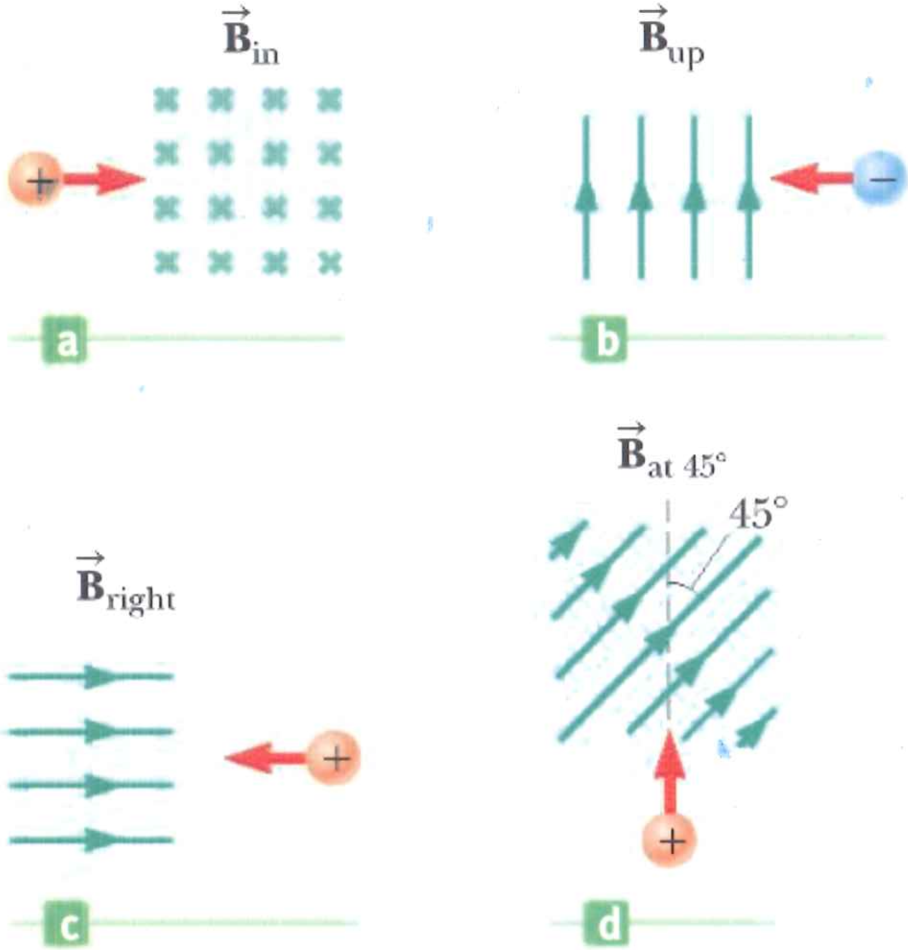
4. Determine the initial direction of the deflection of charged particles as they enter the magnetic fields, as shown in Figure P19.4.



Ch19 - class 15

28. A rectangular loop consists of 100 closely wrapped turns and has dimensions 0.400 m by 0.300 m. The loop is hinged along the y-axis, and the plane of the coil makes an angle of 30.0° with the x-axis (Fig. P19.28). What is the magnitude of the torque exerted on the loop by a uniform magnetic field of 0.800 T directed along the x-axis when the current in the windings has a value of 1.20 A in the direction shown? What is the expected direction of rotation of the loop?

