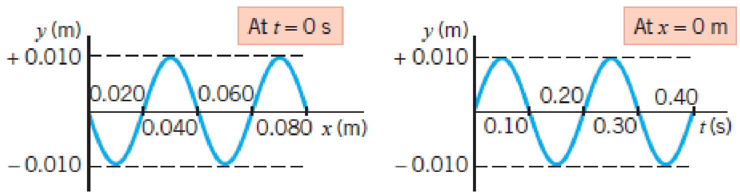
Homework Problem (Physics, Edition 8)

Chapter 16

14. The mass of a string is 5.0×10^{-3} kg, and it is stretched so that the tension in it is 180 N. A transverse wave traveling on this string has a frequency of 260 Hz and a wavelength of 0.60 m. What is the length of the string?

26. The drawing shows two graphs that represent a transverse wave on a string. The wave is moving in the +x direction. Using the information contained in these graphs, write the mathematical expression (similar to Equation 16.3 or 16.4) for the wave.

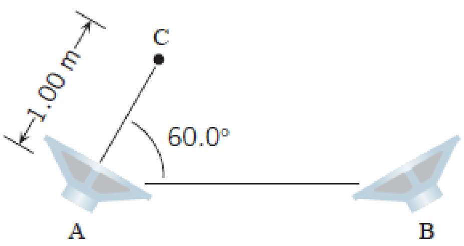


29. The tension in a string is 15 N, and its linear density is 0.85 kg/m. A wave on the string travels toward the x direction; it has an amplitude of 3.6 cm and a frequency of 12 Hz. What are the (a) speed and (b) wavelength of the wave? (c) Write down a mathematical expression (like Equation 16.3 or 16.4) for the wave, substituting numbers for the variables A, f, and λ.

28. A transverse wave is traveling on a string. The displacement of a particle from its equilibrium position is given by $y = (0.021\text{ m})\,sin(25t - 2.0x)$. Note that the phase angle $25t - 2.0x$ is in radians, t is in seconds, and x is in meters. The linear density of the string is 1.6×10^{-2} kg/m. What is the tension in the string?

Chapter 17

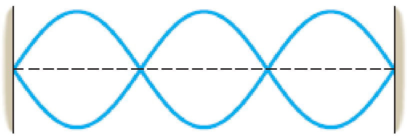
8. Suppose that the two speakers in Figure 17.7 are separated by 2.50 m and are vibrating exactly out of phase at a frequency of 429 Hz. The speed of sound is 343 m/s. Does the observer at C observe constructive or destructive interference when his distance from speaker B is (a) 1.15 m and (b) 2.00 m?



7. The drawing shows a loudspeaker A and point C, where a listener is positioned. A second loudspeaker B is located somewhere to the right of A. Both speakers vibrate in phase and are playing a 68.6-Hz tone. The speed of sound is 343 m/s. What is the closest to speaker A that speaker B can be located, so that the listener hears no sound.

29. The approach to solving this problem is similar to that taken in Multiple-Concept Example 4. On a cello, the string with the largest linear density is the C string. This string produces a fundamental frequency of 65.4 Hz and has a length of 0.800 m between the two fixed ends. Find the tension in the string.

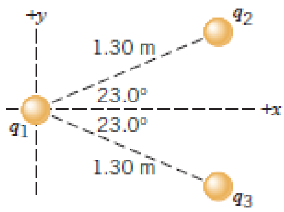
33. A string has a linear density of 8.5×10^{-3} kg/m and is under a tension of 280 N. The string is 1.8 m long, is fixed at both ends, and is vibrating in the standing wave pattern shown in the drawing. Determine the **(a)** speed, **(b)** wavelength, and **(c)** frequency of the traveling waves that make up the standing wave.



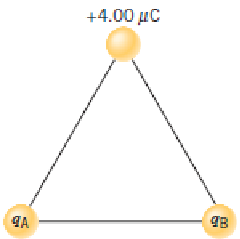
41. A tube of air is open at only one end and has a length of 1.5 m. This tube sustains a standing wave at its third harmonic. What is the distance between one node and the adjacent antinode?

