acceleration of 1.35 m/s^2. What force does the rope exert?

2. A racing car undergoes a uniform acceleration of 4.00 m/s^2. If the net force causing the acceleration is 3.00×10^3 N, what is the mass of the car?

3. A 5.2-kg bowling ball is accelerated from rest to a velocity of 12 m/s as the bowler covers 5.0 m of approach before releasing the ball. What force is exerted on the ball during this time?

4. A high jumper, falling at 4.0 m/s, lands on a foam pit and comes to rest, compressing the pit 0.40 m. If the pit is able to exert an average force of 1200 N on the high jumper in breaking the fall, what is the jumper's mass?

5. On Planet X, a 5.0×10^1-kg barbell can be lifted by exerting a force of only 180 N.

    a. What is the acceleration of gravity on Planet X?

    b. If the same barbell is lifted on Earth, what minimal force is needed?

6. A proton has a mass of 1.672×10^{-27} kg. What is its weight?

7. An applied force of 21 N accelerates a 9.0-kg wagon at 2.0 m/s^2 along the sidewalk.

    a. How large is the frictional force?

    b. What is the coefficient of friction?

8. A 2.0-kg brick has a sliding coefficient of friction of 0.38. What force must be applied to the brick for it to move at a constant velocity?

9. In bench pressing 1.0×10^2 kg, a weight lifter applies a force of 1040 N. How large is the upward acceleration of the weights during the lift?

10. An elevator that weighs 3.0×10^3 N is accelerated upward at 1.0 m/s^2. What force does the cable exert to give it this acceleration?

11. A person weighing 490 N stands on a scale in an elevator.

    a. What does the scale read when the elevator is at rest?

    b. What is the reading on the scale when the elevator rises at a constant velocity?

    c. The elevator slows down at –2.2 m/s^2 as it reaches the desired floor. What does the scale read?

    d. The elevator descends, accelerating at –2.7 m/s^2. What does the scale read?

    e. What does the scale read when the elevator descends at a constant velocity?

    f. Suppose the cable snapped and the elevator fell freely. What would the scale read?

12. A pendulum has a length of 1.00 m.

    a. What is its period on Earth?

    b. What is its period on the moon where the acceleration due to gravity is 1.67 m/s^2?

13. The period of an object oscillating on a spring is

$$T = 2\pi\sqrt{\frac{m}{k}}$$

where m is the mass of the object and k is the spring constant, which indicates the force necessary to produce a unit elongation of the spring. The period of a simple pendulum is

$$T = 2\pi\sqrt{\frac{l}{g}}$$

   a. What mass will produce a 1.0-s period of oscillation if it is attached to a spring with a spring constant of 4.0 N/m?

   b. What length pendulum will produce a period of 1.0 s?

   c. How would the harmonic oscillator and the pendulum have to be modified in order to produce 1.0-s periods on the surface of the moon where g is 1.6 m/s^2?

14. When a 22-kg child steps off a 3.0-kg stationary skateboard with an acceleration of 0.50 m/s^2, with what acceleration will the skateboard travel in the opposite direction?

15. A 10.0-kg mass, m_1, on a frictionless table is accelerated by a 5.0-kg mass, m_2, hanging over the edge of the table. What is the acceleration of the mass along the table?

16. A bricklayer applies a force of 100 N to each of two handles of a wheelbarrow. Its mass is 20 kg and it is loaded with 30 bricks, each of mass 1.5 kg. The handles of the wheelbarrow are 30° from the horizontal, and the coefficient of friction is 0.20. What initial acceleration is given the wheelbarrow?

Chapter 7

1. A 33-N force acting at 90.0° and a 44-N force acting at 60.0° act concurrently on point **P.** What is the magnitude and direction of a third force that produces equilibrium at point **P?**

2. A person weighs 612 N. If the person sits in the middle of a hammock that is 3.0 m long and sags 1.0 m below the points of support, what force would be exerted by each of the two hammock ropes?

3. A bell ringer decides to use a bowling ball to ring the bell. He hangs the 7.3-kg ball from the end of a 2.0 m long rope. He attaches another rope to the ball to pull the ball back, and pulls it horizontally until the ball has moved 0.60 m away from the vertical. How much force must he apply?

4. A mass, M, starts from rest and slides down the frictionless incline of 30°. As it leaves the incline, its speed is 24 m/s.

   a. What is the acceleration of the mass while on the incline?

   b. What is the length of the incline?

   c. How long does it take the mass to reach the floor after it leaves the top of the incline?

5. A ball falls from rest from a height of 4.90×10^2 m.

   a. How long does it remain in the air?

   b. If the ball has a horizontal velocity of 2.00×10^2 m/s when it begins its fall, what horizontal displacement will it have?

6. An archer stands 40.0 m from the target. If the arrow is shot horizontally with a velocity of 90.0 m/s, how far above the bull's-eye must she aim to compensate for gravity pulling her arrow downward?

7. A bridge is 176.4 m above a river. If a lead-weighted fishing line is thrown from the bridge with a horizontal velocity of 22.0 m/s, how far has it moved horizontally when it hits the water?
8. A beach ball, moving with a speed of +1.27 m/s, rolls off a pier and hits the water 0.75 m from the end of the pier. How high above the water is the pier?
9. Carlos has a tendency to drop his bowling ball on his release. Instead of having the ball on the floor at the completion of his swing, Carlos lets go with the ball 0.35 m above the floor. If he throws it horizontally with a velocity of 6.3 m/s, what distance does it travel before you hear a "thud"?
10. A discus is released at an angle of 45° and a velocity of 24.0 m/s.
    a. How long does it stay in the air?
    b. What horizontal distance does it travel?
11. A shot put is released with a velocity of 12 m/s and stays in the air for 2.0 s.
    a. At what angle with the horizontal was it released?
    b. What horizontal distance did it travel?
12. A football is kicked at 45° and travels 82 m before hitting the ground.
    a. What was its initial velocity?
    b. How long was it in the air?
    c. How high did it go?
13. A golf ball is hit with a velocity of 24.5 m/s at 35.0° above the horizontal. Find
    a. the range of the ball.
    b. the maximum height of the ball.
14. A carnival clown rides a motorcycle down a ramp and around a "loop-the-loop." If the loop has a radius of 18 m, what is the slowest speed the rider can have at the top of the loop to avoid falling? **Hint:** At this slowest speed, at the top of the loop, the track exerts no force on the motorcycle.
15. A 75-kg pilot flies a plane in a loop. At the top of the loop, where the plane is completely upside-down for an instant, the pilot hangs freely in the seat and does not push against the seat belt. The airspeed indicator reads 120 m/s. What is the radius of the plane's loop?
16. A 2.0-kg object is attached to a 1.5-m long string and swung in a vertical circle at a constant speed of 12 m/s.
    a. What is the tension in the string when the object is at the bottom of its path?
    b. What is the tension in the string when the object is at the top of its path?
17. A 60.0-kg speed skater with a velocity of 18.0 m/s comes into a curve of 20.0-m radius. How much friction must be exerted between the skates and ice to negotiate the curve?
18. A 20.0-kg child wishes to balance on a seesaw with a child of 32.0 kg. If the smaller child sits 3.2 m from the pivot, where must the larger child sit?

Chapter 8

1. Comet Halley returns every 74 years. Find the average distance of the comet from the sun in astronomical units (AU).
2. Area is measured in m^2, so the rate at which area is swept out by a planet or satellite is measured in m^2/s.
    a. How fast is area swept out by Earth in its orbit about the sun?
    b. How fast is area swept out by the moon in its orbit about Earth? Use 3.9×10^8 m as the average distance between Earth and the moon, and 27.33 days as the moon's period.

3. You wish to launch a satellite that will remain above the same spot on Earth's surface. This means the satellite must have a period of exactly one day. Calculate the radius of the circular orbit this satellite must have. **Hint:** The moon also circles Earth and both the moon and the satellite will obey Kepler's third law. The moon is 3.9×10^8 m from Earth and its period is 27.33 days.

4. The mass of an electron is 9.1×10^{-31} kg. The mass of a proton is 1.7×10^{-27} kg. They are about 1.0×10^{-10} m apart in a hydrogen atom. What gravitational force exists between the proton and the electron of a hydrogen atom?