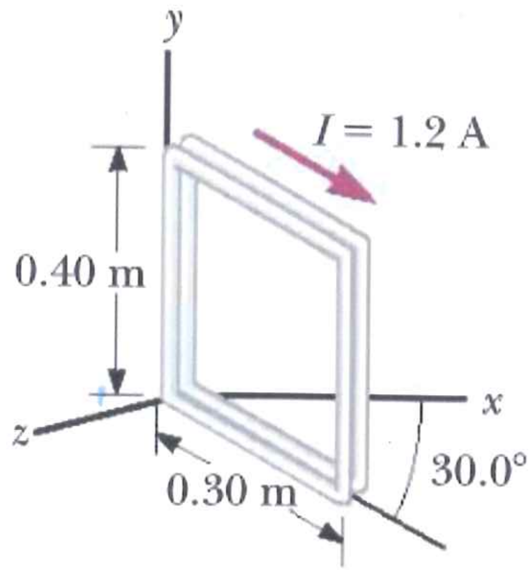


Figure P19.28

ch19-class 15

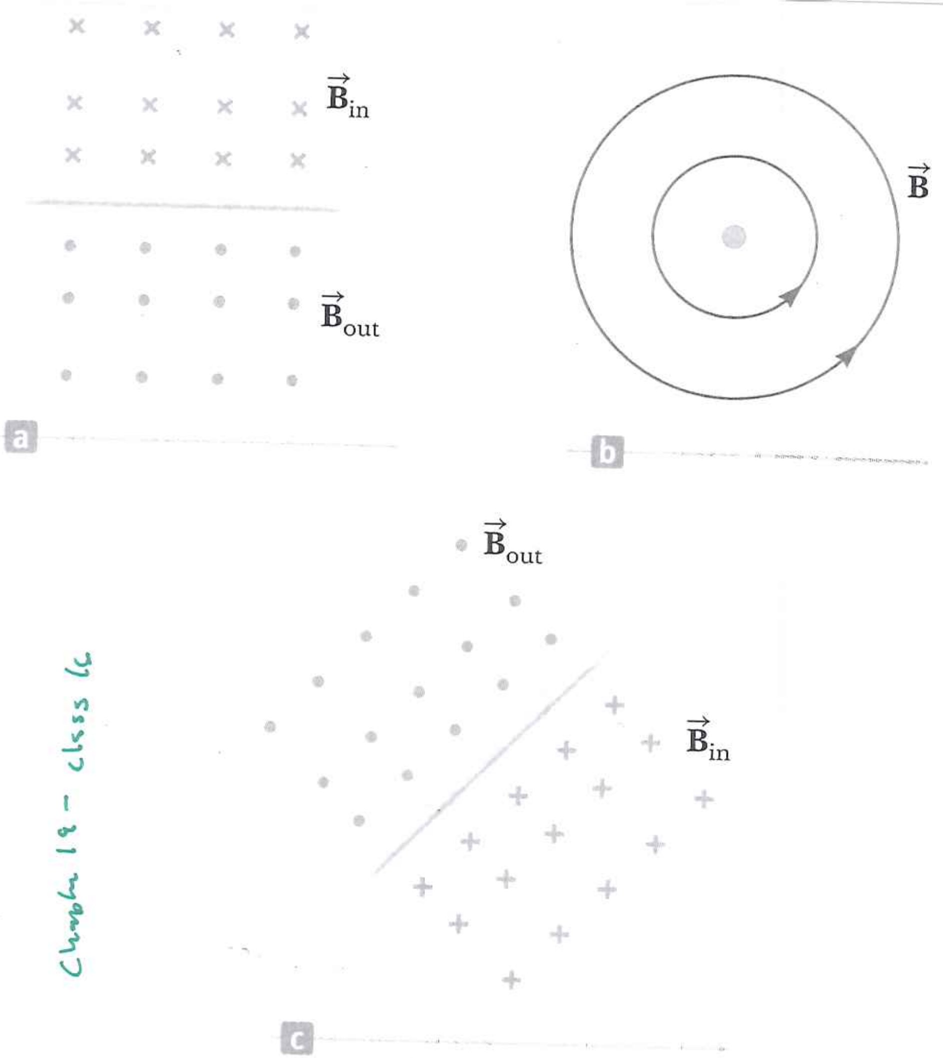
6. **M** A proton moves perpendicular to a uniform magnetic field $\vec{\mathbf{B}}$ at a speed of 1.00×10^7 m/s and experiences an acceleration of 2.00×10^{13} m/s^2 in the positive x-direction when its velocity is in the positive z-direction. Determine the magnitude and direction of the field.

42. **S** A proton (charge $+e$, mass m_p), a deuteron (charge $+e$, mass $2m_p$), and an alpha particle (charge $+2e$, mass $4m_p$) are accelerated from rest through a common potential difference ΔV. Each of the particles enters a uniform magnetic field $\vec{\mathbf{B}}$, with its velocity in a direction perpendicular to $\vec{\mathbf{B}}$. The proton moves in a circular path of radius r_p. In terms of r_p, determine (a) the radius r_d of the circular orbit for the deuteron and (b) the radius r_α for the alpha particle.

18. At a certain location, Earth has a magnetic field of 0.60×10^{-4} T, pointing 75° below the horizontal in a north–south plane. A 10.0-m-long straight wire carries a 15-A current. (a) If the current is directed horizontally toward the east, what are the magnitude and direction of the magnetic force on the wire? (b) What are the magnitude and direction of the force if the current is directed vertically upward?

chapt 19 - class 15

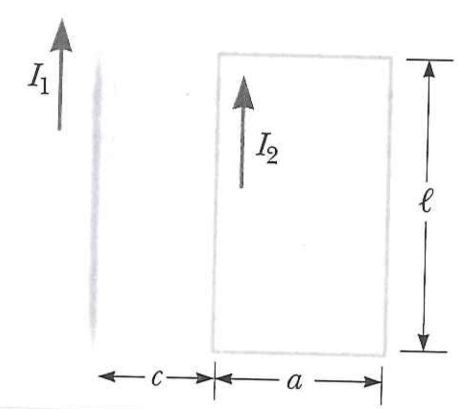
44. In each of parts (a), (b), and (c) of Figure P19.44, find the direction of the current in the wire that would produce a magnetic field directed as shown.



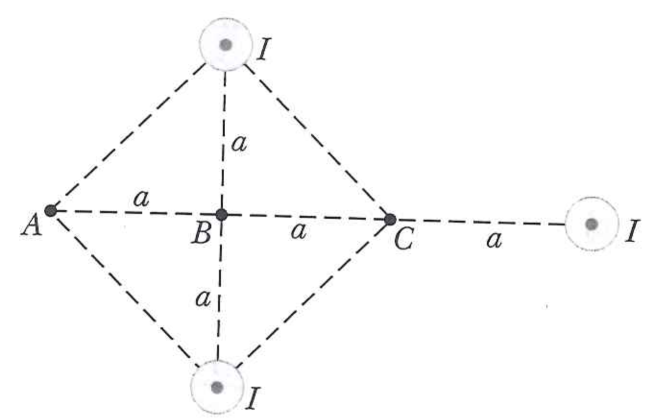
Chapter 19 – class 16

59. M A long solenoid that has 1 000 turns uniformly distributed over a length of 0.400 m produces a magnetic field of magnitude 1.00×10^{-4} T at its center. What current is required in the windings for that to occur?

58. In Figure P19.58 the current in the long, straight wire is $I_1 = 5.00$ A, and the wire lies in the plane of the rectangular loop, which carries 10.0 A. The dimensions shown are $c = 0.100$ m, $a = 0.150$ m, and $\ell = 0.450$ m. Find the magnitude and direction of the net force exerted by the magnetic field due to the straight wire on the loop.



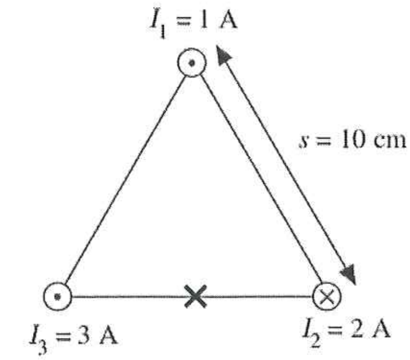
71. Three long, parallel conductors carry currents of $I = 2.0$ A. Figure P19.71 is an end view of the conductors, with each current coming out of the page. Given that $a = 1.0$ cm, determine the magnitude and direction of the magnetic field at points A, B, and C.