Chapter 18

21. Interactive LearningWare 18.2 at www.wiley.com/college/cutnell provides one approach to solving problems such as this one. The drawing shows three point charges fixed in place. The charge at the coordinate origin has a value of q_1=+8.00 μC; the other two charges have identical magnitudes, but opposite signs: q_2=−5.00 μC and q_3= +5.00 μC. **(a)** Determine the net force (magnitude and direction) exerted on q_1 by the other two charges. **(b)** If q_1 had a mass of 1.50 g and it were free to move, what would be its acceleration?



72. The drawing shows an equilateral triangle, each side of which has a length of 2.00 cm. Point charges are fixed to each corner, as shown. The 4.00 _C charge experiences a net force due to the charges q_A and q_B. This net force points vertically downward and has a magnitude of 405 N. Determine the magnitudes and algebraic signs of the charges q_A and q_B

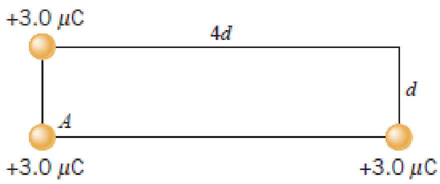


35. Two charges, −16 and +4.0 μC, are fixed in place and separated by 3.0 m. **(a)** At what spot along a line through the charges is the net electric field zero? Locate this spot relative to the positive charge. *(Hint: The spot does not necessarily lie between the two charges.)* **(b)** What would be the force on a charge of +14 μC placed at this spot?

37. Two charges are placed on the *x* axis. One of the charges (q_1= +8.5μC) is at x_1=+3.0 cm and the other (q_2= −21 μC) is at x_1=+9.0 cm. Find the net electric field (magnitude and direction) at **(a)** x = 0 cm and **(b)** x= +6.0 cm.

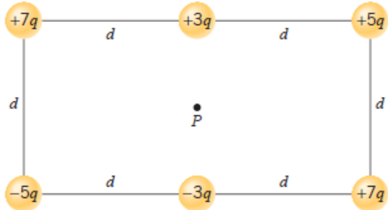
71. Two point charges are located along the *x* axis: q_1= +6.0 μC at x_1= +4.0 cm, and q_2=+6.0 μC at x_2= −4.0 cm. Two other charges are located on the *y* axis: q_3= +3.0 μC at y_3= +5.0 cm, and q_4= −8.0 μC at y_4= −7.0 cm. Find the net electric field (magnitude and direction) at the origin.

25. In the rectangle in the drawing, a charge is to be placed at the empty corner to make the net force on the charge at corner *A* point along the vertical direction. What charge (magnitude and algebraic sign) must be placed at the empty corner?



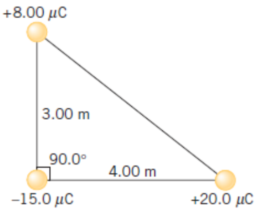
Chapter 19

19. The drawing shows six point charges arranged in a rectangle. The value of q is 9.0 μC, and the distance d is 0.13 m. Find the total electric potential at location P, which is at the center of the rectangle.

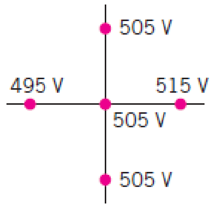


21. Identical +1.8 μC charges are fixed to adjacent corners of a square. What charge (magnitude and algebraic sign) should be fixed to one of the empty corners, so that the total electric potential at the remaining empty corner is 0 V?

27. Determine the electric potential energy for the array of three charges shown in the drawing, relative to its value when the charges are infinitely far away.



39. The drawing shows the potential at five points on a set of axes. Each of the four outer points is 6.0×10^{-3} m from the point at the origin. From the data shown, find the magnitude and direction of the electric field in the vicinity of the origin.



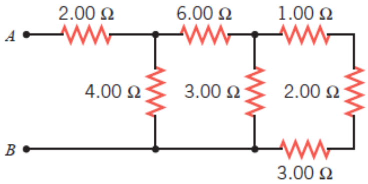
Chapter 20

6. The resistance of a bagel toaster is 14 Ω. To prepare a bagel, the toaster is operated for one minute from a 120-V outlet. How much energy is delivered toΩ the toaster?