5. Two 1.00-kg masses have their centers 1.00 m apart. What is the force of attraction between them?

6. Two satellites of equal mass are put into orbit 30 m apart. The gravitational force between them is 2.0×10^{-7} N.
   a. What is the mass of each satellite?
   b. What is the initial acceleration given to each satellite by the gravitational force?

7. Two large spheres are suspended close to each other. Their centers are 4.0 m apart. One sphere weighs 9.8×10^2 N. The other sphere has a weight of 1.96×10^2 N. What is the gravitational force between them?

8. If the centers of Earth and the moon are 3.9×10^8 m apart, the gravitational force between them is about 1.9×10^{20} N. What is the approximate mass of the moon?

9. **a.** What is the gravitational force between two spherical 8.00-kg masses that are 5.0 m apart?
   b. What is the gravitational force between them when they are 5.0×10^1 m apart?

10. A satellite is placed in a circular orbit with a radius of 1.0×10^7 m and a period of 9.9×10^3 s. Calculate the mass of Earth. **Hint:** Gravity is the net force on such a satellite. Scientists have actually measured the mass of Earth this way.

11. If you weigh 637 N on Earth's surface, how much would you weigh on the planet Mars? (Mars has a mass of 6.37×10^{23} kg and a radius of 3.43×10^6 m.)

12. Using Newton's variation of Kepler's third law and information from **Table 8–1,** calculate the period of Earth's moon if the radius of orbit was twice the actual value of 3.9×10^8 m.

13. Use the data from **Table 8–1** to find the speed and period of a satellite that would orbit Mars 175 km above its surface.

14. What would be the value of *g*, acceleration of gravity, if Earth's mass was double its actual value, but its radius remained the same? If the radius was doubled, but the mass remained the same? If both the mass and radius were doubled?

15. What would be the strength of Earth's gravitational field at a point where an 80.0-kg astronaut would experience a 25% reduction in weight?

16. On the surface of the moon, a 91.0-kg physics teacher weighs only 145.6 N. What is the value of the moon's gravitational field at its surface?

Chapter 9

1. Jim strikes a 0.058-kg golf ball with a force of 272 N and gives it a velocity of 62.0 m/s. How long was the club in contact with the ball?

2. A force of 186 N acts on a 7.3-kg bowling ball for 0.40 s.

a. What is the bowling ball's change in momentum?

b. What is its change in velocity?

3. A 5500-kg freight truck accelerates from 4.2 m/s to 7.8 m/s in 15.0 s by applying a constant force.

a. What change in momentum occurs?

b. How large of a force is exerted?

4. In running a ballistics test at the police department, Officer Rios fires a 6.0-g bullet at 350 m/s into a container that stops it in 0.30 m. What average force stops the bullet?

5. A 0.24-kg volleyball approaches Zina with a velocity of 3.8 m/s. Zina bumps the ball, giving it a velocity of –2.4 m/s. What average force did she apply if the interaction time between her hands and the ball is 0.025 s?

6. A 0.145-kg baseball is pitched at 42 m/s. The batter hits it horizontally to the pitcher at 58 m/s.

a. Find the change in momentum of the ball.

b. If the ball and bat were in contact 4.6×10^{-4} s, what would be the average force while they touched?

7. A 550-kg car traveling at 24.0 m/s collides head-on with a 680-kg pick-up truck. Both vehicles come to a complete stop upon impact.

a. What is the momentum of the car before collision?

b. What is the change in the car's momentum?

c. What is the change in the truck's momentum?

d. What is the velocity of the truck before the collision?

8. A truck weighs four times as much as a car. If the truck coasts into the car at 12 km/h and they stick together, what is their final velocity?

9. A 50.0-g projectile is launched with a horizontal velocity of 647 m/s from a 4.65-kg launcher moving in the same direction at 2.00 m/s. What is the velocity of the launcher after the projectile is launched?

10. Two lab carts are pushed together with a spring mechanism compressed between them. Upon release, the 5.0-kg cart repels one way with a velocity of 0.12 m/s while the 2.0-kg cart goes in the opposite direction. What velocity does it have?

11. A 12.0-g rubber bullet travels at a velocity of 150 m/s, hits a stationary 8.5-kg concrete block resting on a frictionless surface, and ricochets in the opposite direction with a velocity of -1.0×10^2 m/s. How fast will the concrete block be moving?

12. A 6500-kg freight car traveling at 2.5 m/s collides with an 8000-kg stationary freight car. If they interlock upon collision, find their velocity.

13. Miko, mass 42.00 kg, is riding a skateboard, mass 2.00 kg, traveling at 1.20 m/s. Miko jumps off and the skateboard stops dead in its tracks. In what direction and with what velocity did she jump?

14. A cue ball, mass 0.16 kg, rolling at 4.0 m/s, hits a stationary eight-ball of similar mass. If the cue ball travels 45° above its original path, and the eight-ball at 45° below, what is the velocity of each after colliding?

15. Two opposing hockey players, one of mass 82.0 kg skating north at 6.00 m/s and the other of mass 70.0 kg skating east at 3.00 m/s, collide and become tangled.

    a. Draw a vector momentum diagram of the collision.

    b. In what direction and with what velocity do they move after collision?

Chapter 10

1. After scoring a touchdown, an 84.0-kg wide receiver celebrates by leaping 1.20 m off the ground. How much work was done by the player in the celebration?
2. During a tug-of-war, Team A does 2.20×10^5 J of work in pulling Team B 8.00 m. What force was Team A exerting?
3. To keep a car traveling at a constant velocity, 551 N of force is needed to balance frictional forces. How much work is done against friction by the car in traveling from Columbus to Cincinnati, a distance of 161 km?
4. A weightlifter raises a 180-kg barbell to a height of 1.95 m. How much work is done by the weightlifter in lifting the barbells?
5. A wagon is pulled by a force of 38.0 N on the handle at an angle of 42.0° with the horizontal. If the wagon is pulled in a circle of radius 25.0 m, how much work is done?
6. A 185-kg refrigerator is loaded into a moving van by pushing it up a 10.0-m ramp at an angle of inclination of 11.0°. How much work is done by the pusher?
7. A lawn mower is pushed with a force of 88.0 N along a handle that makes an angle of 41.0° with the horizontal. How much work is done by the pusher in moving the mower 1.2 km in mowing the yard?
8. A 17.0-kg crate is to be pulled a distance of 20.0 m, requiring 1210 J of work being done. If the job is done by attaching a rope and pulling with a force of 75.0 N, at what angle is the rope held?
9. An elevator lifts a total mass of 1.1×10^3 kg, a distance of 40.0 m in 12.5 s. How much power does the elevator consume?
10. A cyclist exerts a force of 15.0 N in riding a bike 251 m in 30.0 s. What is the cyclist's power?
11. A 120-kg lawn tractor goes up a 21° incline of 12.0 m in 2.5 s. What power is developed by the tractor?
12. What power does a pump develop to lift 35 L of water per minute from a depth of 110 m? (A liter of water has a mass of 1.00 kg.)
13. A force of 1.4 N is exerted through a distance of 40.0 cm on a rope in a pulley system to lift a 0.50-kg mass 10.0 cm.

    a. Calculate the *MA*.

    b. Calculate the *IMA*.

    c. What is the efficiency of the pulley system?
14. A student exerts a force of 250 N through a distance of 1.6 m on a lever in lifting a 150-kg crate. If the efficiency of the lever is 90%, how far is the crate lifted?
15. Luis pedals a bicycle with a gear radius of 5.00 cm and wheel radius of 38.6 cm. What length of chain must be pulled through to make the wheel revolve once?

Chapter 11

1. Calculate the kinetic energy of a proton, mass 1.67×10^{-27} kg, traveling at 5.20×10^7 m/s.
2. What is the kinetic energy of a 3.2-kg pike swimming at 2.7 km/h?

3. A force of 30.0 N pushes a 1.5-kg cart, initially at rest, a distance of 2.8 m along a frictionless surface.

a. Find the work done on the cart by this force.

b. What is its change in kinetic energy?

c. What is the cart's final velocity?

4. A bike and rider, 82.0-kg combined mass, are traveling at 4.2 m/s. A constant force of −140 N is applied by the brakes in stopping the bike. What braking distance is needed?

