19.1 Magnets, Magnetic Poles, and Magnetic Field Direction

1.   **MC** When the ends of two bar magnets are near each other, they attract one another. The ends must be (a) one north, the other south, (b) both north, (c) both south, (d) either a or b.
2.   **MC** A compass that has been calibrated in the Earth's magnetic field is placed near the end of a permanent bar magnet, and points away from that end of the magnet. It can be concluded that this end of the magnet (a) acts as a north magnetic pole, (b) acts as a south magnetic pole, (c) you can't conclude anything about the magnetic properties of the permanent magnet.
3.   **MC** If you look directly at the south pole of a bar magnet, its magnetic field points (a) to the right, (b) to the left, (c) away from you, or (d) toward you.
4.   **CQ** Given two identical iron bars, one of which is a permanent magnet and the other unmagnetized, how could you tell which is which by using only the two bars?

19.2 Magnetic Field Strength and Magnetic Force

6.   **MC** A proton moves vertically upward perpendicularly to a uniform magnetic field and deflects to the right as you watch it. What is the magnetic field direction: (a) directly away from you, (b) directly toward you, (c) to the right, or (d) to the left?
7.   **MC** An electron is moving horizontally to the east in a uniform magnetic field that is vertical. It is found to deflect north. What direction is the magnetic field? (a) up (b) down or (c) the direction can't be determined from the given data.
8.   **MC** If a negatively charged particle were moving downward along the right edge of this page, which way should a magnetic field (known to be perpendicular to the plane of the paper) be oriented so that the particle would initially be deflected to the left: (a) out of the page, (b) in the plane of the page, or (c) into the page? (c)
9.   **MC** An electron passes through a magnetic field without being deflected. What do you conclude about the angle between the magnetic field direction and that of the electron's velocity, assuming that no other forces act: (a) They could be in the same direction, (b) they could be perpendicular, (c) they could be opposite, or (d) both a and c are possible?
10. **CQ** A proton and an electron are moving at the same velocity perpendicularly to a constant magnetic field. (a) How do the magnitudes of the magnetic forces on them compare? (b) What about the magnitudes of their accelerations?
14. **IE** ● A positive charge moves horizontally to the right across this page and enters a magnetic field directed vertically downward in the plane of the page. (a) What is the direction of the magnetic force on the charge: (1) into the page, (2) out of the page, (3) downward in the plane of the page, or (4) upward in the plane of the page? Explain. (b) If the charge is 0.25 C, its speed is 2.0×10^2 m/s, and it is acted on by a force of 20 N, what is the magnetic field strength?
17. ●● A beam of protons is accelerated to a speed of 5.0×10^6 m/s in a particle accelerator and emerges horizontally from the accelerator into a uniform magnetic field. What $\vec{B}$ field perpendicular to the velocity of the proton would cancel the force of gravity and keep the beam moving exactly horizontally?
18. **IE** ●● An electron travels in the $+x$-direction in a magnetic field and is acted on by a magnetic force in the $-y$-direction. (a) In which of the following directions could the magnetic field be oriented: (1) $-x$-, (2) $+y$-, (3) $+z$-, or (4) $-z$-direction? Explain. (b) If the electron speed is 3.0×10^6 m/s and the magnitude of the force is 5.0×10^{-19} N, what is the magnetic field strength?

19.3 Applications: Charged Particles in Magnetic Fields

22. **MC** In a mass spectrometer two ions with identical charge and speed are accelerated into two different semicircular arcs. Ion A's arc has a radius of 25.0 cm and ion B's arc's radius is 50.0 cm. What can you say about their relative masses? (a) $m_A = m_B$ (b) $m_A = 2m_B$ (c) $m_A = \frac{1}{2}m_B$ (d) you can't say anything given just this data.
23. **MC** In a mass spectrometer two ions with identical mass and speed are accelerated into two different semicircular arcs. Ion A's arc has a radius of 25.0 cm and ion B's arc's radius is 50.0 cm. What can you say about their net charges? (a) $q_A = q_B$ (b) $q_A = 2q_B$ (c) $q_A = \frac{1}{2}q_B$ (d) you can't say anything given just this data.

24. **MC** In the velocity selector shown in > Fig. 19.9, which way will an ion be deflected if its velocity is larger than E/B_1? (a) up (b) down (c) There will be no deflection.
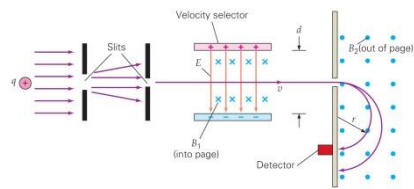
25. Explain how a nearby magnet can distort the display of a computer monitor or television picture tube (<Fig. 19.35).

