

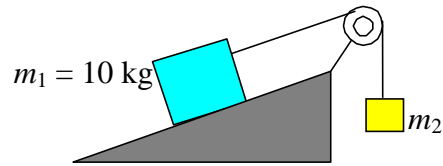
## Physics 121.6 2006-07

### Lecture Examples

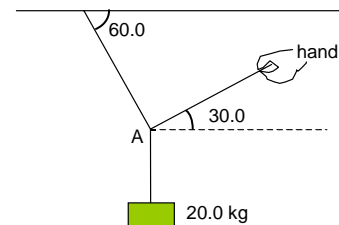
1. Convert 51 km/h into miles/h and m/s. (Ans: 32 mi/h, 14 m/s)
2. The atomic mass of lead is 207.2 u and the density of lead is 11.3 g/cm<sup>3</sup>. Find the mass of one mole of lead atoms. Estimate the volume of one lead atom.  
(Ans: 207 g,  $3 \times 10^{-23}$  cm<sup>3</sup>)
3. A car travels east 2000 m in 10.0 s then travels west 500 m in 5.0 s. Calculate the average velocity and average speed for its trip. (Ans: 100 m/s east, 167 m/s)
4. If the position of an object as a function of time is described by the equation  $x = (5.0 \text{ m/s})t - (2.5 \text{ m/s}^2)t^2$  where  $x$  is in m and  $t$  is in s. (a) Find the average velocity between  $t_i = 0$  and  $t_f = 0.50$  s. (b) Find the instantaneous velocity at time  $t_i = 0$ .
5. A car accelerates from rest to 60.0 km/h in 6.20 s. (a) What is its acceleration (assumed constant)? (b) How far does it travel to reach 60.0 km/h?  
(Ans: 2.69 m/s<sup>2</sup>, 51.8 m)
6. A car traveling at 60 km/h slams on its brakes so that the magnitude of its deceleration is 4.50 m/s<sup>2</sup>. How far does it move before coming to rest?  
(Ans: 30.9 m)
7. A ball is dropped from a height of 10.0 m. (a) How long does it take to reach the ground? (b) With what speed does it hit the ground? (Ans: 1.43 s, 14.0 m/s)
8. A ball is thrown up from the roof of a 50.0 m tall building. It strikes the ground below 5.00 s after it was thrown up. (a) With what speed was it thrown? (b) With what speed does it hit the ground? (c) What was the maximum height of the ball above the ground during its flight? (Ans: 14.4 m/s, 34.5 m/s, 60.7 m)
9. Displacement **A** is 2.0 km north, displacement **B** is 4.0 km east, what is the resultant displacement **R** = **A** + **B**? (Ans: 4.5 km, 27° N of E)
10. I walk 2.00 km at 30.0° N of E then 1.00 km due East. What is my resultant displacement? (Ans: 2.91 km, 20.1° N of E)
11. A stone is thrown horizontally from a bridge, 20.0 m above a river. The initial speed of the stone is 30.0 m/s. (a) What is the time of flight of the stone? (b) What is the horizontal range? (c) What is the final velocity of the stone before impact with the water? (Ans: 2.02 s, 60.6 m, 35.9 m/s at 33.4° down from horizontal.)
12. Now suppose the stone in the previous problem is thrown at an angle of 37.0° up from the horizontal with the same initial speed. (a) What is the time of flight of the stone? (b) What is the horizontal range? (Ans: 4.57 s, 110 m)
13. A boy rides on the rim of a merry-go-round with radius 2.00 m, which is rotating once every 2.50 s. Calculate the speed of the boy and the magnitude of his centripetal acceleration. (Ans: 5.03 m/s, 12.6 m/s<sup>2</sup>)

14. A car is accelerating at a rate of  $1.4 \text{ m/s}^2$  (about 5 km/h/s) as it rounds a curve of radius 25 m. What is its total acceleration at the time when its speed is 8.3 m/s (about 30 km/h)? (Ans:  $3.1 \text{ m/s}^2$  at an angle, towards the centre of the curve, of  $63^\circ$  w.r.t. to the velocity of the car)
15. A plane has an airspeed of 300 km/h. The plane is pointed due North. A wind with speed 75.0 km/h is blowing to the East. What is the velocity of the plane relative to the ground? (Ans: 309 km/h,  $14.0^\circ$  E of N)
16. A 2.00 kg block, on a horizontal frictionless surface, is pushed by a horizontal force of 20.0 N, Calculate the acceleration of the block and the normal reaction force of the surface on the block. (Ans:  $10.0 \text{ m/s}^2$ , 19.6 N)
17. A 2.00 kg block, on a horizontal frictionless surface, is pushed by a force of 20.0 N, which is directed down at an angle of  $30.0^\circ$  to the horizontal. Calculate the acceleration of the block and the normal reaction force of the surface on the block. (Ans:  $8.66 \text{ m/s}^2$ , 29.6 N)
18. A 2.00 kg block, is placed on a frictionless plane, which is inclined at an angle of  $15.0^\circ$  to the horizontal. Calculate the acceleration of the block and the normal reaction force of the plane on the block. (Ans:  $2.54 \text{ m/s}^2$  down the slope, 18.9 N)
19. A 2.00 kg block, is placed on a frictionless plane, which is inclined at an angle of  $15.0^\circ$  to the horizontal. A horizontal force of 5.00 N is applied to the block in a direction that opposes the motion of the block. Calculate the acceleration of the block and the normal reaction force of the plane on the block. (Ans:  $0.12 \text{ m/s}^2$  down the slope, 20.2 N)