5. A 712-kg car is traveling at 5.6 m/s when a force acts on it for 8.4 s, changing its velocity to 10.2 m/s.

a. What is the change in kinetic energy of the car?

b. How far did the car move while the force acted?

c. How large is the force?

6. Five identical 0.85-kg books of 2.50-cm thickness are each lying flat on a table. Calculate the gain in potential energy of the system if they are stacked one on top of the other.

7. Each step of a ladder increases one's vertical height 4.0×10^1 cm. If a 90.0-kg painter climbs 8 steps of the ladder, what is the increase in potential energy?

8. A 0.25-kg ball is dropped from a height of 3.20 m and bounces to a height of 2.40 m. What is its loss in potential energy?

9. A 0.18-kg ball is placed on a compressed spring on the floor. The spring exerts an average force of 2.8 N through a distance of 15 cm as it shoots the ball upward. How high will the ball travel above the release spring?

10. A force of 14.0 N is applied to a 1.5-kg cart as it travels 2.6 m along an inclined plane at constant speed. What is the angle of inclination of the plane?

11. A 15.0-kg model plane flies horizontally at a constant speed of 12.5 m/s.

a. Calculate its kinetic energy.

b. The plane goes into a dive and levels off 20.4 m closer to Earth. How much potential energy does it lose during the dive? Assume no additional drag.

c. How much kinetic energy does the plane gain during the dive?

d. What is its new kinetic energy?

e. What is its new horizontal velocity?

12. A 1200-kg car starts from rest and accelerates to 72 km/h in 20.0 s. Friction exerts an average force of 450 N on the car during this time.

a. What is the net work done on the car?

b. How far does the car move during its acceleration?

c. What is the net force exerted on the car during this time?

d. What is the forward force exerted on the car as a result of the engine, power train, and wheels pushing backward on the road?

13. In an electronics factory, small cabinets slide down a 30.0° incline a distance of 16.0 m to reach the next assembly stage. The cabinets have a mass of 10.0 kg each.

a. Calculate the speed each cabinet would acquire if the incline were frictionless.

b. What kinetic energy would a cabinet have under such circumstances?

14. An average force of 8.2 N is used to pull a 0.40-kg rock, stretching a sling shot 43 cm. The rock is shot downward from a bridge 18 m above a stream. What will be the velocity of the rock just before it enters the water?

15. A 15-g bullet is fired horizontally into a 3.000-kg block of wood suspended by a long cord. The bullet sticks in the block. Compute the velocity of the bullet if the impact causes the block to swing 1.0×10^1 cm above its initial level.

Chapter 12

1. The boiling point of liquid chlorine is –34.60°C. Find this temperature in Kelvin.
2. Fluorine has a melting point of 50.28 K. Find this temperature in degrees Celsius.
3. Five kilograms of ice cubes are moved from the freezing compartment of a refrigerator into a home freezer. The refrigerator's freezing compartment is kept at –4.0°C. The home freezer is kept at –17°C. How much heat does the freezer's cooling system remove from the ice cubes?
4. How much thermal energy must be added to 124 g of brass at 12.5°C to raise its temperature to 97.0°C?
5. 2.8×10^5 J of thermal energy are added to a sample of water and its temperature changes from 293 K to 308 K. What is the mass of the water?
6. 1420 J of thermal energy are added to a 100.0-g block of carbon at –20.0°C. What final temperature will the carbon reach?
7. A gold brick, mass 10.5 kg, requires 2.08×10^4 J to change its temperature from 35.0°C to 50.0°C. What is the specific heat of gold?
8. An 8.00×10^2-g block of lead is heated in boiling water, 100.0°C, until the block's temperature is the same as the water's. The lead is then removed from the boiling water and dropped into 2.50×10^2 g of cool water at 12.2°C. After a short time, the temperature of both lead and water is 20.0°C.
   a. How much energy is gained by the cool water?
   b. On the basis of these measurements, what is the specific heat of lead?
9. 250.0 g of copper at 100.0°C are placed in a cup containing 325.0 g of water at 20.0°C. Assume no heat loss to the surroundings. What is the final temperature of the copper and water?
10. A 4.00×10^2-g sample of methanol at 30.0°C is mixed with a 2.00×10^2-g sample of water at 0.00°C. Assume no heat loss to the surroundings. What is the final temperature of the mixture?
11. How much heat is needed to change 50.0 g of water at 80.0°C to steam at 110.0°C?
12. The specific heat of mercury is 140 J/kg · C°. Its heat of vaporization is 3.06×10^5 J/kg. How much energy is needed to heat 1.0 kg of mercury metal from 10.0°C to its boiling point and vaporize it completely? The boiling point of mercury is 357°C.
13. 30.0 g of –3.0°C ice are placed in a cup containing 104.0 g of water at 62.0°C. All the ice melts. Find the final temperature of the mixture. Assume no heat loss to the surroundings.
14. Water flows over a falls 125.0 m high. If the potential energy of the water is all converted to thermal energy, calculate the temperature difference between the water at the top and the bottom of the falls.
15. During the game, the metabolism of basketball players often increases by as much as 30.0 W. How much perspiration must a player vaporize per hour to dissipate this extra thermal energy?

Chapter 13

1. How tall must a column of mercury, $\rho = 1.36 \times 10^4$ kg/m^3, be to exert a pressure equal to the atmosphere?
2. A dog, whose paw has an area of 12.0 cm^2, has a mass of 8.0 kg. What average pressure does the dog exert while standing?
3. A crate, whose bottom surface is 50.4 cm by 28.3 cm, exerts a pressure of 2.50×10^3 Pa on the floor. What is the mass of the crate?
4. The dimensions of a waterbed are 2.13 m by 1.52 m by 0.380 m. If the frame has a mass of 91.0 kg and the mattress is filled with water, what pressure does the bed exert on the floor?
5. A rectangular block of tin, $\rho = 7.29 \times 10^3$ kg/m^3, has dimensions of 5.00 cm by 8.50 cm by 2.25 cm. What pressure does it exert on a table top if it is lying on its side of
   a. greatest surface area?
   b. smallest surface area?
6. A rowboat, mass 42.0 kg, is floating on a lake.
   a. What is the size of the buoyant force?
   b. What is the volume of the submerged part of the boat?
7. A hydraulic lift has a large piston of 20.00-cm diameter and a small piston of 5.00-cm diameter. What is the mechanical advantage of the lift?
8. A lever on a hydraulic system gives a mechanical advantage of 5.00. The cross-sectional area of the small piston is 0.0400 m^2, and that of the large piston is 0.280 m^2. If a force of 25.0 N is exerted on the lever, what is the force given by the larger piston?
9. A piece of metal weighs 75.0 N in air and 60.0 N in water. What is the density of the metal?
10. A river barge with vertical sides is 20.0 m long and 10.0 m wide. It floats 3.00 m out of the water when empty. When loaded with coals, the water is only 1.00 m from the top. What is the weight of the load of coal?
11. What is the change in the length of a 15.0-m steel rail as it is cooled from 1535°C to 20°C?
12. A concrete sidewalk section 8.000 m by 1.000 m by 0.100 m at exactly 0°C will expand to what volume at 35°C?
13. An air-filled balloon of 15.0-cm radius at 11°C is heated to 121°C. What change in volume occurs?
14. A circular, pyrex watch glass of 10.0-cm diameter at 21°C is heated to 501°C. What change will be found in the circumference of the glass?
15. A 200.0-cm copper wire and a 201-cm platinum wire are both at exactly 0°C. At what temperature will they be of equal length?

Chapter 14

1. A periodic transverse wave that has a frequency of 10.0 Hz travels along a string. The distance between a crest and either adjacent trough is 2.50 m. What is its wavelength?
2. A wave generator produces 16.0 pulses in 4.00 s.
   a. What is its period?
   b. What is its frequency?
3. A wave generator produces 22.5 pulses in 5.50 s.
   a. What is its period?
   b. What is its frequency?