The following questions are worth 10 pts each

Record your steps! (Grade based on method displayed not just numerical result)

17. As shown below three long wires are arranged in an equilateral triangle with side 10 cm. The currents I_1 and I_3 come directly out of this page; I_2 goes into the page. We seek the magnetic field vector at the spot marked X (i.e., the midpoint of the horizontal segment).



   A. Directly on the diagram, draw (approximately) and label the magnetic field vector (including direction) at X due to each of the three currents. Label the magnetic field due to I_1: $\mathbf{B}_1$, etc.

   B. Draw (approximately) the sum of these three magnetic field vectors. Label an angle that describes the direction of this net magnetic field vector.

   C. Calculate the net magnetic field vector at the spot marked X, by finding its x and y components.

   D. Calculate the numerical value of the angle you labeled in part (B).

54. **Q|C** **S** Two long, parallel wires separated by a distance $2d$ carry equal currents in the same direction. An end view of the two wires is shown in Figure P19.54, where the currents are out of the page. (a) What is the direction of the magnetic field at P on the x-axis set up by the two wires? (b) Find an expression for the magnitude of the field at P. (c) From your result to part (b), determine the field at a point midway between the two wires. Does your result meet with your expectation? Explain.

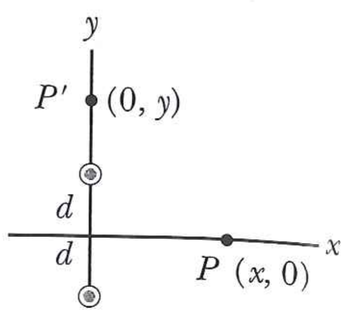
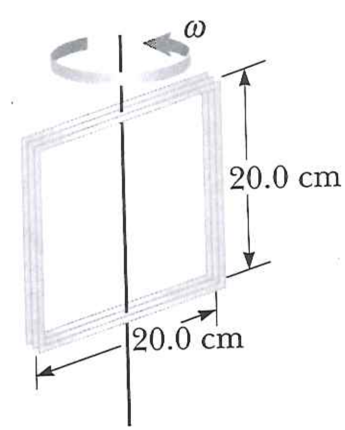


Figure P19.54

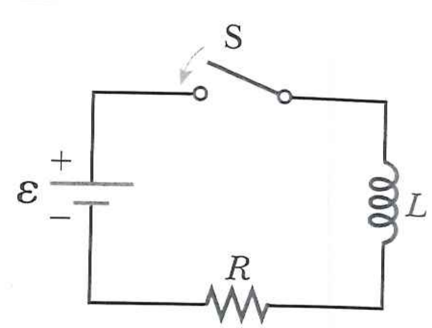
chapter 19 - class 16

ch 20
class 18

32. A 100-turn square wire coil of area 0.040 m^2 rotates about a vertical axis at 1 500 rev/min, as indicated in Figure P20.32. The horizontal component of Earth's magnetic field at the location of the loop is 2.0×10^{-5} T. Calculate the maximum emf induced in the coil by Earth's field.



38. A technician wraps wire around a tube of length 36 cm having a diameter of 8.0 cm. When the windings are evenly spread over the full length of the tube, the result is a solenoid containing 580 turns of wire. (a) Find the self-inductance of this solenoid. (b) If the current in this solenoid increases at the rate of 4.0 A/s, what is the self-induced emf in the solenoid?



48. Consider the circuit shown in Figure P20.43. Take $\mathcal{E} =$ 6.00 V, $L = 8.00$ mH, and $R = 4.00\ \Omega$. (a) What is the inductive time constant of the circuit? (b) Calculate the current in the circuit 250 μs after the switch is closed. (c) What is the value of the final steady-state current? (d) How long does it take the current to reach 80.0% of its maximum value?

50. A 300-turn solenoid has a radius of 5.00 cm and a length of 20.0 cm. Find (a) the inductance of the solenoid and (b) the energy stored in the solenoid when the current in its windings is 0.500 A.

Ch 21
class 19

10. **Q|C** An AC generator with an output rms voltage of 36.0 V at a frequency of 60.0 Hz is connected across a 12.0-μF capacitor. Find the (a) capacitive reactance, (b) rms current, and (c) maximum current in the circuit. (d) Does the capacitor have its maximum charge when the current takes its maximum value? Explain.

12. A generator delivers an AC voltage of the form $\Delta v = (98.0\text{ V})\sin(80\pi t)$ to a capacitor. The maximum current in the circuit is 0.500 A. Find the (a) rms voltage of the generator, (b) frequency of the generator, (c) rms current, (d) reactance, and (e) value of the capacitance.

15. **M** In a purely inductive AC circuit as shown in Figure P21.15, $\Delta V_{max} = 100$ V. (a) The maximum current is 7.50 A at 50.0 Hz. Calculate the inductance L. (b) At what angular frequency ω is the maximum current 2.50 A?

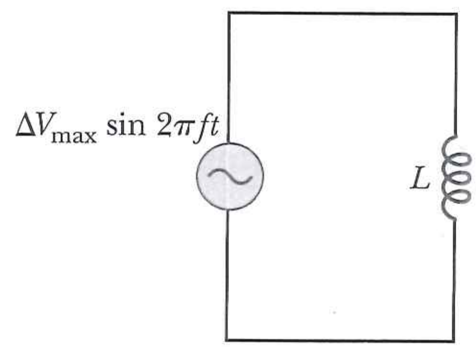


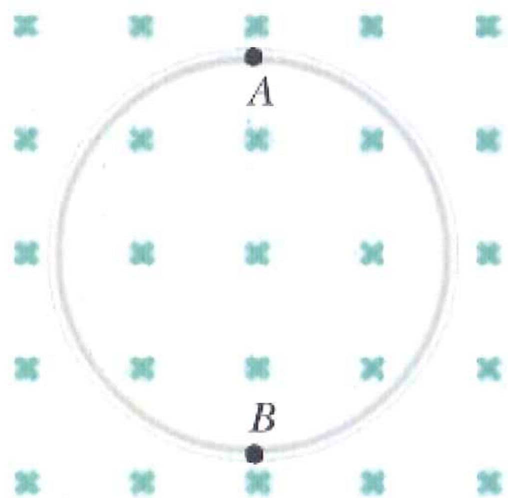
Figure P21.15

19. A 40.0-μF capacitor is connected to a 50.0-Ω resistor and a generator whose rms output is 30.0 V at 60.0 Hz. Find (a) the rms current in the circuit, (b) the rms voltage drop across the resistor, (c) the rms voltage drop across the capacitor, and (d) the phase angle for the circuit.