28. ● An ionized deuteron (a particle with a $+e$ charge) passes through a velocity selector whose perpendicular magnetic and electric fields have magnitudes of 40 mT and 8.0 kV/m, respectively. Find the speed of the ion.

29. ● In a velocity selector, the uniform magnetic field of 1.5 T is produced by a large magnet. Two parallel plates with a separation of 1.5 cm produce the perpendicular electric field. What voltage should be applied across the plates so that (a) a singly charged ion traveling at 8.0×10^4 m/s will pass through undeflected or (b) a doubly charged ion traveling at the same speed will pass through undeflected?

30. ● A charged particle travels undeflected through perpendicular electric and magnetic fields whose magnitudes are 3000 N/C and 30 mT, respectively. Find the speed of the particle if it is (a) a proton or (b) an alpha particle. (An alpha particle is a helium nucleus—a positive ion with a double positive charge.)

31. ●● In an experimental technique for treating deep tumors, unstable positively charged pions (π^+, elementary particles with a mass of 2.25×10^{-28} kg) are aimed to penetrate the flesh and to disintegrate at the tumor site, releasing energy to kill cancer cells. If pions with a kinetic energy of 10 keV are required and if a velocity selector with an electric field strength of 2.0×10^3 V/m is used, what must be the magnetic field strength?

19.4 Magnetic Forces on Current-Carrying Wires
and
19.5 Applications: Current-Carrying Wires in Magnetic Fields

35. **MC** A long, straight, horizontal wire located on the equator carries a current directed toward the east. What is the direction of the force on the wire due to the Earth's magnetic field: (a) east, (b) west, (c) south, or (d) upward?

36. **MC** A long, straight, horizontal wire located on the equator carries a current. In what direction should the current be if the object is to attempt to balance the wire's weight with the magnetic force on it: (a) east, (b) west, (c) south, or (d) upward?

37. **MC** You are looking horizontally due west directly at the circular plane of a current-carrying coil. The coil is in a uniform vertically upward magnetic field. When released, the top of the coil starts to rotate away from you as the bottom rotates toward you. Which direction is the current in the coil: (a) clockwise, (b) counterclockwise, or (c) can't tell from the data given?

39. **CQ** Predict what should happen to the length of a spring when a large current passes through it. [*Hint*: Consider the current direction in the neighboring spring coils.]

43. ● A 2.0-m length of straight wire carries a current of 20 A in a uniform magnetic field of 50 mT whose direction is at an angle of 37° from the direction of the current. Find the force on the wire.

44. ●● Show how you can use a right-hand force rule to find the direction of the current in a wire in a magnetic field if you know the force on the wire. The forces on some specific wires are shown in >Fig. 19.37.

45. ●● A straight wire 50 cm long conducts a current of 4.0 A directed vertically upward. If the wire is acted on by a force of 1.0×10^{-2} N in the eastward direction due to a magnetic field at right angles to the length of the wire, what are the magnitude and direction of the magnetic field?

46. ●● A horizontal magnetic field of 1.0×10^{-4} T is at an angle of 30° to the direction of the current in a straight, horizontal wire 75 cm long. If the wire carries a current of 15 A, what is the magnitude of the force on the wire?

56. **IE** ●● A long wire is placed 2.0 cm directly below a rigidly mounted second wire (▼Fig. 19.39). (a) Use the right-hand source and force rules to determine whether the currents in the wires should be in (1) the same or (2) the opposite direction so that the lower wire is in equilibrium. (It "floats.") (b) If the lower wire has a linear mass density of 1.5×10^{-3} kg/m and the wires carry the same current, what should be the current?
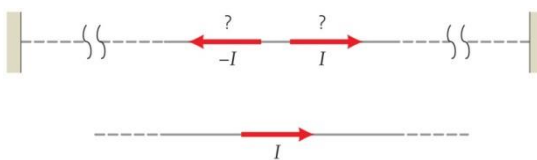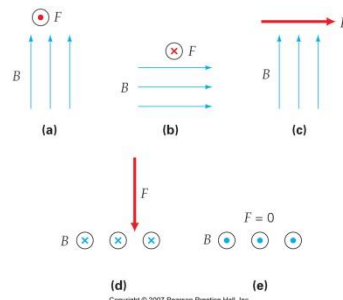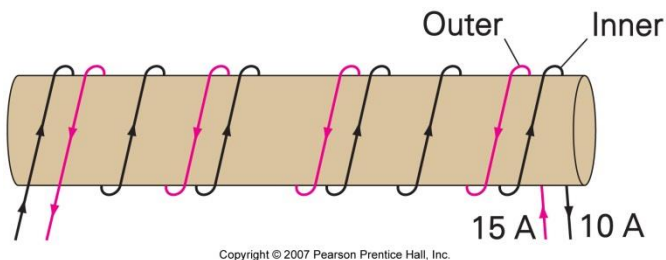
19.6 Electromagnetism: The Source of Magnetic Fields