4. What is the speed of a periodic wave disturbance that has a frequency of 2.50 Hz and a wavelength of 0.600 m?
5. One pulse is generated every 0.100 s in a tank of water. What is the speed of propagation of the wave if the wavelength of the surface wave is 3.30 cm?
6. Five pulses are generated every 0.100 s in a tank of water. What is the speed of propagation of the wave if the wavelength of the surface wave is 1.20 cm?
7. A periodic longitudinal wave that has a frequency of 20.0 Hz travels along a coil spring. If the distance between successive compressions is 0.400 m, what is the speed of the wave?
8. What is the wavelength of a water wave that has a frequency of 2.50 Hz and a speed of 4.0 m/s?
9. The speed of a transverse wave in a string is 15.0 m/s. If a source produces a disturbance that has a frequency of 5.00 Hz, what is its wavelength?
10. The speed of a transverse wave in a string is 15.0 m/s. If a source produces a disturbance that has a wavelength of 1.25 m, what is the frequency of the wave?
11. A wave has an angle of incidence of 24°. What is the angle of reflection?

Chapter 15

1. The echo of a ship's foghorn, reflected from an iceberg, is heard 5.0 s after the horn is sounded. How far away is the iceberg?
2. What is the speed of sound that has a frequency of 250 Hz and a wavelength of 0.600 m?
3. A sound wave has a frequency of 2000 Hz and travels along a steel rod. If the distance between successive compressions is 0.400 m, what is the speed of the wave?
4. What is the wavelength of a sound wave that has a frequency of 250 Hz and a speed of 4.0×10^2 m/s?
5. What is the wavelength of sound that has a frequency of 539.8 Hz?
6. What is the wavelength of sound that has a frequency of 320.0 Hz?
7. A stone is dropped into a mine shaft 250.0 m deep. How many seconds pass before the stone is heard to strike the bottom of the shaft?
8. A rifle is shot in a valley formed between two parallel mountains. The echo from one mountain is heard after 2.00 s and from the other mountain 2.00 s later. What is the width of the valley?
9. Sam, a train engineer, blows a whistle that has a frequency of 4.0×10^2 Hz as the train approaches a station. If the speed of the train is 25 m/s, what frequency will be heard by a person at the station?
10. Shawon is on a train that is traveling at 95 km/h. The train passes a factory whose whistle is blowing at 288 Hz. What frequency does Shawon hear as the train approaches the factory?
11. What is the sound level of a sound that has a sound pressure one tenth of 90 dB?
12. What is the sound level of a sound that has a sound pressure ten times 90 dB?
13. A tuning fork produces a resonance with a closed tube 19.0 cm long. What is the lowest possible frequency of the tuning fork?
14. How do the frequencies of notes that are an octave apart compare?
15. Two tuning forks of 319 Hz and 324 Hz are sounded simultaneously. What frequency of sound will the listener hear?

16. How many beats will be heard each second when a string with a frequency of 288 Hz is plucked simultaneously with another string that has a frequency of 296 Hz?

17. A tuning fork has a frequency of 440.0 Hz. If another tuning fork of slightly lower pitch is sounded at the same time, 5.0 beats per second are produced. What is the frequency of the second tuning fork?

Chapter 16

1. The wavelength of blue light is about 4.5×10^{-7} m. Convert this to nm.

2. As a spacecraft passes directly over Cape Canaveral, radar pulses are transmitted toward the craft and are then reflected back toward the ground. If the total time interval was 3.00×10^{-3} s, how far above the ground was the spacecraft when it passed over Cape Canaveral?

3. It takes 4.0 years for light from a star to reach Earth. How far away is this star from Earth?

4. The planet Venus is sometimes a very bright object in the night sky. Venus is 4.1×10^{10} m away from Earth when it is closest to Earth. How long would we have to wait for a radar signal from Earth to return from Venus and be detected?

5. The distance from Earth to the moon is about 3.8×10^{8} m. A beam of light is sent to the moon and, after it reflects, returns to Earth. How long did it take to make the round trip?

6. A baseball fan in a ball park is 101 m away from the batter's box when the batter hits the ball. How long after the batter hits the ball does the fan see it occur?

7. A radio station on the AM band has an assigned frequency of 825 kHz (kilohertz). What is the wavelength of the station?

8. A short-wave ham radio operator uses the 6-meter band. On what frequency does the ham operate?

9. Find the illumination 8.0 m below a 405-lm lamp.

10. Two lamps illuminate a screen equally. The first lamp has an intensity of 12.5 cd and is 3.0 m from the screen. The second lamp is 9.0 m from the screen. What is its intensity?

11. A 15-cd point source lamp and a 45-cd point source lamp provide equal illuminations on a wall. If the 45-cd lamp is 12 m away from the wall, how far from the wall is the 15-cd lamp?

12. What is the name given to the electromagnetic radiation that has a wavelength slightly longer than visible light?

13. What is the name given to the electromagnetic radiation that has a wavelength slightly shorter than visible light?

14. If a black object absorbs all light rays incident on it, how can we see it?

15. What is the appearance of a red dress in a closed room illuminated only by green light?

16. A shirt that is the color of a primary color is illuminated with the complement of that primary color. What color do you see?

Chapter 17

1. A ray of light strikes a mirror at an angle of incidence of 28°. What is the angle of reflection?

2. A ray of light passes from an unknown substance into air. If the angle in the unknown substance is 35.0° and the angle in air is 52.0°, what is the index of refraction of the unknown substance?

3. A ray of light has an angle of incidence of 25.0° upon the surface of a piece of quartz. What is the angle of refraction?

4. A beam of light passes from water into polyethylene, index of refraction = 1.50. If the angle in water is 57.5°, what is the angle in polyethylene?

5. Mi-ling makes some hydrogen sulfide, index of refraction = 1.000 644. If Mi-ling measures an angle of 85.000° in the hydrogen sulfide, what angle will Mi-ling measure in air if the index of refraction of air is 1.000 292 6?

6. Luisa submerged some ice in water and shined a laser beam through the water and into the ice. Luisa found the angle in ice was larger than the angle in water. Which material has a larger index of refraction?

7. A ray of light enters a triangular crown glass prism perpendicular to one face and it emerges from an adjacent side. If the two adjacent sides meet at a 30.0° angle, what is the angle the light ray has in the air when it comes out?

8. Make a drawing, to scale, of the side of an aquarium in which the water is 12.0 cm deep. From a single point on the bottom, draw two lines upward, one vertical and the other 5.0° from the vertical. Let these two lines represent two light rays that start from the same point on the bottom of the tank. Compute the directions the refracted rays will travel above the surface of the water. Draw in these rays and continue them backward into the tank until they intersect. At what depth does the bottom of the tank appear to be if you look into the water? Divide the apparent depth into the true depth and compare it to the index of refraction.

9. Find the speed of light in water.

10. Find the speed of light in antimony trioxide if it has an index of refraction of 2.35.

11. The speed of light in a special piece of glass is 1.75×10^8 m/s. What is its index of refraction?

12. Glenn gently pours some acetic acid, index of refraction = 1.37, onto some antimony trioxide, index of refraction = 2.35. What angle will Glenn find in the acetic acid if the angle in the antimony trioxide is 42.0°?

13. Marcos finds that a plastic has a critical angle of 40.0°. What is the index of refraction of the plastic?

14. Aisha decides to find the critical angle of arsenic trioxide, index of refraction = 2.01, which is very toxic. What angle did Aisha find?

15. A light source is in a cylindrical container of carbon dichloride, index of refraction = 1.500. The light source sends a ray of light parallel to the bottom of the container at a 45.0° angle from the radius to the circumference. What will the path of the light ray be?

16. With a square block of glass, index of refraction = 1.50, it is impossible, when looking into one side, to see out of an adjacent side of the square block of glass. It appears to be a mirror. Use your knowledge of geometry and critical angles to show that this is true.

17. The index of refraction for red light in arsenic trioxide is 2.010, and the index of refraction for blue light is 2.023. Find the difference between the angles of refraction if white light is incident at an angle of 65.0°.

18. The index of refraction for red light in a diamond is 2.410, and the index of refraction for blue light is 2.450. Find the difference in the speed of light in diamond.