24. An AC source operating at 60 Hz with a maximum voltage of 170 V is connected in series with a resistor (R = 1.2 kΩ) and an inductor (L = 2.8 H). (a) What is the maximum value of the current in the circuit? (b) What are the maximum values of the potential difference across the resistor and the inductor? (c) When the current is at a maximum, what are the magnitudes of the potential differences across the resistor, the inductor, and the AC source? (d) When the current is zero, what are the magnitudes of the potential difference across the resistor, the inductor, and the AC source?

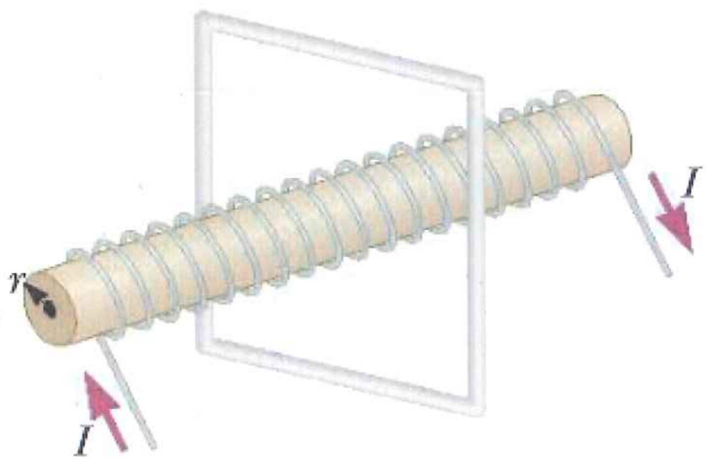
5. A long, straight wire lies in the plane of a circular coil with a radius of 0.010 m. The wire carries a current of 2.0 A and is placed along a diameter of the coil. (a) What is the net flux through the coil? (b) If the wire passes through the center of the coil and is perpendicular to the plane of the coil, what is the net flux

12. A circular loop of wire of radius 12.0 cm is placed in a magnetic field directed perpendicular to the plane of the loop, as shown in Figure P20.10. If the field decreases at the rate of 0.050 0 T/s in some time interval, what is the magnitude of the emf induced in the loop during this interval?



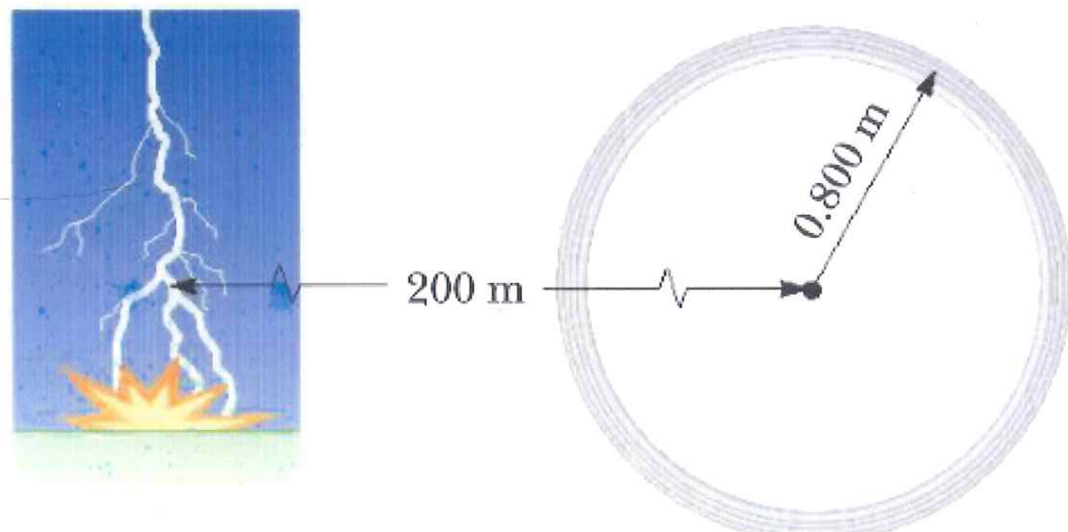
class 17
ch 20

60. A long solenoid of radius $r = 2.00$ cm is wound with 3.50×10^3 turns/m and carries a current that changes at the rate of 28.5 A/s as in Figure P20.60. What is the magnitude of the emf induced in the square conducting loop surrounding the center of the solenoid?