61.   **MC** A long, straight wire is parallel to the ground and carries a steady current to the east. At a point directly below the wire, what is the direction of the magnetic field the wire produces: (a) north, (b) east, (c) south, or (d) west?

62.   **MC** You are looking directly into one end of a long solenoid. The magnetic field at its center points at you. What is the direction of the current in the solenoid, as viewed by you: (a) clockwise, (b) counterclockwise, (c) directly toward you, or (d) directly away from you?

63.   **MC** A current-carrying loop of wire is in the plane of this paper. Outside the loop, its magnetic field points into the paper. What is the direction of the current in the loop: (a) clockwise, (b) counterclockwise, or (c) can't tell from the data given?

68.   **CQ** Two circular wire loops are coplanar (that is, their areas are in the same plane) and have a common center. The outer one carries a current of 10 A in the clockwise direction. To create a zero magnetic field at their center, what should be the direction of the current in the inner loop? Should its current be 10 A, larger than 10 A, or smaller than 10 A? Explain your reasoning.

76.   ●● In >Fig. 19.38, find the magnetic field (magnitude and direction) at point A, which is located 9.0 cm away from wire 2 on a line perpendicular to the line joining the wires.

77.   ●● Suppose that the current in wire 1 in >Fig. 19.38 were in the opposite direction. What would be the magnetic field midway between the wires?

79.   ●● A coil of four circular loops of radius 5.0 cm carries a current of 2.0 A clockwise, as viewed from above the coil's plane. What is the magnetic field at the center of the coil?
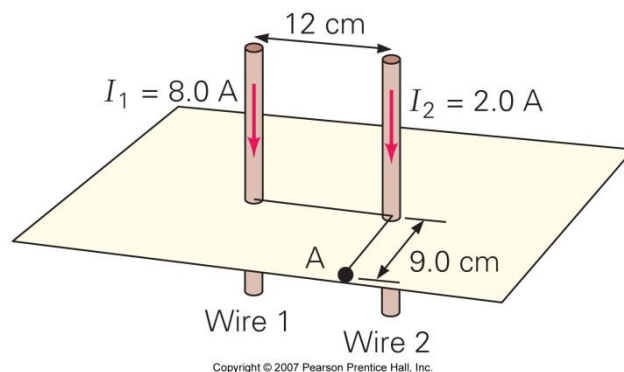
83.   ●●● A solenoid is wound with 200 turns per centimeter. An outer layer of insulated wire with 180 turns per centimeter is wound over the solenoid's first layer of wire. When the solenoid is operating, the inner coil carries a current of 10 A and the outer coil carries a current of 15 A in the direction opposite to that of the current in the inner coil (>Fig. 19.43). (a) What is the magnitude of the magnetic field at the center of the doubly wound solenoid? (b) What is the direction of the magnetic field at the center for this configuration?

19.7 Magnetic Materials

87.   **MC** The main source of magnetism in magnetic materials is from (a) electron orbits, (b) electron spin, (c) magnetic poles, (d) nuclear properties.

88.   **MC** When a ferromagnetic material is placed in an external magnetic field, (a) the domain orientation may change, (b) the domain boundaries may change, (c) new domains are created, (d) both a and b.

89.   **CQ** If you are looking down on the orbital plane of the electron in a hydrogen atom and the electron orbits counterclockwise, what is the direction of the magnetic field the electron produces at the proton?

90.   **CQ** What is the purpose of the iron core often used at the center of a solenoid?

91.   **CQ** Discuss several ways you destroy or reduce the magnetic field of a permanent magnet.

92.   ●● A solenoid with 100 turns per centimeter has an iron core with a relative permeability of 2000. The solenoid carries a current of 0.040 A. (a) What is the magnetic field at the center of the solenoid? (b) How much greater is the magnetic field with the iron core than it would be without it?