Chapter 18

1. Sally's face is 75 cm in front of a plane mirror. Where is the image of Sally's face?
2. A concave mirror has a focal length of 10.0 cm. What is its radius of curvature?
3. Light from a distant star is collected by a concave mirror that has a radius of curvature of 150 cm. How far from the mirror is the image of the star?
4. An object is placed 25.0 cm away from a concave mirror that has a focal length of 5.00 cm. Where is the image located?
5. An object and its image as seen in a concave mirror are the same height when the object is 48.4 cm from the mirror. What is the focal length of the mirror?
6. An object placed 50.0 cm from a concave mirror gives a real image 33.3 cm from the mirror. If the image is 28.4 cm high, what is the height of the object?
7. An object, 15.8 cm high, is located 87.6 cm from a concave mirror that has a focal length of 17.0 cm.
   a. Where is the image located?
   b. How high is the image?
8. The image of the moon is formed by a concave mirror whose radius of curvature is 4.20 m at a time when the moon's distance is 3.80×10^5 km. What is the diameter of the image of the moon if the diameter of the moon is 3480 km?
9. A shaving mirror has a radius of curvature of 30.0 cm. When a face is 10.0 cm away from the mirror, what is the magnification of the mirror?
10. A convex mirror has a focal length of −16 cm. How far behind the mirror does the image of a person 3.0 m away appear?
11. How far behind the surface of a convex mirror, focal length of −6.0 cm, does a car 10.0 m from the mirror appear?
12. A converging lens has a focal length of 25.5 cm. If it is placed 72.5 cm from an object, at what distance from the lens will the image be?
13. If an object is 10.0 cm from a converging lens that has a focal length of 5.00 cm, how far from the lens will the image be?
14. The focal length of a lens in a box camera is 10.0 cm. The fixed distance between the lens and the film is 11.0 cm. If an object is clearly focused on the film, how far must the object be from the lens?
15. An object 3.0 cm tall is placed 22 cm in front of a converging lens. A real image is formed 11 cm from the lens. What is the size of the image?
16. An object 3.0 cm tall is placed 20 cm in front of a converging lens. A real image is formed 10 cm from the lens. What is the focal length of the lens?
17. What is the focal length of the lens in your eye when you read a book that is 35.0 cm from your eye? The distance from the lens to the retina is 0.19 mm.
18. When an object 5.0 cm tall is placed 12 cm from a converging lens, an image is formed on the same side of the lens as the object but the image is 61 cm away from the lens. What is the focal length of the lens?
19. When an object 5.0 cm tall is placed 12 cm from a converging lens, an image is formed on the same side of the lens as the object but the image is 61 cm away from the lens. What is the size of the image?

Chapter 19

1. Monochromatic light passes through two slits that are 0.0300 cm apart and it falls on a screen 1.20×10^2 cm away. The first-order image is 0.160 cm from the middle of the center band. What is the wavelength of the light used?
2. Green light passes through a double slit for which $d = 0.20$ mm and it falls on a screen 2.00 m away. The first-order image is at 0.50 cm. What is the wavelength of the light?
3. Yellow light that has a wavelength of 6.00×10^2 nm passes through two narrow slits that are 0.200 mm apart. An interference pattern is produced on a screen 1.80×10^2 cm away. What is the location of the first-order image?
4. Violet light that has a wavelength of 4.00×10^2 nm passes through two slits that are 0.0100 cm apart. How far away must the screen be so the first-order image is at 0.300 cm?
5. Two radio transmitters are 25.0 m apart and each one sends out a radio wave with a wavelength of 10.0 m. The two radio towers act exactly like a double-slit source for light. How far from the central band is the first-order image if you are 15.0 km away? (Yes, this really happens. Radio stations can and do fade in and out as you cross the nodals and the antinodals.)
6. Monochromatic light passes through a single slit, 0.500 mm wide, and falls on a screen 1.0 m away. If the distance from the center of the pattern to the first band is 2.6 mm, what is the wavelength of the light?
7. Red light that has a wavelength of 7.50×10^2 nm passes through a single slit that is 0.1350 mm wide. How far away from the screen must the slit be if the first dark band is 0.9000 cm away from the central bright band?
8. Microwaves with a wavelength of 3.5 cm pass through a single slit 0.85 cm wide and fall on a screen 91 cm away. What is the distance to the first-order band?
9. Radio waves that are emitted by two adjacent radio transmitters behave like light waves coming from a double slit. If two transmitters, 1500 m apart, each send out radio waves with a wavelength of 150 m, what is the diffraction angle?
10. What is the average distance between the lines of a diffraction grating if the number of lines per millimeter is 425?
11. A transmission grating with 5.85×10^3 lines/cm is illuminated by monochromatic light that has a wavelength of 492 nm. What is the diffraction angle for the first-order image?
12. Monochromatic light illuminates a transmission grating having 5900 lines/cm. The diffraction angle for a first-order image is 18.0°. What is the wavelength of the light in nanometers?
13. A transmission grating, 5.80×10^3 lines/cm, is illuminated by a monochromatic light source that has a wavelength of 495 nm. How far from the center line is the first-order image if the distance to the grating is 1.25 m?
14. A pinhole camera uses a 1.5-mm hole instead of a lens to form an image. What is the resolution of this camera for green light, 545-nm wavelength, if the film is 6.0 cm behind the pinhole?

Chapter 20

1. Two charges, q_1 and q_2, are separated by a distance, d, and exert a force on each other. What new force will exist if d is doubled?
2. Two charges, q_1 and q_2, are separated by a distance, d, and exert a force, f, on each other. What new force will exist if q_1 and q_2 are both doubled?
3. Two identical point charges are separated by a distance of 3.0 cm and they repel each other with a force of 4.0×10^{-5} N. What is the new force if the distance between the point charges is doubled?
4. An electric force of 2.5×10^{-4} N acts between two small equally charged spheres, which are 2.0 cm apart. Calculate the force acting between the spheres if the charge on one of the spheres is doubled and the spheres move to a 5.0-cm separation.
5. How many electrons would be required to have a total charge of 1.00 C on a sphere?
6. If two identical charges, 1.000 C each, are separated by a distance of 1.00 km, what is the force between them?
7. Two point charges are separated by 10.0 cm. If one charge is +20.00 μC and the other is –6.00 μC, what is the force between them?
8. The two point charges in the previous problem are allowed to touch each other and are again separated by 10.00 cm. Now what is the force between them?
9. Determine the electrostatic force of attraction between a proton and an electron that are separated by 5.00×10^{2} nm.
10. Find the force between two charged spheres 1.25 cm apart if the charge on one sphere is 2.50 μC and the charge on the other sphere is 1.75×10^{-8} C.
11. Two identical point charges are 3.00 cm apart. Find the charge on each of them if the force of repulsion is 4.00×10^{-7} N.
12. A charge of 4.0×10^{-5} C is attracted by a second charge with a force of 350 N when the separation is 10.0 cm. Calculate the size of the second charge.
13. Three particles are placed on a straight line. The left particle has a charge of $+4.6 \times 10^{-6}$ C, the middle particle has a charge of -2.3×10^{-6} C, and the right particle has a charge of -2.3×10^{-6} C. The left particle is 12 cm from the middle particle and the right particle is 24 cm from the middle particle. Find the total force on the middle particle.
14. The left particle in the problem above is moved directly above the middle particle, still 12 cm away. Find the force on the middle particle.

Chapter 21

1. How strong would an electric field have to be to produce a force of 1.00 N if the charge was 1.000×10^{3} μC?
2. A positive charge of 7.0 mC experiences a 5.6×10^{-2} N force when placed in an electric field. What is the size of the electric field intensity?
3. A positive test charge of 6.5×10^{-6} C experiences a force of 4.5×10^{-5} N. What is the magnitude of the electric field intensity?
4. A charge experiences a force of 3.0×10^{-3} N in an electric field of intensity 2.0 N/C. What is the magnitude of the charge?
5. What is the size of the force on an electron when the electron is in a uniform electric field that has an intensity of 1.000×10^{3} N/C?

6. Sketch the electric field lines around a -1.0-μC charge.

7. It takes 8.00 mJ to move a charge of 4.00 μC from point **A** to point **C** in an electric field. What is the potential difference between the two points?

8. How much work is required to move a positive charge of 2.5 μC between two points that have a potential difference of 60.0 V?

9. A cloud has a potential difference relative to a tree of 9.00×10^2 MV. During a lightning storm, a charge of 1.00×10^2 C travels through this potential difference. How much work is done on this charge?

10. A constant electric field of 750 N/C is between a set of parallel plates. What is the potential difference between the parallel plates if they are 1.5 cm apart?