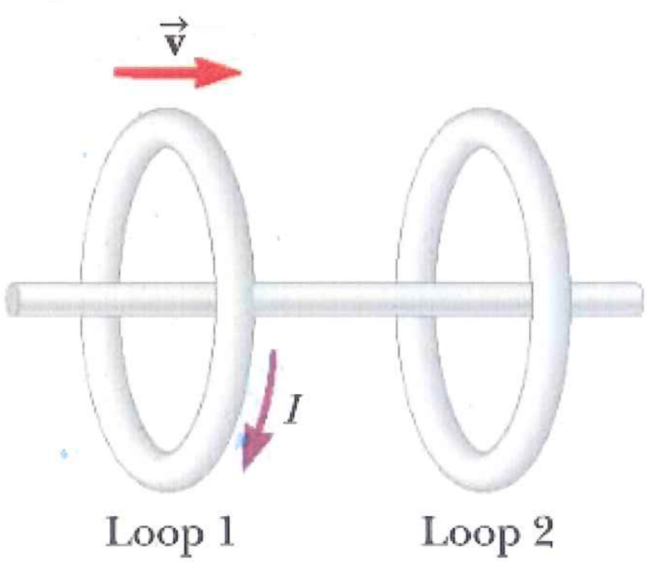
class 17
ch 20

61. The bolt of lightning depicted in Figure P20.61 passes 200 m from a 100-turn coil oriented as shown. If the current in the lightning bolt falls from 6.02×10^6 A to zero in 10.5 μs, what is the average voltage induced in the coil? Assume the distance to the center of the coil determines the average magnetic field at the coil's position. Treat the lightning bolt as a long, vertical wire.



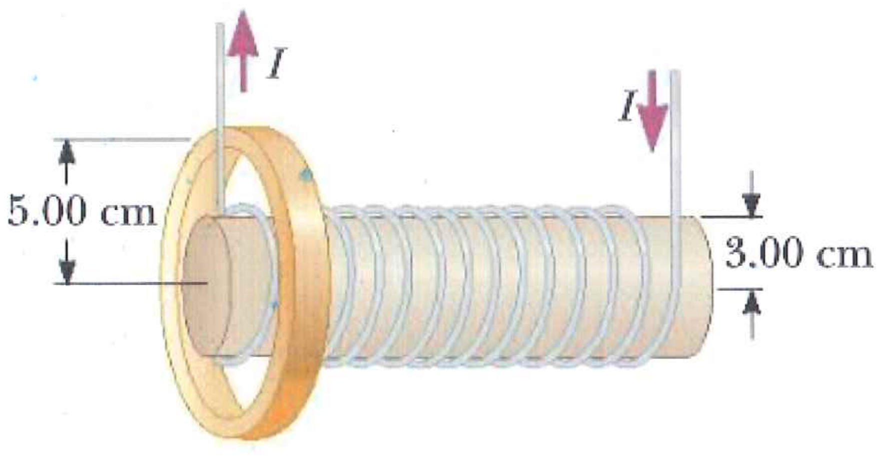
class 17
ch 20

53. Two circular loops of wire surround an insulating rod as in Figure P20.53. Loop 1 carries a current I in the clockwise direction when viewed from the left end. If loop 1 moves toward loop 2, which remains stationary, what is the direction of the induced current in loop 2 when viewed from the left end?