20. Two blocks are attached by a light string over a massless and frictionless pulley as shown. The mass of the block on the incline is  $m_1 = 10 \text{ kg}$  and the hanging block has mass  $m_2$ . The incline is frictionless and is at an angle of  $37^\circ$  to the horizontal. When the blocks are released the hanging block accelerates upwards at  $3.0 \text{ m/s}^2$ . Find the mass  $m_2$ , the normal reaction force of incline on  $m_1$ , and the tension in the string. (Ans: 2.3 kg, 78 N, 29 N)



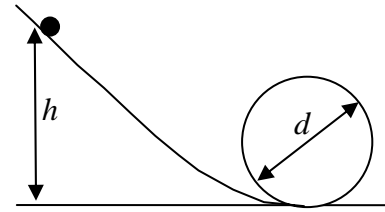
21. A string attached to the roof is connected to a mass of 20.0 kg. Another string is attached to point A and is held stationary by a hand so that the strings make the angles shown. Find the magnitudes of the force with which the hand pulls and the tension in the string attached to the roof. (Ans: 99.5 N, 187 N)



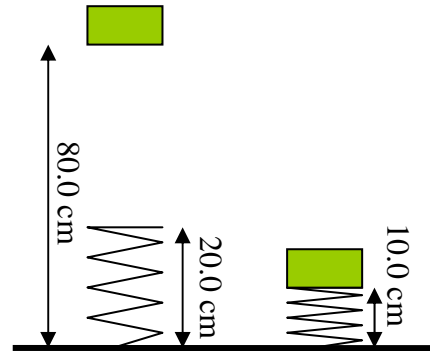
22. A 2.00 kg block, on a horizontal surface with coefficient of static friction 0.900, is pushed by a force that is directed down at an angle of  $30.0^\circ$  to the horizontal. Find the minimum magnitude of the force needed to get the block to start moving. (Ans: 42.4 N)
23. A block slides down an inclined plane at a constant velocity when the angle of the plane is  $23.5^\circ$  to the horizontal. Find the coefficient of kinetic friction between the block and the plane. (Ans: 0.435)

24. A mass of 0.300 kg is swung around in a horizontal circle at the end of a 1.20 m long piece of string. The angle between the string and the horizontal is  $6.00^\circ$ .  
(a) What is the tension in the string and (b) what is the period of the motion?  
(Ans: 28.1 N, 0.709 s)
25. A car drives around a 45 m radius curve which is banked at an angle of  $20^\circ$ . What is the speed of the car so that there is no sideways friction force on the tires?  
(Ans: 13 m/s)
26. A roller-coaster car goes around a vertical circular loop-the-loop with a diameter of 50.0 m. Ignoring friction, what is the minimum speed of the car at the top of the loop so that the car stays in contact with the track? (Ans: 15.7 m/s = 56 km/h)
27. Find an expression for the terminal velocity of a solid sphere falling through the air. How does the terminal velocity depend on the density and radius of the sphere?
28. A man raises a 3.0 kg mass to a height of 2.0 m at a constant speed. (a) What is the work done by the man on the mass? (b) What is the work done by the force of gravity on the mass? (c) What is the work done by the net force on the mass?  
(Ans: (a) 59 J, (b)  $-59$  J, (c) 0)
29. A block is pulled along a horizontal surface with a force of 10 N which is applied at an angle of  $30^\circ$  to the horizontal. The block moves 2.0 m along the surface. What is the work done on the block by the force? (Ans: 17 J)
30. Consider the vectors  $\mathbf{a} = 3\hat{\mathbf{i}} + 2\hat{\mathbf{j}}$  and  $\mathbf{b} = 2\hat{\mathbf{i}} + 4\hat{\mathbf{j}}$ . What is the angle between  $\mathbf{a}$  and  $\mathbf{b}$ ? (Ans:  $29.8^\circ$ )
31. When a mass of 0.200 kg is hung from the end of a vertically suspended spring, the spring is stretched by 10.0 cm. What is the spring constant of the spring?  
(Ans: 19.6 N/m)
32. A box, of mass 4.0 kg, slides down a frictionless incline, which is at an angle of  $30^\circ$  to the horizontal. It slides a distance of 2.5 m. (a) What is the net work done on the box as it slides? (b) If the box starts from rest, what is its final speed?  
(Ans: 49 J, 4.9 m/s)
33. A box of mass 30.0 kg slides down a ramp. It starts from rest and reaches a speed of 5.00 m/s at the bottom. In that time it moves down a vertical distance of 3.00 m and across a horizontal distance of 4.00 m. (a) Find the work done by the friction force on the box. (b) Find the magnitude of the force of friction between the ramp and the box. (Ans:  $-507$  N, 101 N)
34. A car moving at a speed of 50.0 km/h slams on its brakes and skids to rest. If the coefficient of kinetic friction between the tires and the road is 0.500, what is the stopping distance? (Ans: 19.7 m)
35. A car delivers 100 hp to the wheels. The mass of the car and driver is 1800 kg. If the car starts from rest on level ground, and the power is constant, what is the speed of the car after 2.0 s and after 4.0 s? (Ignore any energy lost to friction.)  
(Ans: 13 m/s, 18 m/s)
36. A brick is dropped from a height of 4.0 m. Ignoring air resistance, with what speed does it hit the ground? (Ans: 8.9 m/s)