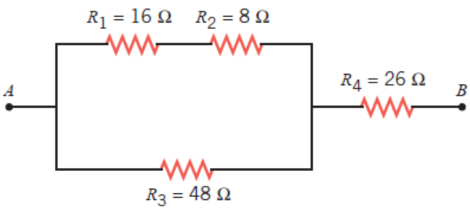
43. Three resistors, 25, 45, and 75 Ω are connected in series, and 0.51-A current passes through them. What are **(a)** the equivalent resistance and **(b)** the potential difference across the three resistors?

55. Two resistors, 42.0 and 64.0 Ω, are connected in parallel. The current through the 64.0-Ω resistor is 3.00 A. **(a)** Determine the current in the other resistor. **(b)** What is the total power supplied to the two resistors?

64. Find the equivalent resistance between points A and B in the drawing.



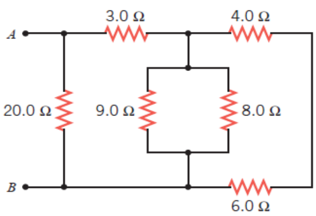
Problem 64



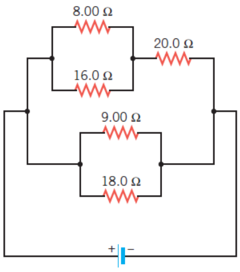
Problem 66

66. Find the equivalent resistance between the points A and B in the drawing.

65. Determine the equivalent resistance between the points A and B for the group of resistors in the drawing.

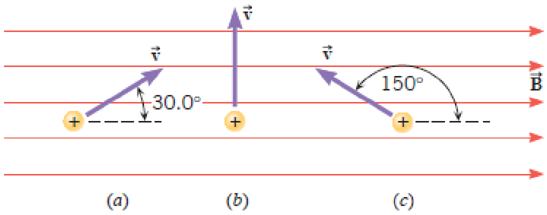


71. The current in the 8.00-Ω resistor in the drawing is 0.500 A. Find the current in **(a)** the 20.0-_ resistor and in **(b)** the 9.00-Ω resistor.



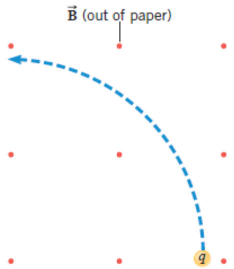
Chapter 21

1. A particle with a charge of +8.4 μC and a speed of 45 m/s enters a uniform magnetic field whose magnitude is 0.30 T. For each of the three cases in the drawing, find the magnitude and direction of the magnetic force on the particle.

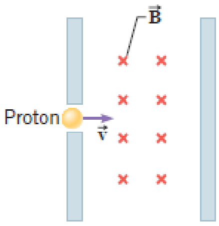


7. A charge is moving perpendicular to a magnetic field and experiences a force whose magnitude is 2.7×10^{-3} N If this same charge were to move at the same speed and the angle between its velocity and the same magnetic field were 38°, what would be the magnitude of the magnetic force that the charge would experience?

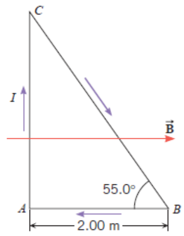
15. A charged particle enters a uniform magnetic field and follows the circular path shown in the drawing. **(a)** Is the particle positively or negatively charged? Why? **(b)** The particle's speed is 140 m/s, the magnitude of the magnetic field is 0.48 T, and the radius of the path is 960 m. Determine the mass of the particle, given that its charge has a magnitude of 8.2×10^{-4} C.



23. Consult **Interactive Solution 21.23** at **www.wiley.com/college/cutnell** to review a model for solving this problem. A proton with a speed of 8.2×10^{6} m/s is shot into a region between two plates that are separated by a distance of 0.23 m. As the drawing shows, a magnetic field exists between the plates, and it is perpendicular to the velocity of the proton. What must be the magnitude of the magnetic field so the proton just misses colliding with the opposite plate?



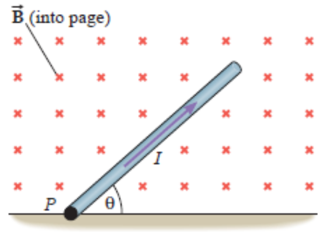
Problem 23



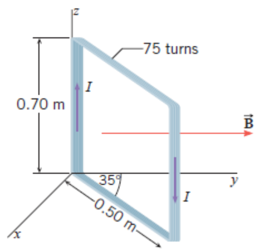
Problem 78

78. The triangular loop of wire shown in the drawing carries a current of I = 4.70 A. A uniform magnetic field is directed parallel to side AB of the triangle and has a magnitude of 1.80 T. **(a)** Find the magnitude and direction of the magnetic force exerted on each side of the triangle. **(b)** Determine the magnitude of the net force exerted on the triangle.