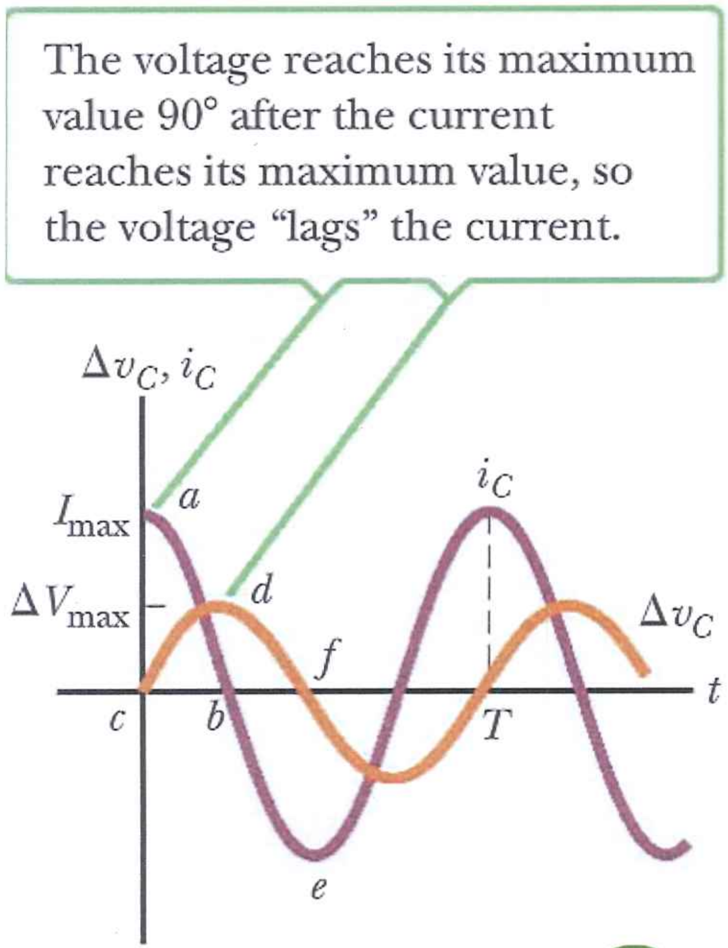


class 17
ch 20

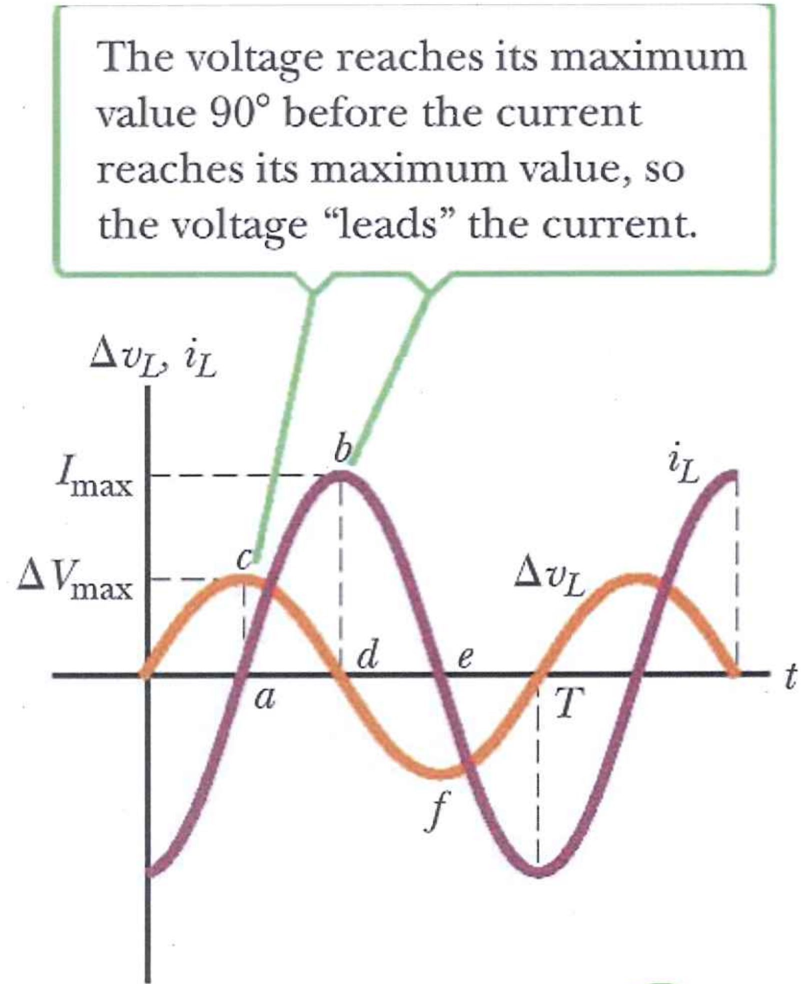
64. An aluminum ring of radius 5.00 cm and resistance $3.00 \times 10^{-4}\ \Omega$ is placed around the top of a long air-core solenoid with 1 000 turns per meter and a smaller radius of 3.00 cm, as in Figure P20.64. If the current in the solenoid is increasing at a constant rate of 270 A/s, what is the induced current in the ring? Assume the magnetic field produced by the solenoid over the area at the end of the solenoid is one-half as strong as the field at the center of the solenoid. Assume also the solenoid produces a negligible field outside its cross-sectional area.



class 17
ch 20



Active Figure 21.5
Plots of current and voltage across a capacitor versus time in an AC circuit.



Active Figure 21.7
Plots of current and voltage across an inductor versus time in an AC circuit.

18. A sinusoidal voltage $\Delta v = (80.0\text{ V})\sin(150t)$ is applied to a series *RLC* circuit with $L = 80.0$ mH, $C = 125.0\ \mu$F, and $R = 40.0\ \Omega$. (a) What is the impedance of the circuit? (b) What is the maximum current in the circuit?

22. A 50.0-Ω resistor, a 0.100-H inductor, and a 10.0-μF capacitor are connected in series to a 60.0-Hz source. The rms current in the circuit is 2.75 A. Find the rms voltages across (a) the resistor, (b) the inductor, (c) the capacitor, and (d) the *RLC* combination. (e) Sketch the phasor diagram for this circuit.

32. An AC voltage of the form $\Delta v = (90.0\text{ V})\sin(350t)$ is applied to a series *RLC* circuit. If $R = 50.0\ \Omega$, $C = 25.0\ \mu$F, and $L = 0.200$ H, find the (a) impedance of the circuit, (b) rms current in the circuit, and (c) average power delivered to the circuit.

chapt 21
class 20

42. A series circuit contains a 3.00-H inductor, a 3.00-μF capacitor, and a 30.0-Ω resistor connected to a 120-V (rms) source of variable frequency. Find the power delivered to the circuit when the frequency of the source is (a) the resonance frequency, (b) one-half the resonance frequency, (c) one-fourth the resonance frequency, (d) two times the resonance frequency, and (e) four times the resonance frequency. From your calculations, can you draw a conclusion about the frequency at which the maximum power is delivered to the circuit?

45. An AC power generator produces 50 A (rms) at 3 600 V. The voltage is stepped up to 100 000 V by an ideal transformer, and the energy is transmitted through a long-distance power line that has a resistance of 100 Ω. What percentage of the power delivered by the generator is dissipated as heat in the power line?

54. BIO **Operation of the pulse oximeter (see previous problem).** The transmission of light energy as it passes through a solution of light-absorbing molecules is described by the Beer–Lambert law

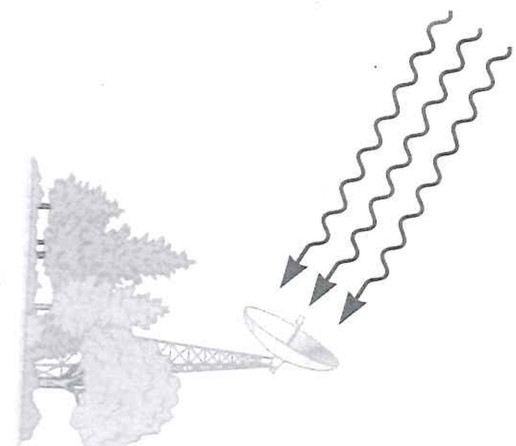
$$I = I_0 10^{-\epsilon CL} \quad \text{or} \quad \log_{10}\left(\frac{I}{I_0}\right) = -\epsilon CL$$

which gives the decrease in intensity I in terms of the distance L the light has traveled through a fluid with a concentration C of the light-absorbing molecule. The quantity ϵ is called the extinction coefficient, and its value depends on the frequency of the light. (It has units of m^2/mol.) Assume the extinction coefficient for 660-nm light passing through a solution of oxygenated hemoglobin is identical to the coefficient for 940-nm light passing through deoxygenated hemoglobin. Also assume 940-nm light has zero absorption ($\epsilon = 0$) in oxygenated hemoglobin and 660-nm light has zero absorption in deoxygenated hemoglobin. If 33% of the energy of the red source and 76% of the infrared energy is transmitted through the blood, what is the fraction of hemoglobin that is oxygenated?