37. A roller-coaster car starts from rest at a height  $h$  and goes around a vertical loop-the-loop of diameter  $d$  as shown. Ignoring friction, find the minimum height  $h$  so that the car remains in contact with the track. (Ans:  $h = \frac{5d}{4}$ )



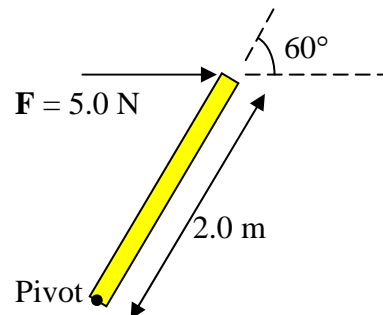
38. A mass of 1.00 kg is dropped from a height above the floor of 80.0 cm onto a spring, of unstretched length of 20.0 cm, which is resting on the floor. It comes to rest, momentarily, at a height of 10.0 cm from the floor. If we can ignore friction, find the spring constant of the spring. (Ans:  $1.37 \times 10^3$  N/m)



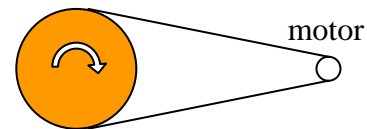
39. An elevator, with mass 1000 kg, carries a load of 800 kg. It moves up with a constant speed of 3.00 m/s and there is constant friction force of 4000 N on the elevator. What is the power that the motor must deliver? (Ans: 64.9 kW)
40. A cannon with mass 600 kg fires a cannonball with mass 2.0 kg. The muzzle speed of the cannonball is 20 m/s. What is the recoil speed of the cannon? (Ans:  $6.7 \times 10^{-2}$  m/s)
41. A ball of putty, with mass 0.20 kg is thrown towards a wall with a speed of 16 m/s. It sticks to the wall and the duration of the collision is 0.70 s. What is the impulse on the ball? What is the average force on the ball? (Ans:  $-3.20$  kg.m/s,  $-4.6$  N)
42. A 20,000 kg truck collides head on with a 1500 kg car. The speed of the truck is 5.0 m/s (18 km/h) and the speed of the car is 8.0 m/s (29 km/h). After the collision the two vehicles stick together. (a) What is the speed of the wreck after the collision? (b) If each driver has a mass of 100 kg and the duration of the collision is 0.20 s what is the average magnitude force on each driver? (Ans: 4.1 m/s, truck driver  $4.5 \times 10^2$  N, car driver  $6.1 \times 10^3$  N)
43. A ball of mass  $m$  moving in the  $+x$  direction on a frictionless surface, collides head-on with a stationary ball of mass  $2m$ . After the collision the ball with mass  $2m$  is moving in the  $+x$  direction with speed 2.00 m/s. The collision is elastic. Find the initial and final velocity of the ball with mass  $m$ . (Ans: +3.00 m/s,  $-1.00$  m/s)
44. A ball of mass 0.20 kg travels in the  $+x$  direction with speed 5.0 m/s. It collides, head on, with a stationary ball of mass 0.30 kg. The collision is elastic. Find the velocities of the balls after the collision. (Ans:  $-1.0$  m/s, +4.0 m/s)
45. A billiard ball hits a stationary billiard ball. (The balls have equal mass.) After the collision the first ball moves at an angle of  $30^\circ$  to its original direction at a speed of 1.0 m/s. The other ball moves at an angle of  $60^\circ$  to the original direction of the first ball. Find the original speed of the first ball and the speed of the second ball after the collision. (Ans: 1.2 m/s, 0.58 m/s)
46. A mass of 2.0 kg is at the origin and a mass of 5.0 kg is at  $x = 2.0$  m. Find the position of the centre of mass of this system. (Ans:  $x = 1.4$  m)