39. Consult **Interactive Solution 21.39** at **www.wiley.com/college/cutnell** to explore a model for solving this problem. The drawing shows a thin, uniform rod that has a length of 0.45 m and a mass of 0.094 kg. This rod lies in the plane of the paper and is attached to the floor by a hinge at point *P*. A uniform magnetic field of 0.36 T is directed perpendicularly into the plane of the paper. There is a current I = 4.1 A in the rod, which does not rotate clockwise or counterclockwise. Find the angle θ *(Hint: The magnetic force may be taken to act at the center of gravity.)*

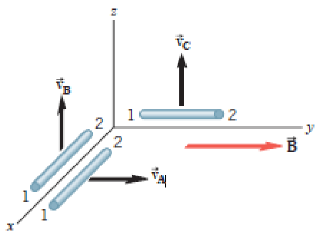


47. The rectangular loop in the drawing consists of 75 turns and carries a current of I=4.4 A. A 1.8-T magnetic field is directed along the +y axis. The loop is free to rotate about the z axis. **(a)**Determine the magnitude of the net torque exerted on the loop and **(b)** state whether the 35° angle will increase or decrease.

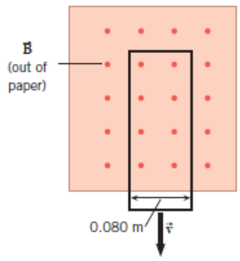


Chapter 22

5. The drawing shows three identical rods (A, B, and C) moving in different planes. A constant magnetic field of magnitude 0.45 T is directed along the +y axis. The length of each rod is L = 1.3 m, and the speeds are the same, $v_A = v_B = v_C$ = 2.7 m/s. For each rod, find the magnitude of the motional emf, and indicate which end (1 or 2) of the rod is positive.



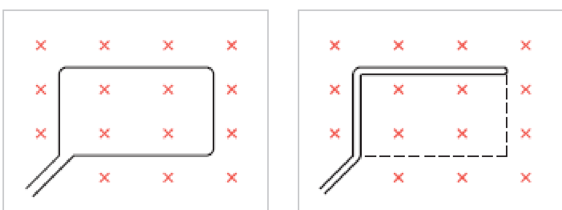
Problem 5



Problem 16

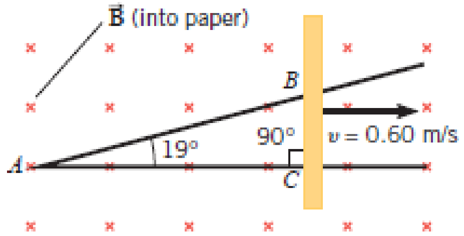
16. A long, narrow, rectangular loop of wire is moving toward the bottom of the page with a speed of 0.020 m/s (see the drawing). The loop is leaving a region in which a 2.4-T magnetic field exists; the magnetic field outside this region is zero. During a time of 2.0 s, what is the magnitude of the *change* in the magnetic flux?

72. A rectangular loop of wire with sides 0.20 and 0.35 m lies in a plane perpendicular to a constant magnetic field (see part *a* of the drawing). The magnetic field has a magnitude of 0.65 T and is directed parallel to the normal of the loop's surface. In a time of 0.18 s, onehalf of the loop is then folded back onto the other half, as indicated in part *b* of the drawing. Determine the magnitude of the average emf induced in the loop.

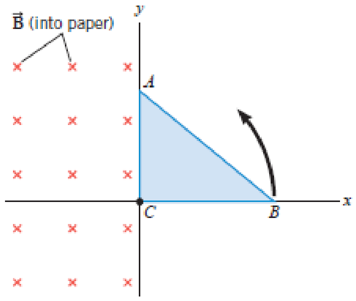


(*a*) (*b*)

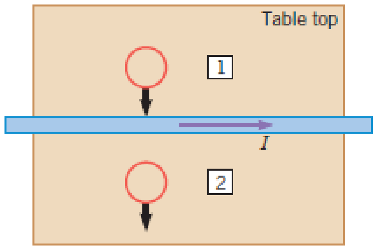
77. Interactive Solution 22.77 at **www.wiley.com/college/cutnell** offers some help for this problem. A copper rod is sliding on two conducting rails that make an angle of 19° with respect to each other, as in the drawing. The rod is moving to the right with a constant speed of 0.60 m/s. A 0.38-T uniform magnetic field is perpendicular to the plane of the paper. Determine the magnitude of the average emf induced in the triangle *ABC* during the 6.0-s period after the rod has passed point *A*.