11. A spark will jump between two people if the electric field exceeds 4.0×10^6 V/m. You shuffle across a rug and a spark jumps when you put your finger 0.15 cm from another person's arm. Calculate the potential difference between your body and the other person's arm.

12. A potential difference of 0.90 V exists from one side to the other side of a cell membrane that is 5.0 nm thick. What is the electric field across the membrane?

13. An oil drop having a charge of 8.0×10^{-19} C is suspended between two charged parallel plates. The plates are separated by a distance of 8.0 mm, and there is a potential difference of 1200 V between the plates. What is the weight of the suspended oil drop?

14. A capacitor accumulates 4.0 μC on each plate when the potential difference between the plates is 100 V. What is the capacitance of the capacitor?

15. What is the voltage across a capacitor with a charge of 6.0 nC and a capacitance 7.0 pF?

16. How large is the charge accumulated on one of the plates of a 30.0-μF capacitor when the potential difference between the plates is 120 V?

Chapter 22

1. How many amperes of current are in a wire through which 1.00×10^{18} electrons flow per second?

2. A current of 5.00 A was in a copper wire for 20.0 s. How many coulombs of charge flowed through the wire in this time?

3. What power is supplied to a motor that operates on a 120-V line and draws 1.50 A of current?

4. An electric lamp is connected to a 110-V source. If the current through the lamp is 0.75 A, what is the power consumption of the lamp?

5. A lamp is labeled 6.0 V and 12 W.
   a. What is the current through the lamp when it is operating?
   b. How much energy is supplied to the lamp in 1.000×10^3 s?

6. There is a current of 3.00 A through a resistor when it is connected to a 12.0-V battery. What is the resistance of the resistor?

7. A small lamp is designed to draw a current of 3.00×10^2 mA in a 6.00-V circuit. What is the resistance of the lamp?

8. What potential difference is required if you want a current of 8.00 mA in a load having a resistance of 50.0 Ω?

9. In common metals, resistance increases as the temperature increases. An electric toaster has a resistance of 12.0 Ω when hot.
   - **a.** What will be the current through it when it is connected to 125 V?
   - **b.** When the toaster is first turned on, will the current be more or less than during operation?

10. The resistance of a lamp is 230 Ω. The voltage is 115 V when the lamp is turned on.
   - **a.** What is the current in the lamp?
   - **b.** If the voltage rises to 120 V, what is the current?

11. What should the resistance of the lamp in part **a** of the previous problem be if the lamp is to draw the same current, but in a 230-V circuit?

12. A 110-W lamp draws 0.909 A. What is the lamp's resistance?

13. Each coil in a resistance box is capable of dissipating heat at the rate of 4.00 W. What is the maximum current that should be allowed through a coil to avoid overheating if the coil has a resistance of
   - **a.** 2.00 Ω?
   - **b.** 20.00 Ω?

14. What is the power supplied to a lamp that is operated by a battery having a 12-V potential difference across its terminals when the resistance of the lamp is 6.0 Ω?

15. How much does it cost to run a 2.00-W clock for one year (365.25 days) if it costs 3.53 cents/kWh?

16. A small electric furnace that expends 2.00 kW of power is connected across a potential difference of 120.0 V.
   - **a.** What is the current in the circuit?
   - **b.** What is the resistance of the furnace?
   - **c.** What is the cost of operating the furnace for 24.0 h at 7.00 cents/kWh?

Chapter 23

1. The load across a 50.0-V battery consists of a series combination of two lamps with resistances of 125 Ω and 225 Ω.
   - **a.** Find the total resistance of the circuit.
   - **b.** Find the current in the circuit.
   - **c.** Find the potential difference across the 125-Ω lamp.

2. The load across a 12-V battery consists of a series combination of three resistances that are 15 Ω, 21 Ω, and 24 Ω, respectively.
   - **a.** Draw the circuit diagram.
   - **b.** What is the total resistance of the load?
   - **c.** What is the magnitude of the circuit current?

3. The load across a 12-V battery consists of a series combination of three resistances R_1, R_2, and R_3. R_1 is 210 Ω, R_2 is 350 Ω, and R_3 is 120 Ω.
   - **a.** Find the equivalent resistance of the circuit.
   - **b.** Find the current in the circuit.
   - **c.** Find the potential difference across R_3.

4. The load across a 40.0-V battery consists of a series combination of three resistances R_1, R_2, and R_3. R_1 is 240 Ω and R_3 is 120 Ω. The potential difference across R_1 is 24 V.
   - **a.** Find the current in the circuit.
   - **b.** Find the equivalent resistance of the circuit.
   - **c.** Find the resistance of R_2.

5. Wes is designing a voltage divider using a 12.0-V battery and a 100.0-Ω resistor as R_2. What resistor should be used as R_1 if the output voltage is 4.75 V?

6. Two resistances, one 12 Ω and the other 18 Ω, are connected in parallel. What is the equivalent resistance of the parallel combination?

7. Three resistances of 12 Ω each are connected in parallel. What is the equivalent resistance?

8. Two resistances, one 62 Ω and the other 88 Ω, are connected in parallel. The resistors are then connected to a 12-V battery.
   - **a.** What is the equivalent resistance of the parallel combination?
   - **b.** What is the current through each resistor?

9. A 35-Ω, 55-Ω, and 85-Ω resistor are connected in parallel. The resistors are then connected to a 35-V battery.
   - **a.** What is the equivalent resistance of the parallel combination?
   - **b.** What is the current through each resistor?

10. A 110-V household circuit that contains an 1800-W microwave, a 1000-W toaster, and an 800-W coffeemaker is connected to a 20-A fuse. Will the fuse melt if the microwave and the coffeemaker are both on?

11. Resistors R_1, R_2, and R_3 have resistances of 15.0 Ω, 9.0 Ω, and 8.0 Ω respectively. R_1 and R_2 are connected in series, and their combination is in parallel with R_3 to form a load across a 6.0-V battery.
    - **a.** Draw the circuit diagram.
    - **b.** What is the total resistance of the load?
    - **c.** What is the magnitude of the circuit current?
    - **d.** What is the current in R_3?
    - **e.** What is the potential difference across R_2?

12. A 15.0-Ω resistor is connected in series to a 120-V generator and two 10.0-Ω resistors that are connected in parallel to each other.
    - **a.** Draw the circuit diagram.
    - **b.** What is the total resistance of the load?
    - **c.** What is the magnitude of the circuit current?
    - **d.** What is the current in one of the 10.0-Ω resistors?
    - **e.** What is the potential difference across the 15.0-Ω resistor?

13. How would you change the resistance of a voltmeter to allow the voltmeter to measure a larger potential difference?

14. How would you change the shunt in an ammeter to allow the ammeter to measure a larger current?

15. An ohmmeter is made by connecting a 6.0-V battery in series with an adjustable resistor and an ideal ammeter. The ammeter deflects full-scale with a current of 1.0 mA. The two leads are touched together and the resistance is adjusted so 1.0-mA current flows.
    - **a.** What is the resistance of the adjustable resistor?
    - **b.** The leads are now connected to an unknown resistance. What external resistance would produce a reading of 0.50 mA, half full-scale?
    - **c.** What external resistance would produce a reading of 0.25 mA, quarter-scale?
    - **d.** What external resistance would produce a reading of 0.75 mA, three-quarter full-scale?