47. Calculate the average angular speed of Mars in its orbit about the Sun. The period of its orbit is 687 days and the average radius of its orbit is  $2.29 \times 10^{11}$  m.  
(Ans:  $1.06 \times 10^{-7}$  rad/s)
48. A Ferris wheel starts from rest with an angular acceleration of  $0.126 \text{ rad/s}^2$ . The radius of the Ferris wheel is 15.0 m. (a) What is its angular speed after 2.00 revolutions? (b) How long does it take to go 2.00 revolutions?  
(Ans: 1.78 rad/s, 14.1 s)
49. For the Ferris wheel in the previous problem: (c) Find the speed of the car after 2.00 revolutions. (d) Find the tangential acceleration of the car. (e) Find the centripetal acceleration of the car after 2.00 revolutions. (Ans: 26.7 m/s,  $1.89 \text{ m/s}^2$ ,  $47.5 \text{ m/s}^2$ )
50. A dumbbell, made from a rod of negligible mass of length 70.0 cm, has a mass of 0.20 kg connected to one end, and a mass of 0.30 kg connected to the other end. The dumbbell is made to spin, about an axis passing perpendicularly through the centre of the rod, at a rate of 1.0 rev/s. Calculate the moment of inertia of the dumbbell about this axis and calculate its rotational kinetic energy.  
(Ans:  $6.1 \times 10^{-2} \text{ kg}\cdot\text{m}^2$ , 1.2 J)
51. Given that the moment of inertia of a uniform rod of mass  $M$  and length  $L$  that is rotating about its centre is  $I_{CM} = \frac{1}{12}ML^2$ , find the moment of inertia if the rod rotates about one end. (Ans:  $I_{end} = \frac{1}{3}ML^2$ )
52. A bar of mass 0.300 kg and length 1.00 m is pivoted at one end and a mass of 0.200 kg is attached to the other end. The bar rotates about the pivot point once every 1.00 s. Find the kinetic energy of the system. (Ans: 5.92 J)

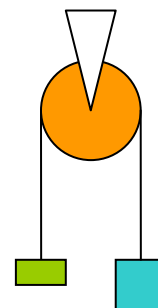
53. A bar of length 2.0 m is attached to a pivot point at one end. A force of 5.0 N is applied to the other end as shown. Calculate the torque on the bar about the pivot due to this force.  
(Ans: 8.7 N.m)



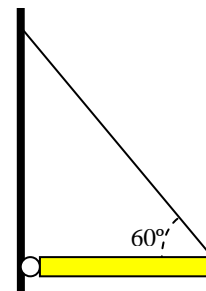
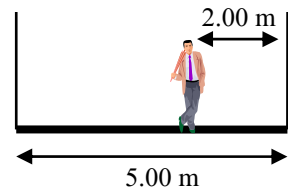
54. A wheel, which is made from a solid disk of mass 30. kg and radius 0.50 m, is attached to a motor via a belt. When the motor is turned on the disc starts from rest and reaches an angular speed of 20. rev/s in a time of 15. s. What is the tension in the belt? (Ans: 63 N)



55. Atwood's machine: The two masses, 5.0 kg and 8.0 kg, are attached to the ends of a light string that is looped over a pulley. The pulley is a solid disk of mass 2.0 kg and radius 0.30 m. Find the acceleration of the masses. Ignore friction. (Ans: 2.1 m/s)