36. The drawing shows that a uniform magnetic field is directed perpendicularly into the plane of the paper and fills the entire region to the left of the *y* axis. There is no magnetic field to the right of the *y* axis. A rigid right triangle *ABC* is made of copper wire. The triangle rotates counterclockwise about the origin at point *C*. What is the direction (clockwise or counterclockwise) of the induced current when the triangle is crossing **(a)** the +*y* axis, **(b)** the −*x* axis, **(c)** the –*y* axis, and **(d)** the +*x* axis? For each case, justify your answer.



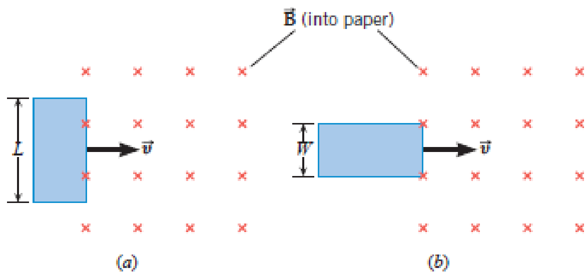
Problem 36



Problem 35

35. Review Conceptual Example 9 as an aid in understanding this problem. A long, straight wire lies on a table and carries a current *I*. As the drawing shows, a small circular loop of wire is pushed across the top of the table from position 1 to position 2. Determine the direction of the induced current, clockwise or counterclockwise, as the loop moves past **(a)** position 1 and **(b)** position 2. Justify your answers.

25. Parts *a* and *b* of the drawing show the same uniform and constant (in time) magnetic field $\vec{B}$ directed perpendicularly into the paper over a rectangular region. Outside this region, there is no field. Also shown is a rectangular coil (one turn), which lies in the plane of the paper. In part *a* the long side of the coil (length = *L*) is just at the edge of the field region, while in part *b* the short side (width = *W*) is just at the edge. It is known that *L*/*W* = 3.0. In both parts of the drawing the coil is pushed into the field with the same velocity $\vec{v}$ until it is completely within the field region. The magnitude of the average emf induced in the coil in part *a* is 0.15 V. What is its magnitude in part *b*?



Chapter 23

2. Two identical capacitors are connected in parallel to an ac generator that has a frequency of 610 Hz and produces a voltage of 24 V. The current in the circuit is 0.16 A. What is the capacitance of each capacitor?

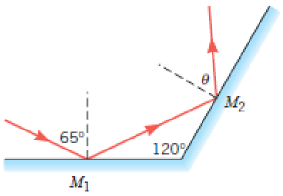
14. An ac generator has a frequency of 7.5 kHz and a voltage of 39 V. When an inductor is connected between the terminals of this generator, the current in the inductor is 42 mA. What is the inductance of the inductor?

21. Multiple-Concept Example 3 reviews some of the basic ideas that are pertinent to this problem. A circuit consists of a 215-Ω resistor and a 0.200-H inductor. These two elements are connected in series across a generator that has a frequency of 106 Hz and a voltage of 234 V. **(a)** What is the current in the circuit? **(b)** Determine the phase angle between the current and the voltage of the generator.

Chapter 25

4. Suppose that you are walking perpendicularly with a velocity of +0.90 m/s toward a stationary plane mirror. What is the velocity of your image relative to you? The direction in which you walk is the positive direction.

5. Two plane mirrors are separated by 120°, as the drawing illustrates. If a ray strikes mirror M_1 at a 65° angle of incidence, at what angle θ does it leave mirror M_2?



Problem 5

23. A mirror produces an image that is located 34.0 cm behind the mirror when the object is located 7.50 cm in front of the mirror. What is the focal length of the mirror, and is the mirror concave or convex?