Appendix B

Chapter 24

1. Assume the current in the wire shown in **Figure 24–24** on page 576 goes in the opposite direction. Copy the wire segment and sketch the new magnetic field the current generated.
2. Assume the current shown in **Figure 24–25** on page 577 goes into the page instead of out of the page. Copy the figure with the new current and sketch the magnetic field.
3. What happens to the strength of a magnetic field around a wire if the current in the wire is doubled?
4. What happens to the magnetic field inside the coil of **Figure 24–26** on page 577 if the current shown was reversed?
5. What is the direction of the force on a current-carrying wire in a magnetic field if the current is toward the left on a page and the magnetic field is down the page?
6. A 0.25 m long wire is carrying a 1.25 A current while the wire is perpendicular to a 0.35-T magnetic field. What is the force on the wire?
7. A 3.0-cm long wire lies perpendicular to a magnetic field with a magnetic induction of 0.40 T. Calculate the force on the wire if the current in the wire is 5.0 A.
8. What is the force on a 3.5-m long wire that is carrying a 12-A current if the wire is perpendicular to Earth's magnetic field?
9. A wire, 0.50 m long, is put into a uniform magnetic field. The force exerted upon the wire when the current in the wire is 20 A is 3.0 N. What is the magnetic induction of the field acting upon the wire?
10. What is the size of the current in a 35-cm long wire that is perpendicular to a magnetic field of 0.085 T if the force on the wire is 125 mN?
11. A galvanometer has a full-scale deflection when the current is 50.0 μA. If the galvanometer has a resistance of 1.0 kΩ, what should the resistance of the multiplier resistor be to make a voltmeter with a full-scale deflection of 30.0 V?
12. A charged particle is moving to the right in a magnetic field whose direction is up the page. Show by diagram the direction of the force exerted by the magnetic field upon the particle if the particle is a positive proton.
13. An electron beam moving horizontally away from you is deflected toward the right after passing through a certain region of space that contains a constant magnetic field. What is the direction of the magnetic field?
14. A beam of electrons moving left at 3.0×10^7 m/s passes at right angles to a uniform magnetic field that is down and in which the magnetic induction is 2.0×10^{-4} T. What force acts upon each electron in the beam?
15. The electrons in a beam in a cathode ray tube are moving horizontally at 5.0×10^7 m/s and pass through a vertical magnetic field of 3.5×10^{-3} T. What size force acts on each of the electrons in the beam?
16. An ion of oxygen having 2 elementary negative electric charges is moving at right angles to a uniform magnetic field for which $B = 0.30$ T. If its velocity is 2.0×10^7 m/s, what force is acting on the ion?

Chapter 25

1. A north-south wire is moved toward the east through a magnetic field that is pointing down, into Earth. What is the direction of the induced current?
2. A wire, 1.0 m long, is moved at right angles to Earth's magnetic field where the magnetic induction is 5.0×10^{-5} T at a speed of 4.0 m/s. What is the *EMF* induced in the wire?
3. An *EMF* of 2.0 mV is induced in a wire 0.10 m long when it is moving perpendicularly across a uniform magnetic field at a velocity of 4.0 m/s. What is the magnetic induction of the field?
4. With what speed must a 0.20 m long wire cut across a magnetic field for which B is 2.5 T if it is to have an *EMF* of 10 V induced in it?
5. At what speed must a wire conductor 50 cm long be moved at right angles to a magnetic field of induction 0.20 T to induce an *EMF* of 1.0 V in it?
6. A wire, 0.40 m long, cuts perpendicularly across a magnetic field for which B is 2.0 T at a velocity of 8.0 m/s.
   a. What *EMF* is induced in the wire?
   b. If the wire is in a circuit having a resistance of 6.4 Ω, what is the size of the current through the wire?
7. A coil of wire, which has a total length of 7.50 m, is moved perpendicularly to Earth's magnetic field at 5.50 m/s. What is the size of the current in the wire if the total resistance of the wire is 5.0×10^{-2} mΩ?
8. A house lighting circuit is rated at 120 V effective voltage. What is the peak voltage that can be expected in this circuit?
9. A toaster draws 2.5 A of alternating current. What is the peak current through this toaster?
10. The insulation of a capacitor will break down if the instantaneous voltage exceeds 575 V. What is the largest effective alternating voltage that may be applied to the capacitor?
11. A magnetic circuit breaker will open its circuit if the instantaneous current reaches 21.25 A. What is the largest effective current the circuit will carry?
12. The peak value of the alternating voltage applied to a 144-Ω resistor is 1.00×10^2 V. What power must the resistor be able to handle?
13. Shawn drops a magnet, S-pole down, through a vertical copper pipe.
    a. What is the direction of the induced current in the copper pipe as the bottom of the magnet passes?
    b. The induced current produces a magnetic field. What is the direction of the induced magnetic field?
14. The electricity received at an electrical substation has a potential difference of 240 000 V. What should the ratio of the turns of the step-down transformer be to have an output of 440 V?
15. The CRT in a television uses a step-up transformer to change 120 V to 48 000 V. The secondary side of the transformer has 20 000 turns and an output of 1.0 mA.
    a. How many turns does the primary side have?
    b. What is the input current?

Extra Practice Problems

Chapter 26

1. A beam of electrons travels through a set of crossed electric and magnetic fields. What is the speed of the electrons if the magnetic field is 85 mT and the electric field is 6.5×10^4 N/C?
2. Electrons, moving at 8.5×10^7 m/s, pass through crossed magnetic and electric fields undeflected. What is the size of the magnetic field if the electric field is 4.0×10^4 N/C?
3. What effect does increasing the magnetic induction of the field have on the radius of the particle's path for a given particle moving at a fixed speed?
4. An electron is moving at 2.0×10^8 m/s in a constant magnetic field. How strong should the magnetic field be to keep the electron moving in a circle of radius 0.50 m?
5. A positively charged ion, having two elementary charges and a velocity of 5.0×10^7 m/s, is moving across a magnetic field for which $B = 4.0$ T. If the mass of the ion is 6.8×10^{-27} kg, what is the radius of the circular path it travels?
6. A beam of electrons, moving at 2.0×10^8 m/s, passes at right angles to uniform magnetic field of 41 mT. What is the radius of the circular path in which this beam will travel through the magnetic field?
7. An unknown particle is accelerated by a potential difference of 1.50×10^2 V. The particle then enters a magnetic field of 50.0 mT, and follows a curved path with a radius of 9.80 cm. What is the ratio of q/m?
8. A beam of doubly ionized oxygen atoms is accelerated by a potential difference of 232 V. The oxygen then enters a magnetic field of 75.0 mT, and follows a curved path with a radius of 8.3 cm. What is the mass of the oxygen atom?
9. If the atomic mass unit is equal to 1.67×10^{-27} kg, how many atomic mass units are in the oxygen atom in the previous problem?
10. A hydrogen ion is accelerated through an accelerating potential of 1.00×10^2 V and then through a magnetic field of 50.0 mT to standardize the mass spectrometer. What is the radius of curvature if the mass of the ion is 1.67×10^{-27} kg?
11. What is the change in the radius of curvature if a doubly ionized neon atom, mass $= 3.34 \times 10^{-26}$ kg, is sent through the mass spectrometer in the previous problem?
12. An FM radio station broadcasts on a frequency of 94.5 MHz. What is the antenna length that would give the best reception for this radio station?

Chapter 27

1. Consider an incandescent light bulb on a dimmer control. What happens to the color of the light given off by the bulb as the dimmer control is turned down?
2. What would the change in frequency of the vibration of an atom be according to Planck's theory if it gave off 5.44×10^{-19} J, while changing its value of n by 1?
3. What is the maximum kinetic energy of photoelectrons ejected from a metal that has a stopping potential of 3.8 V?

4. The stopping potential needed to return all the electrons ejected from a metal is 7.3 V. What is the maximum kinetic energy of the electrons in J?

5. What is the potential difference needed to stop photoelectrons that have a maximum kinetic energy of 8.0×10^{-19} J?

6. The threshold frequency of a certain metal is 8.0×10^{14} Hz. What is the work function of the metal?

7. If light with a frequency of 1.6×10^{15} Hz falls on the metal in the previous problem, what is the maximum kinetic energy of the photoelectrons?

8. The threshold frequency of a certain metal is 3.00×10^{14} Hz. What is the maximum kinetic energy of the ejected photoelectrons when the metal is illuminated by light with a wavelength of 6.50×10^{2} nm?