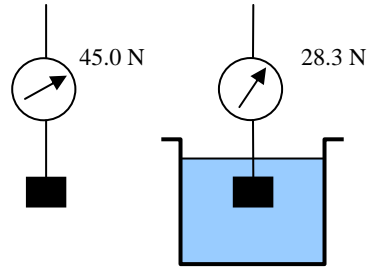


56. A circular object, with radius 0.100 m, rolls without slipping down a ramp. It starts from rest and after rolling to the bottom, a distance of 3.00 m down the ramp, it has a speed of 2.00 m/s. (a) Find its angular speed at the bottom. (b) How many revolutions did the object make to reach the bottom? (c) Calculate the angular acceleration of the object about its centre as it rolls. (Ans: 20.0 rad/s, 4.77 rev, 6.67 rad/s<sup>2</sup>)
57. A sphere, a cylinder and a hoop, roll, without slipping, from the same height down a ramp. Which reaches the bottom first?
58. An object of mass 3.0 kg is moving with speed 1.5 m/s in the +x direction along the y = 2.0 m line. Calculate the angular momentum of the object about the origin. (Ans: 9.0 kg.m<sup>2</sup>/s in the -z direction)
59. A light rod with two masses attached to its ends, rotates horizontally about a vertical axis that passes through the center of the rod. The length of the rod is 1.0 m and the masses are 1.0 kg each. The rod and masses rotate with an initial angular velocity of 8.0 rad/s. An internal mechanism pulls both masses half way towards the axis of rotation. Find the final angular velocity of the rod and masses. Find the initial and final rotational kinetic energies of the system. Is kinetic energy conserved? (Ans: 32 rad/s, 16 J, 64 J, no)
60. A man, with weight 800 N stands on a “light” plank supported by two ropes attached to the ends of the plank. Ignore the weight of the plank. The plank has length 5.00 m and the man stands 2.00 m from one end. Find the tensions in the ropes. (Ans: 480 N, 320 N)
61. A uniform bar of length 4.0 m and mass 10 kg is attached to a wall with a hinge. The bar is supported horizontally by a string which is attached to the wall and to the free end of the bar such that the string makes an angle of 60° with the bar as shown. Find the tension in the string and the reaction force of the hinge on the bar. (Ans: 57 N, 57 N at 60° to horizontal)
62. What is the radius of the orbit of a geosynchronous communications satellite (in a geostationary orbit)? (Ans: 4.2 × 10<sup>7</sup> m)
63. Newton calculated the period of the Moon in its orbit around the Earth to compare with the known period. At that time he knew the radius of the Moon’s orbit (3.84 × 10<sup>8</sup> m), but he did not know the Universal Gravitational Constant or the mass of the Earth. He did know the acceleration due to gravity at the Earth’s surface (9.80 m/s<sup>2</sup>) and the radius of the Earth (6.37 × 10<sup>6</sup> m). How did he calculate the Moon’s period and what answer would he get? (Ans: 27.4 days)
64. A projectile, fired straight up from Earth’s surface with initial speed v<sub>0</sub>, reaches a maximum height of 3200 km. Neglecting air friction what is v<sub>0</sub>? What speed would be needed so the projectile never falls back to Earth? (Ans: 6.47 × 10<sup>3</sup> m/s, 1.12 × 10<sup>4</sup> m/s)



65. What is the pressure at the base of a dam where the water depth is 30.0 m? What is the pressure difference across the base of the dam? (Ans:  $3.95 \times 10^5$  Pa,  $2.94 \times 10^5$  Pa)
66. Find the fraction of the volume of an iceberg that is under the surface of the water. (At  $0^\circ$  C, Density of sea water =  $1.03 \times 10^3$  kg/m<sup>3</sup>, Density of sea ice =  $0.92 \times 10^3$  kg/m<sup>3</sup>) (Ans: 0.89)

67. Find the Density of a metal object that weighs 45.0 N in air, but when fully submerged in water, a spring gauge reads 28.3 N.  
(Ans:  $2.69 \times 10^3$  kg/m<sup>3</sup> = 2.69 g/cm<sup>3</sup>)