37. The image behind a convex mirror (radius of curvature = 68 cm) is located 22 cm from the mirror. **(a)** Where is the object located and **(b)** what is the magnification of the mirror? Determine whether the image is **(c)** upright or inverted and **(d)** larger or smaller than the object.

40. A concave mirror has a focal length of 12 cm. This mirror forms an image located 36 cm in front of the mirror. What is the magnification of the mirror?

38. A concave mirror (f = 45 cm) produces an image whose distance from the mirror is one-third the object distance. Determine **(a)** the object distance and **(b)** the (positive) image distance.

Chapter 26

12. What type of single lens produces a virtual image that is inverted with respect to the object? **(a)** Both a converging and a diverging lens can produce such an image. **(b)** Neither a converging nor a diverging lens produces such an image. **(c)** A converging lens **(d)** A diverging lens.

20. Which one of the five choices below best completes the following statement? The fact that the refractive index depends on the wavelength of light is the cause of __________. **(a)** dispersion **(b)** chromatic aberration **(c)** spherical aberration **(d)** dispersion and chromatic aberration **(e)** spherical aberration and chromatic aberration

107. **Concept Simulation 26.1** at **www.wiley.com/college/cutnell** illustrates the concepts that are pertinent to this problem. A ray of light is traveling in glass and strikes a glass–liquid interface. The angle of incidence is 58.0°, and the index of refraction of glass is n = 1.50. **(a)** What must be the index of refraction of the liquid so that the direction of the light entering the liquid is not changed? **(b)** What is the largest index of refraction that the liquid can have, so that none of the light is transmitted into the liquid and all of it is reflected back into the glass?

3. The refractive indices of materials A and B have a ratio of n_A/n_B = 1.33. The speed of light in material A is 1.25 $\times 10^8$ m/s. What is the speed of light in material B?

Chapter 27

55. In a Young's double-slit experiment, the wavelength of the light used is 520 nm (in vacuum), and the separation between the slits is 1.4 $\times 10^{-6}$ m. Determine the angle that locates **(a)** the dark fringe for which m = 0, **(b)** the bright fringe for which m = 1, **(c)** the dark fringe for which m = 1, and **(d)** the bright fringe for which m = 2.

9. Refer to **Interactive Solution 27.9** at **www.wiley.com/college/cutnell** for help in solving this problem. In a Young's double-slit experiment the separation y between the second-order bright fringe and the central bright fringe on a flat screen is 0.0180 m when the light has a wavelength of 425 nm. Assume that the angles that locate the fringes on the screen are small enough so that $\sin\theta \approx \tan\theta$. Find the separation y when the light has a wavelength of 585 nm.

25. A diffraction pattern forms when light passes through a single slit. The wavelength of the light is 675 nm. Determine the angle that locates the first dark fringe when the width of the slit is **(a)** 1.8 $\times 10^{-4}$ m m and **(b)** 1.8 $\times$ 10^{-6} m .

27. A flat screen is located 0.60 m away from a single slit. Light with a wavelength of 510 nm (in vacuum) shines through the slit and produces a diffraction pattern. The width of the central bright fringe on the screen is 0.050 m. What is the width of the slit?

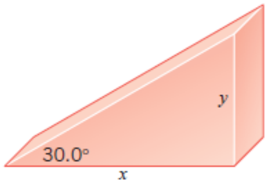
32. In a single-slit diffraction pattern, the central fringe is 450 times as wide as the slit. The screen is 18 000 times farther from the slit than the slit is wide. What is the ratio λ/W, where λ is the wavelength of the light shining through the slit and W is the width of the slit? Assume that the angle that locates a dark fringe on the screen is small, so that $\sin\theta \approx \tan\theta$.

Chapter 28

2. A particle known as a pion lives for a short time before breaking apart into other particles. Suppose that a pion is moving at a speed of 0.990c, and an observer who is stationary in a laboratory measures the pion's lifetime to be 3.5 $\times 10^{-8}$ s. **(a)** What is the lifetime according to a hypothetical person who is riding along with the pion? **(b)** According to this hypothetical person, how far does the laboratory move before the pion breaks apart?

43. Two spaceships A and B are exploring a new planet. Relative to this planet, spaceship A has a speed of 0.60*c*, and spaceship B has a speed of 0.80*c*. What is the ratio D_A/D_B of the values for the planet's diameter that each spaceship measures in a direction that is parallel to its motion?