55. The Sun delivers an average power of 1 370 W/m^2 to the top of Earth's atmosphere. Find the magnitudes of $\vec{\mathbf{E}}_{max}$ and $\vec{\mathbf{B}}_{max}$ for the electromagnetic waves at the top of the atmosphere.

65. While driving at a constant speed of 80 km/h, you are passed by a car traveling at 120 km/h. If the frequency of light emitted by the taillights of the car that passes you is 4.3×10^{14} Hz, what frequency will you observe? What is the change in frequency?

73. M A dish antenna with a diameter of 20.0 m receives (at normal incidence) a radio signal from a distant source, as shown in Figure P21.73. The radio signal is a continuous sinusoidal wave with amplitude $E_{max} = 0.20\ \mu V/m$. Assume the antenna absorbs all the radiation that falls on the dish. (a) What is the amplitude of the magnetic field in this wave? (b) What is the intensity of the radiation received by the antenna? (c) What is the power received by the antenna?



55. The Sun delivers an average power of 1 370 W/m^2 to the top of Earth's atmosphere. Find the magnitudes of $\vec{E}_{max}$ and $\vec{B}_{max}$ for the electromagnetic waves at the top of the atmosphere.

76. **BIO** **Q|C** The U.S. Food and Drug Administration limits the radiation leakage of microwave ovens to no more than 5.0 mW/cm^2 at a distance of 2.0 in. A typical cell phone, which also transmits microwaves, has a peak output power of about 2.0 W. (a) Approximating the cell phone as a point source, calculate the radiation intensity of a cell phone at a distance of 2.0 in. How does the answer compare with the maximum allowable microwave oven leakage? (b) The distance from your ear to your brain is about 2 in. What would the radiation intensity in your brain be if you used a Bluetooth headset, keeping the phone in your pocket, 1.0 m away from your brain? Most headsets are so-called Class 2 devices with a maximum output power of 2.5 mW.

↑ ch 21 class 21

ch 22 class 22 →

14. Two plane mirrors are at an angle of $\theta_1 = 50.0°$ with each other as in the side view shown in Figure P22.14. If a horizontal ray is incident on mirror 1, at what angle θ_2 does the outgoing reflected ray make with the surface of mirror 2?

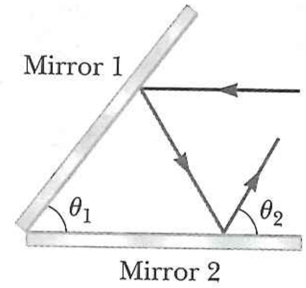


Figure P22.14

9. An underwater scuba diver sees the Sun at an apparent angle of 45.0° from the vertical. What is the actual direction of the Sun?

21. A block of crown glass is immersed in water as in Figure P22.21. A light ray is incident on the top face at an angle of $\theta_1 = 42.0°$ with the normal and exits the block at point P. (a) Find the vertical distance y from the top of the block to P. (b) Find the angle of refraction θ_2 of the light ray leaving the block at P.

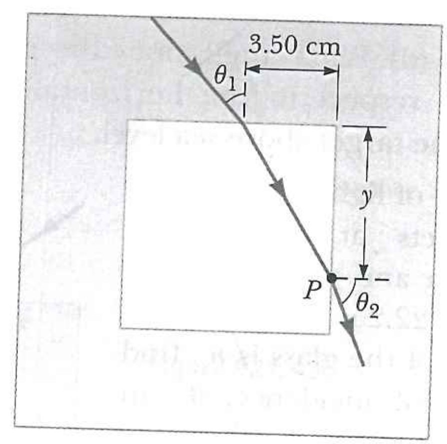
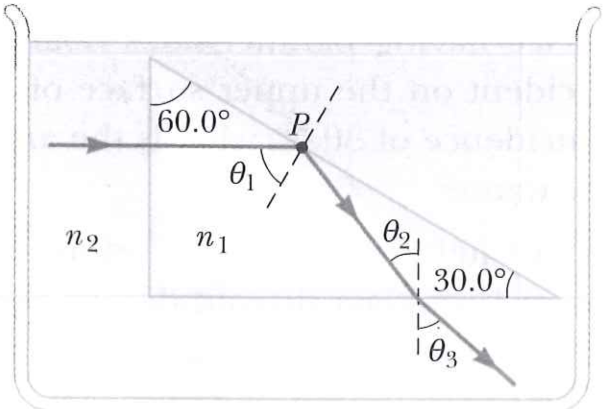
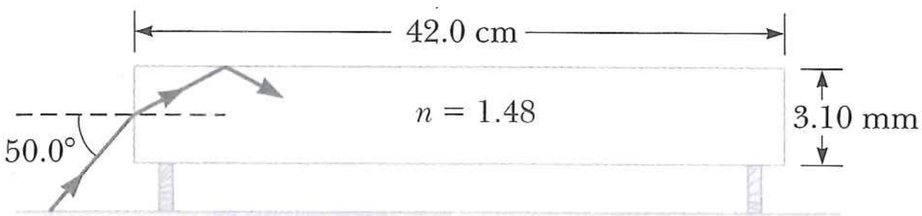


Figure P22.21

49. As shown in Figure P22.49, a light ray is incident normal to one face of a 30°–60°–90° block of flint glass (a prism) that is immersed in water. (a) Determine the exit angle θ_3 of the ray. (b) A substance is dissolved in the water to increase the index of refraction n_2. At what value of n_2 does total internal reflection cease at point P?



56. A laser beam strikes one end of a slab of material, as in Figure P22.56. The index of refraction of the slab is 1.48. Determine the number of internal reflections of the beam before it emerges from the opposite end of the slab.



ch 22
class 22

30. The index of refraction for crown glass is 1.512 at a wavelength of 660 nm (red), whereas its index of refraction is 1.530 at a wavelength of 410 nm (violet). If both wavelengths are incident on a slab of crown glass at the same angle of incidence, 60.0°, what is the angle of refraction for each wavelength?