9. What is the momentum of a photon of violet light that has a wavelength of 4.00×10^{2} nm?

10. What is the momentum of a photon of red light that has a wavelength of 7.00×10^{2} nm?

11. What is the wavelength associated with an electron moving at 3.0×10^{6} m/s?

12. What velocity would an electron need to have a wavelength of 3.0×10^{-10} m associated with it?

13. An electron is accelerated across a potential difference of 5.0×10^{3} V in the CRT of a television.

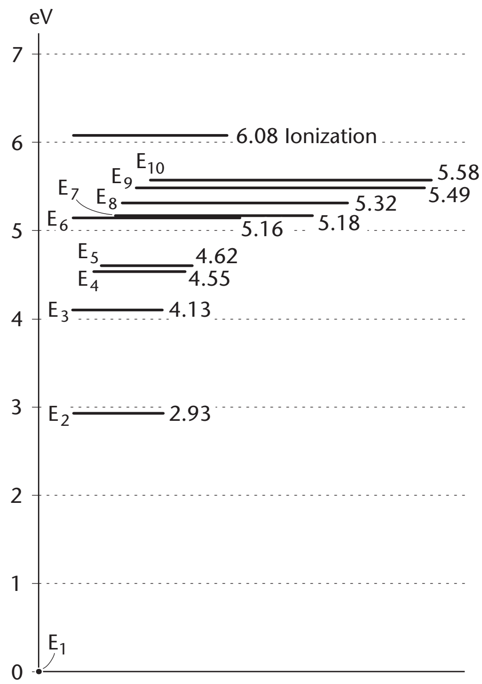
    a. What is the velocity of the electron if it started from rest?

    b. What is the wavelength associated with the electron?

Chapter 28

1. A calcium atom drops from 5.16 eV above the ground state to 2.93 eV above the ground state. What is the frequency of the photon emitted by the atom?

2. A calcium atom is in an excited state when the energy level is 2.93 eV, E_2, above the ground state. A photon of energy 1.20 eV strikes the calcium atom and is absorbed by it. To what energy level is the calcium atom raised? Refer to the diagram below.



Energy Level Diagram for Calcium Atom

3. A calcium atom is in an excited state at the E_6 energy level. How much energy is released when the atom dropped down to the E_2 energy level? Refer to the diagram above.

4. A photon of orange light, wavelength of 6.00×10^2 nm, enters a calcium atom in the E_6 excited state and ionizes the atom. What kinetic energy will the electron have as it is ejected from the atom?

5. Calculate the radius of the orbital associated with the energy level E_4 of the hydrogen atom.

6. Calculate the energy associated with the E_7 and the E_2 energy levels of the hydrogen atom.

7. Calculate the difference in energy levels in the previous problems.

8. What frequency photon is emitted from the hydrogen atom when the atom releases the energy found in the previous problem?

Chapter 29

1. An LED, light-emitting diode, produces infrared radiation, wavelength 800.0 nm, when an electron jumps from the conduction band to the valence band. Find the energy width of the forbidden gap in this diode.

2. How many free electrons exist in 1.00 cm^3 of lithium? Its density is 0.534 g/cm^3, atomic mass is 6.941 g/mole, and there is one free electron per atom.

3. The voltage drop across a diode is 0.70 V when it is connected in series to a 210-Ω resistor and a battery, and there is a 11-mA current. If the LED has an equivalent resistance of 70 Ω, what potential difference must be supplied by the battery?

4. What resistor would replace the 210-Ω resistor in the previous problem if the current was changed to 29 mA?

5. What would the new current in the previous problem be if the leads on the battery were reversed?

Chapter 30

1. What particles, and how many of each, make up an atom of $^{109}_{47}\text{Ag}$?

2. A calcium ion has 20 protons and 20 neutrons. Write its isotopic symbol.

3. What is the isotopic symbol of a zinc atom composed of 30 protons and 34 neutrons?

4. Write the complete nuclear equation for the alpha decay of $^{210}_{84}\text{Po}$.

5. Write the complete nuclear equation for the beta decay of $^{14}_{6}\text{C}$.

6. Complete the nuclear reaction: $^{225}_{89}\text{Ac} \rightarrow {}^{4}_{2}\text{He} + \underline{\quad}$

7. Complete the nuclear reaction: $^{227}_{88}\text{Ra} \rightarrow {}^{0}_{-1}\text{e} + \underline{\quad} + \underline{\quad}$

8. Complete the nuclear reaction: $^{65}_{29}\text{Cu} + {}^{1}_{0}\text{n} \rightarrow \underline{\quad} \rightarrow {}^{1}_{1}\text{p} + \underline{\quad}$

9. Complete the nuclear equation: $^{235}_{92}\text{U} + {}^{1}_{0}\text{n} \rightarrow {}^{96}_{40}\text{Zr} + 3({}^{1}_{0}\text{n}) + \underline{\quad}$

10. An isotope has a half-life of 3.0 days. What percent of the original material will be left after
    - **a.** 6.0 days?
    - **b.** 9.0 days?
    - **c.** 12 days?

11. $^{211}_{86}\text{Rn}$ has a half-life of 15 h. What fraction of a sample would be left after 60 h?

12. $^{209}_{84}\text{Po}$ has a half-life of 103 years. How long would it take for a 100-g sample to decay so only 3.1 g of Po-209 was left?

13. The positron, $^{0}_{+1}\text{e}$, is the antiparticle to the electron and is the particle ejected from the nucleus in some nuclear reactions. Complete the nuclear reaction: $^{17}_{9}\text{F} \rightarrow {}^{0}_{+1}\text{e} +$

14. Complete the nuclear reaction: $^{22}_{11}\text{Na} \rightarrow {}^{0}_{+1}\text{e} +$

15. Find the charge of a π^+ meson made of a *u* and *anti-d* quark pair.

16. Baryons are particles that are made of three quarks. Find the charge on each of the following baryons.

    a. neutron; *d*, *d*, *u* quark triplet

    b. antiproton; *anti-u*, *anti-u*, *anti-d* quark triplet

Chapter 31

1. The carbon isotope, $^{12}_{6}C$, has a nuclear mass of 12.000 000 u.

    a. What is the mass defect of this isotope?

    b. What is the binding energy of its nucleus?

2. The sulfur isotope, $^{32}_{16}S$, has a nuclear mass of 31.972 07 u.

    a. What is the mass defect of this isotope?

    b. What is the binding energy of its nucleus?

3. The sodium isotope, $^{22}_{11}Na$, has a nuclear mass of 21.994 44 u.

    a. What is the mass defect of this isotope?

    b. What is the binding energy of its nucleus?

    c. What is the binding energy per nucleon?

4. The binding energy for $^{7}_{3}Li$ is 39.25 MeV. Calculate the mass of the lithium-7 nucleus in atomic mass units.

5. Write the complete nuclear equation for the positron decay of $^{132}_{55}Cs$.

6. Complete the nuclear reaction:
$^{14}_{7}N + ^{1}_{0}n \rightarrow \_\_\_ \rightarrow ^{1}_{1}p + \_\_\_$

7. Complete the nuclear reaction:
$^{65}_{29}Cu + ^{1}_{0}n \rightarrow \_\_\_ \rightarrow ^{1}_{1}p + \_\_\_$

8. When a magnesium isotope, $^{24}_{12}Mg$, is bombarded with neutrons, it absorbs a neutron and then emits a proton. Write the complete nuclear equation for this reaction.

9. When oxygen-17 is bombarded by neutrons, it absorbs a neutron and then emits an alpha particle. The resulting nucleus is unstable and it will emit a beta particle. Write the complete nuclear equation for this reaction.

10. Complete the following fission reaction:
$^{239}_{94}Pu + ^{1}_{0}n \rightarrow ^{137}_{52}Te + 3(^{1}_{0}n) + \_\_\_$

11. Complete the following fission reaction:
$^{233}_{92}U + ^{1}_{0}n \rightarrow ^{134}_{55}Cs + 2(^{1}_{0}n) + \_\_\_$

12. Complete the following fission reaction:
$^{235}_{92}U + ^{1}_{0}n \rightarrow ^{90}_{38}Sr + 10(^{1}_{0}n) + \_\_\_$

13. Strontium-90 has a mass of 89.907 747 u, xenon-136 has a mass of 135.907 221 u, and uranium-235 has a mass of 235.043 915 u.

    a. Compute the mass defect in the previous problem.

    b. Compute the amount of energy released.

14. One of the simplest fusion reactions involves the production of deuterium, $^{2}_{1}H$ (2.014 102 u), from a neutron and a proton. Write the complete fusion reaction and find the amount of energy released.

15. The fusion reactions most likely to succeed in a fusion reactor are listed below. Complete each fusion reaction.

    a. $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{1}H + \_\_\_$

    b. $^{2}_{1}H + ^{2}_{1}H \rightarrow ^{3}_{2}He + \_\_\_$

    c. $^{2}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + \_\_\_$

    d. $^{3}_{1}H + ^{3}_{1}H \rightarrow ^{4}_{2}He + 2\ \_\_\_$

Extra Practice Problems