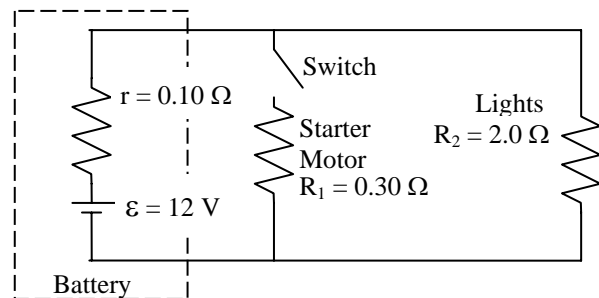


68. The cross-sectional area of an aorta at an aneurysm increases by 70%. The normal blood flow speed in the aorta is 0.40 m/s. Determine the increase in pressure at the aneurysm. Density of blood is  $1.05 \times 10^3$  kg/m<sup>3</sup>. (Ans: 55 Pa = 0.42 mm.Hg)
69. When a mass of 0.500 kg is hung from the end of a spring, the spring is stretched by 10.0 cm. (a) What is the spring constant of the spring? The mass is then lifted up by 5.00 cm and then released from rest. (b) Find the equation for the position of the mass as a function of time. What are the maximum magnitudes of the velocity and acceleration of the mass as it oscillates? (c) Find the frequency and period of the resulting oscillation. (d) What is the position and velocity of the mass at a time of 0.250 s after it was released? (Ans: (a) 49.0 N/m, (b) 0.495 m/s, 4.90 m/s<sup>2</sup> (c) 1.58 Hz, 0.635 s, (d) -0.0393 m, -0.306 m/s)
70. Find the length of a Grandfather Clock pendulum (with a period of exactly 2.00 s). (Ans: 0.99 m)
71. A uniform rod of length 0.800 m is hinged at one end. What is the frequency and period of small swings? (Ans: 0.682 Hz, 1.47 s)
72. A wave is described by the equation:  $y = 0.20 \sin(0.40\pi x + 14\pi t)$ , where  $x$  and  $y$  are in metres and  $t$  is in seconds. What are the amplitude, wavelength, frequency, period, and speed of this wave? (Ans: 0.20 m, 5.0 m, 7.0 Hz, 0.14 s, 35 m/s,)
73. A string of length 40 cm, which has a mass per unit length of 200 g/m, is under a tension of 80 N. What is the speed of a wave in this string? If one end of the string is wiggled at a frequency of 2.0 Hz, what is the wavelength of the resulting wave in the string? (Ans: 20 m/s, 10 m)
74. For the string in the previous problem, what power is transferred to the other end of the string if the amplitude of the wiggle is 4.0 cm? (Ans: 0.51 W)
75. At a distance of 20.0 m from a jet engine, the intensity of sound is fifty times that which can cause permanent ear damage. At what distance from the engine is it safe? (Ans: 141 m)
76. About the smallest sound level change a person can notice is 3 dB. By what factor does the sound intensity increase? (Ans: about 2)

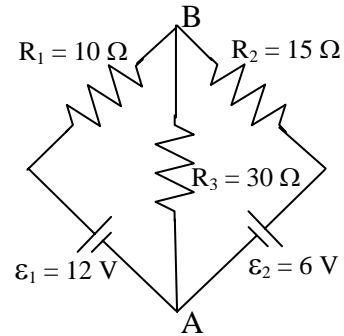
77. A certain hearing aid increases the sound intensity level by 30 dB. A person needs a minimum sound intensity of  $2.0 \times 10^{-9} \text{ W/m}^2$  to hear without the hearing aid. Can the person hear a whisper of intensity  $1.0 \times 10^{-11} \text{ W/m}^2$  while using the hearing aid? (Ans: yes)
78. A train whistle, as heard by the engineer in the locomotive, has a frequency of 800 Hz. A person, standing near the tracks, hears the whistle and notes it has a frequency of 760 Hz. What is the speed of the train? Is the train approaching or going away from the person? (Ans: 18.1 m/s, going away)
79. Two speakers emit, in phase, the same frequency of 343 Hz. The speakers are 10 m apart. A man stands half way between the two speakers. Will the man hear constructive or destructive interference of the two sounds? The man now walks towards one of the speakers. How far will he walk before he reaches a point with minimum sound intensity. (Ans: Constructive, 0.25 m)
80. A guitar string has a length of 40 cm and is under tension of 80 N. The string has a mass per unit length of 200 g/m. What is the speed of a wave along this string and what frequency sounds will result when the string is plucked? (Ans: 20 m/s, 25 Hz, 50 Hz, 75 Hz....)
81. A loud speaker is placed over the open end of a 2.0 m long pipe. By changing the frequency of the sound from the speaker it is noted that there are many resonant frequencies. One of these is at 280 Hz, and the next higher frequency one is at 360 Hz. Is the other end of the pipe open or closed? Use this information to find the speed of sound in the air in the pipe. (Ans: Closed, 320 m/s)
82. A piano tuner strikes middle A (440 Hz). This piano has two strings for this note. He knows that one of the strings is tuned to exactly 440 Hz. When both strings sound together he perceives that the note is flat and he hears beats with a frequency of 2.0 Hz. What is the frequency of the second string? (Ans: 438 Hz)
83. Find the frequency of light that, when it travels in a vacuum, has a wavelength of 598 nm. What wavelength does this light have when it travels in water? The refractive index of water is 1.33. (Ans:  $5.02 \times 10^{14} \text{ Hz}$ , 450 nm)
84. Light travels from water into air. The refractive index of water is 1.33. If the angle of incidence is  $30^\circ$ , find the angle of refraction. (Ans:  $41.7^\circ$ )
85. Find the critical angles for total internal reflection when light strikes a glass-air boundary and when light strikes a diamond-air boundary. The refractive index of the glass is 1.50 and for diamond it is 2.42. (Ans:  $41.8^\circ$ ,  $24.4^\circ$ )
86. A paper clip, with height 2.0 cm is placed 25 cm in front of a concave mirror with a radius of 40.0 cm. Find the location of the image, the magnification of the system and the height of the image of the paper clip. Is the image upright or upside down and is the image real or virtual? (Ans: +100 cm, -4.0, -8.0 cm, upside down, real)
87. A fish appears to be 40 cm below the surface of the water. What is the actual depth of the fish? (Ans: 53.2 cm)