← ch 22

7. A convex spherical mirror, whose focal length has a magnitude of 15.0 cm, is to form an image 10.0 cm behind the mirror. (a) Where should the object be placed? (b) What is the magnification of the mirror?

← ch 23

class 23

10. **Q|C** While looking at her image in a cosmetic mirror, Dina notes that her face is highly magnified when she is close to the mirror, but as she backs away from the mirror, her image first becomes blurry, then disappears when she is about 30 cm from the mirror, and then inverts when she is beyond 30 cm. Based on these observations, what can she conclude about the properties of the mirror?

11. A 2.00-cm-high object is placed 3.00 cm in front of a concave mirror. If the image is 5.00 cm high and virtual, what is the focal length of the mirror?

18. **Q|C** A concave mirror has a radius of curvature of 24.0 cm. (a) Determine the object position for which the resulting image is upright and larger than the object by a factor of 3.00. (b) Draw a ray diagram to determine the position of the image. (c) Is the image real or virtual?

64. A certain Christmas tree ornament is a silver sphere having a diameter of 8.50 cm. (a) If the size of an image created by reflection in the ornament is three-fourth's the reflected object's actual size, determine the object's location. (b) Use a principal-ray diagram to determine whether the image is upright or inverted.

34. **Q|C** A diverging lens has a focal length of 20.0 cm. Use graph paper to construct accurate ray diagrams for object distances of (a) 40.0 cm and (b) 10.0 cm. In each case determine the location of the image from the diagram and the image magnification, and state whether the image is upright or inverted. (c) Estimate the magnitude of uncertainty in locating the points in the graph. Are your answers and the uncertainty consistent with the algebraic answers found in Problem 33?

36. The nickel's image in Figure P23.36 has twice the diameter of the nickel when the lens is 2.84 cm from the nickel. Determine the focal length of the lens.

ch 23 class 25

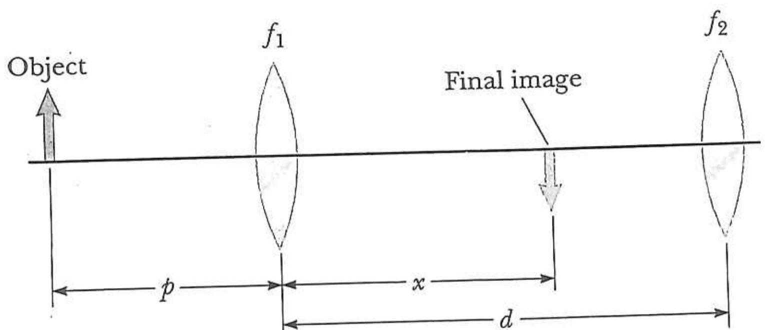
38. **M** An object is located 20.0 cm to the left of a diverging lens having a focal length $f = -32.0$ cm. Determine (a) the location and (b) the magnification of the image. (c) Construct a ray diagram for this arrangement.

29. **BIO** A contact lens is made of plastic with an index of refraction of 1.50. The lens has an outer radius of curvature of +2.00 cm and an inner radius of curvature of +2.50 cm. What is the focal length of the lens?

30. An object is placed 50.0 cm from a screen. (a) Where should a converging lens of focal length 10.0 cm be placed to form an image on the screen? (b) Find the magnification of the lens.

42. Object O_1 is 15.0 cm to the left of a converging lens with a 10.0-cm focal length. A second lens is positioned 10.0 cm to the right of the first lens and is observed to form a virtual image at the position of the original object O_1. (a) What is the focal length of the second lens? (b) What is the overall magnification of this system? (c) What is the nature (i.e., real or virtual, upright or inverted) of the final image?

44. Two converging lenses having focal lengths of f_1 = 10.0 cm and f_2 = 20.0 cm are placed d = 50.0 cm apart, as shown in Figure P23.44. The final image is to be located between the lenses, at the position x = 31.0 cm indicated. (a) How far to the left of the first lens should the object be positioned? (b) What is the overall magnification of the system? (c) Is the final image upright or inverted?



57. An object 2.00 cm high is placed 40.0 cm to the left of a converging lens having a focal length of 30.0 cm. A diverging lens having a focal length of −20.0 cm is placed 110 cm to the right of the converging lens. (a) Determine the final position and magnification of the final image. (b) Is the image upright or inverted? (c) Repeat parts (a) and (b) for the case in which the second lens is a converging lens having a focal length of +20.0 cm.

45. Lens L_1 in Figure P23.45 has a focal length of 15.0 cm and is located a fixed distance in front of the film plane of a camera. Lens L_2 has a focal length of 13.0 cm, and its distance d from the film plane can be varied from 5.00 cm to 10.0 cm. Determine the range of distances for which objects can be focused on the film.

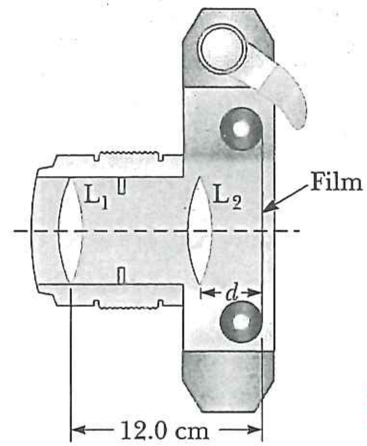


Figure P23.45

ch 23
class 25

59. Figure P23.59 shows a converging lens with radii R_1 = 9.00 cm and R_2 = −11.00 cm, in front of a concave spherical mirror of radius R = 8.00 cm. The focal points (F_1 and F_2) for the thin lens and the center of curvature (C) of the mirror are also shown. (a) If the focal points F_1 and F_2 are 5.00 cm from the vertex of the thin lens, what is the index of refraction of the lens? (b) If the lens and mirror are 20.0 cm apart and an object is placed 8.00 cm to the left of the lens, what is the position of the final image and its magnification as seen by the eye in the figure? (c) Is the final image inverted or upright? Explain.