15. As the drawing shows, a carpenter on a space station has constructed a 30.0° ramp. A rocket moves past the space station with a relative speed of 0.730*c* in a direction parallel to side *x*. What does a person aboard the rocket measure for the angle of the ramp?



14. An unstable high-energy particle is created in the laboratory, and it moves at a speed of 0.990*c*. Relative to a stationary reference frame fixed to the laboratory, the particle travels a distance of 1.05×10^{-3} m before disintegrating. What are **(a)** the proper distance and **(b)** the distance measured by a hypothetical person traveling with the particle? Determine the particle's **(c)** proper lifetime and **(d)** its dilated lifetime.

27. Suppose that one gallon of gasoline produces 1.1×10^{8} J of energy, and this energy is sufficient to operate a car for twenty miles. An aspirin tablet has a mass of 325 mg. If the aspirin could be converted completely into thermal energy, how many miles could the car go on a single tablet?

29. How much work must be done on an electron to accelerate it from rest to a speed of 0.990*c*?

40. Two identical spaceships are under construction. The constructed length of each spaceship is 1.50 km. After being launched, spaceship A moves away from earth at a constant velocity (speed is 0.850*c*) with respect to the earth. Spaceship B follows in the same direction at a different constant velocity (speed is 0.500*c*) with respect to the earth. Determine the length that a passenger on one spaceship measures for the other spaceship.

Chapter 29

47. Radiation of a certain wavelength causes electrons with a maximum kinetic energy of 0.68 eV to be ejected from a metal whose work function is 2.75 eV. What will be the maximum kinetic energy (in eV) with which this same radiation ejects electrons from another metal whose work function is 2.17 eV?

11. Multiple-Concept Example 3 reviews the concepts necessary to solve this problem. Light is incident on the surface of metallic sodium, whose work function is 2.3 eV. The maximum speed of the photoelectrons emitted by the surface is 1.2×10^{6} m/s. What is the wavelength of the light?

48. How fast does a proton have to be moving in order to have the same de Broglie wavelength as an electron that is moving with a speed of 4.50×10^{6} m/s?

49. The width of the central bright fringe in a diffraction pattern on a screen is identical when either electrons or red light (vacuum wavelength = 661 nm) pass through a single slit. The distance between the screen and the slit is the same in each case and is large compared to the slit width. How fast are the electrons moving?

40. An object is moving along a straight line, and the uncertainty in its position is 2.5 m. **(a)** Find the minimum uncertainty in the momentum of the object. Find the minimum uncertainty in the object's velocity, assuming that the object is **(b)** a golf ball (mass =0.045 kg) and **(c)** an electron.

Chapter 30

10. (a) What is the minimum energy (in electron volts) that is required to remove the electron from the ground state of a singly ionized helium atom (He^+, $Z = 2$)? **(b)** What is the ionization energy for He^+?

13. A hydrogen atom is in the ground state. It absorbs energy and makes a transition to the $n = 3$ excited state. The atom returns to the ground state by emitting two photons. What are their wavelengths?

15. In the hydrogen atom the radius of orbit B is sixteen times greater than the radius of orbit A. The total energy of the electron in orbit A is −3.40 eV. What is the total energy of the electron in orbit B?

18. The energy of the $n = 2$ Bohr orbit is −30.6 eV for an unidentified ionized atom in which only one electron moves about the nucleus. What is the radius of the $n = 5$ orbit for this species?

23. The orbital quantum number for the electron in a hydrogen atom is $\ell = 5$. What is the smallest possible value (algebraically) for the total energy of this electron? Give your answer in electron volts.

27. The principal quantum number for an electron in an atom is $n = 6$, and the magnetic quantum number is $m_\ell = 2$. What possible values for the orbital quantum number ℓ could this electron have?

29. Review Conceptual Example 6 as background for this problem. For the hydrogen atom, the Bohr model and quantum mechanics both give the same value for the energy of the nth state. However, they do not give the same value for the orbital angular momentum L. **(a)** For $n = 1$, determine the values of L [in units of $h/(2\pi)$] predicted by the Bohr model and quantum mechanics. **(b)** Repeat part (a) for $n = 3$, noting that quantum mechanics permits more than one value of ℓ when the electron is in the $n = 3$ state.