88. A paper clip, with height 2.0 cm is placed 15 cm in front of a diverging lens, with focal length 20 cm. Find the location of the image, the magnification of the system and the height of the image of the paper clip. Is the image upright or upside down and is the image real or virtual? (Ans: -11 cm, +0.44, +0.89 cm, upright, virtual)
89. Consider a two lens system consisting of a converging lens (lens 1) with focal length 10 cm and a converging lens (lens 2) with focal length 15 cm separated by 40 cm. An object is placed 15 cm in front of lens 1. Find the location of the image and the total magnification of the system. (Ans: 30 cm in front of lens 2, -6.0)
90. Consider a two lens system consisting of a converging lens (lens 1) with focal length 10 cm and a diverging lens (lens 2) with focal length 15 cm separated by 20 cm. An object is placed 15 cm in front of lens 1. Find the location of the image and the total magnification of the system. (Ans: 30 cm behind lens 2, -6.0)
91. A photograph of a house is taken with a camera that has a lens with focal length 64.0 mm. The house is 6.50 m tall and is 20.0 m from the camera. How far from the lens must the film be for an "in focus" image? How high is the image on the film? (Ans: 64.2 mm, 2.09 cm)
92. A nearsighted woman's far point is at 150 cm. What power of lenses in her eyeglasses, or contact lenses, does she need? (Ans: -0.67 Diopters)
93. A man uses a jeweller's loupe to look at a diamond ring. The focal length of the loupe is 4.00 cm. What angular magnification does he observe if the man focuses his eye to see the image at his near point, which is 31.0 cm? (Ans: 8.75)
94. A microscope has an objective lens of focal length 1.00 cm and an eyepiece with focal length 2.50 cm. The distance between the objective lens and the eyepiece is 18.5 cm. If the woman using the microscope has a near point at 25.0 cm, what angular magnification does she observe? (Ans: -160)
95. A telescope has an objective lens with a focal length of 2.50 m and an eyepiece with a focal length of 3.00 cm. What is the magnification observed when looking at the moon with the eye relaxed? (Ans: -83)
96. In a two-slit interference experiment the pair of slits are separated by 1.50 mm. On a screen 2.00 m away we see dark lines separated by 0.600 mm. What is the wavelength of the light being used? At what angle is the first dark line seen? (Ans: 450 nm,  $1.50 \times 10^{-4}$  rad)
97. A diffraction grating has 4000 lines/inch. When light with wavelength 700 nm is incident normally on this grating, at what angles are the first and second order maxima observed? (Ans:  $6.33^\circ$ ,  $12.7^\circ$ )
98. Two charges,  $q_1 = +2.00 \mu\text{C}$ , and  $q_2 = -3.00 \mu\text{C}$ , are fixed on the  $x$ -axis.  $q_1$  at the origin and  $q_2$  at  $x = 1.00$  m. A third charge,  $q = +6.00 \mu\text{C}$ , is placed on the  $y$ -axis at  $y = 1.00$  m. Find the net force on the charge  $q$ . (Ans: 0.0765 N at  $41.6^\circ$  up from  $+x$ -axis.)
99. A charge,  $q_1 = +2.0 \mu\text{C}$ , is fixed at the origin, and a charge  $q_2 = -2.0 \mu\text{C}$  is at  $x = 0$ ,  $y = +2.0$  m. Find the electric field at point  $x = +1.0$  m,  $y = +1.0$  m. (Ans:  $1.3 \times 10^4$  N/C in  $+y$  direction.)

100. An electron is released from rest in a region where there is a uniform electric field of 5000 N/C. What is the speed of the electron after it has moved a distance of 10 cm? (Ans:  $1.3 \times 10^7$  m/s)
101. The potential difference between the filament and the accelerating electrode in a TV picture tube is 5000 V. What is the kinetic energy of an electron accelerated through this potential difference. (Ans: 5 keV =  $8.0 \times 10^{-16}$  J)
102. A  $-1.0 \mu\text{C}$  charge is placed a distance of 4.0 m to the right of a  $+1.0 \mu\text{C}$  charge. Calculate the electric field and the absolute electric potential at a point A, located 1.0 m from the  $+1.0 \mu\text{C}$  charge along a line between the two charges, and at a point B midway between the two charges. (Ans: A:  $1.0 \times 10^4$  N/C to right,  $+6.0 \times 10^3$  V, B:  $4.5 \times 10^4$  N/C to right, 0 V)
103. For the situation described in the previous example, a mass of  $1.0 \mu\text{g}$  with charge  $-2.0 \mu\text{C}$  is released from rest at point B. What is the mass's kinetic energy and speed when it reaches point A? (Ans:  $1.0 \times 10^{-2}$  J,  $4.9 \times 10^3$  m/s)
104. Calculate the electron drift speed in a copper wire, 1.0 mm in diameter, which is carrying a current of 1.0 A. Assume each copper atom contributes 1 electron that can move in the metal. The atomic mass of copper is 63.5 g/mole and the density of copper is  $8.95 \text{ g/cm}^3$ . (Ans:  $9.4 \times 10^{-3}$  cm/s)
105. An aluminum wire of length 10.0 m and diameter 0.500 mm has 50.0 V across its ends. Calculate the current flowing in the wire. The resistivity of aluminum is  $2.83 \times 10^{-8} \Omega\cdot\text{m}$ . (Ans: 34.7 A)
106. The aluminum wire in the previous example was at a temperature of  $20^\circ\text{C}$ . The temperature coefficient of resistivity for aluminum is  $0.0039 \text{ }^\circ\text{C}^{-1}$ . What is the current in the wire when the temperature is raised to  $50^\circ\text{C}$ ? (Ans: 31.1 A)
107. Consider a 100 W set of Christmas lights which are run from a voltage source of 120 V. What is the current through the lights and what is the total resistance of the lights? How much does it cost to have the lights turned on for 8 hours per day for 4 weeks at a rate of 9 cents/kw-hr? (Ans: 0.83 A, 144  $\Omega$ , \$2.02)
108. A battery has an open circuit voltage of 15.0 V. When a load resistance of  $2.00 \Omega$  is connected to it, 72.0 W is delivered to the load. (a) Find the internal resistance of the battery. (b) Find the terminal voltage of the battery. (Ans:  $0.500 \Omega$ , 12.0 V)
109. An equivalent circuit for a car battery which is connected to the head-lights and is connected via a switch to the starter motor, is shown in the diagram. With the starter switch (a) open and (b) closed: (i) Find the power delivered to the lights. (ii) Find the terminal voltage of the battery. (Ans: 65 W, 11.4 V, 38 W, 8.7 V)

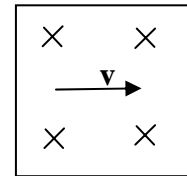


110. In the circuit shown, find the currents through the resistances  $R_1$ ,  $R_2$  and  $R_3$  and find the potential difference of point B with respect to point A.  
(Ans: 0.400 A, -0.133 A, 0.267 A, +8.00 V)

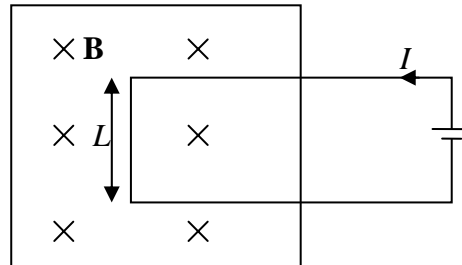


111. A 1000 W toaster is run from an alternating voltage source rated at 120 V (rms). What is the rms current through the toaster? What is the resistance of the toaster? What is the peak current through the toaster? (Ans: 8.33 A, 14.4 Ω, 11.8 A)

112. Find the force on a proton, with kinetic energy 10 keV, that is moving perpendicular to a magnetic field of magnitude 2.0 kG. (Ans:  $4.4 \times 10^{-14}$  N)



113. A loop of wire is partially in a region of uniform magnetic field of magnitude  $B = 0.60$  T as shown in the diagram. The width of the loop  $L$  is 2.0 cm and the current flowing in the loop is  $I = 3.0$  A. Find the net force on the loop of wire.  
(Ans:  $3.6 \times 10^{-2}$  N to right)



114. A beam of electrons is moving in a horizontal circle in a uniform magnetic field that is directed downward. The speed of the electrons is  $1.0 \times 10^7$  m/s and the magnitude of the magnetic field is  $1.0 \times 10^{-3}$  T. (a) As seen from above, are the electrons moving clockwise or counter clockwise? (b) What is the radius of the electron's orbit? (c) What is the period of their motion? (Ans: clockwise, 5.7 cm,  $3.6 \times 10^{-8}$  s)

115. A velocity selector consists of a region of space where there is a magnetic field and an electric field. The  $\mathbf{E}$  and  $\mathbf{B}$  vectors are perpendicular to each other. There are collimators at either end of this region of space so that only charged particles that travel in a straight line can make it through. Only one velocity of the charged particle has a trajectory that is a straight line. Find that velocity if the magnitude of the electric field is  $9.3 \times 10^5$  V/m and the magnitude of the magnetic field is 0.40 T. (Ans:  $2.3 \times 10^6$  m/s)

