14. A bar magnet falling inside a vertical metal tube reaches a terminal velocity even if the tube is evacuated so that there is no air resistance. Explain.
15. It has been proposed that eddy currents be used to help sort solid waste for recycling. The waste is first ground into tiny pieces and iron removed with a magnet. The waste then is allowed to slide down an incline over permanent magnets. How will this aid in the separation of nonferrous metals (Al, Cu, Pb, brass) from nonmetallic materials?
16. The pivoted metal bar with slots in Fig. 21–50 falls much more quickly through a magnetic field than does a solid bar. Explain.

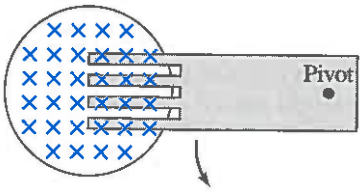

FIGURE 21–50
Question 16.

17. If an aluminum sheet is held between the poles of a large bar magnet, it requires some force to pull it out of the magnetic field even though the sheet is not ferromagnetic and does not touch the pole faces. Explain.
18. A bar magnet is held above the floor and dropped (Fig. 21–51). In case (a), the magnet falls through a wire loop. In case (b), there is nothing between the magnet and the floor. How will the speeds of the magnets compare? Explain.

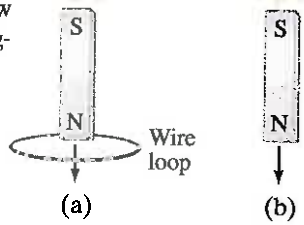

FIGURE 21–51
Question 18 and MisConceptual Question 5.

19. A metal bar, pivoted at one end, oscillates freely in the absence of a magnetic field; but in a magnetic field, its oscillations are quickly damped out. Explain. (This *magnetic damping* is used in a number of practical devices.)
20. An enclosed transformer has four wire leads coming from it. How could you determine the ratio of turns on the two coils without taking the transformer apart? How would you know which wires paired with which?
21. The use of higher-voltage lines in homes—say, 600 V or 1200 V—would reduce energy waste. Why are they not used?
22. A transformer designed for a 120-V ac input will often "burn out" if connected to a 120-V dc source. Explain. [*Hint*: The resistance of the primary coil is usually very low.]

*23. How would you arrange two flat circular coils so that their mutual inductance was (*a*) greatest, (*b*) least (without separating them by a great distance)? Explain.
*24. Does the emf of the battery in Fig. 21–37 affect the time needed for the *LR* circuit to reach (*a*) a given fraction of its maximum possible current, (*b*) a given value of current? Explain.
*25. In an *LRC* circuit, can the rms voltage across (*a*) an inductor, (*b*) a capacitor, be greater than the rms voltage of the ac source? Explain.
*26. Describe briefly how the frequency of the source emf affects the impedance of (*a*) a pure resistance, (*b*) a pure capacitance, (*c*) a pure inductance, (*d*) an *LRC* circuit near resonance (*R* small), (*e*) an *LRC* circuit far from resonance (*R* small).
*27. Describe how to make the impedance in an *LRC* circuit a minimum.
*28. An *LRC* resonant circuit is often called an *oscillator* circuit. What is it that oscillates?
*29. Is the ac current in the inductor always the same as the current in the resistor of an *LRC* circuit? Explain.

MisConceptual Questions

1. A coil rests in the plane of the page while a magnetic field is directed into the page. A clockwise current is induced
   (*a*) when the magnetic field gets stronger.
   (*b*) when the size of the coil decreases.
   (*c*) when the coil is moved sideways across the page.
   (*d*) when the magnetic field is tilted so it is no longer perpendicular to the page.
2. A wire loop moves at constant velocity without rotation through a constant magnetic field. The induced current in the loop will be
   (*a*) clockwise. (*b*) counterclockwise. (*c*) zero.
   (*d*) We need to know the orientation of the loop relative to the magnetic field.
3. A square loop moves to the right from an area where $\vec{B} = 0$, completely through a region containing a uniform magnetic field directed into the page (Fig. 21–52), and then out to $B = 0$ after point L. A current is induced in the loop
   (*a*) only as it passes line J. (*d*) as it passes line J or line L.
   (*b*) only as it passes line K. (*e*) as it passes all three lines.
   (*c*) only as it passes line L.

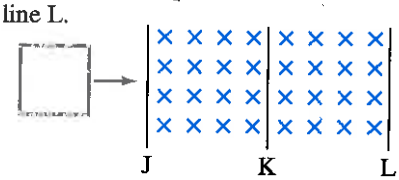

FIGURE 21–52
MisConceptual Question 3.

4. Two loops of wire are moving in the vicinity of a very long straight wire carrying a steady current (Fig. 21–53). Find the direction of the induced current in each loop.

For C:
(*a*) clockwise.
(*b*) counterclockwise.
(*c*) zero.
(*d*) alternating (ac).

For D:
(*a*) clockwise.
(*b*) counterclockwise.
(*c*) zero.
(*d*) alternating (ac).

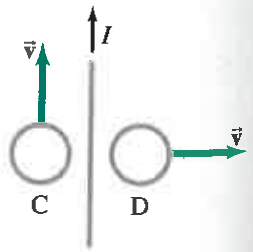

FIGURE 21–53
MisConceptual Question 4.

5. If there is induced current in Question 18 (see Fig. 21–51), wouldn't that cost energy? Where would that energy come from in case (a)?
   (*a*) Induced current doesn't need energy.
   (*b*) Energy conservation is violated.
   (*c*) There is less kinetic energy.
   (*d*) There is more gravitational potential energy.

6. A nonconducting plastic hoop is held in a magnetic field that points out of the page (Fig. 21–54). As the strength of the field increases,
(*a*) an induced emf will be produced that causes a clockwise current.
(*b*) an induced emf will be produced that causes a counterclockwise current.
(*c*) an induced emf will be produced but no current.
(*d*) no induced emf will be produced.

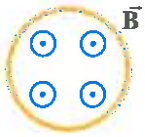

FIGURE 21–54
MisConceptual Question 6.

7. A long straight wire carries a current I as shown in Fig. 21–55. A small loop of wire rests in the plane of the page. Which of the following will *not* induce a current in the loop?
(*a*) Increasing the current in the straight wire.
(*b*) Moving the loop in a direction parallel to the wire.
(*c*) Rotating the loop so that it becomes perpendicular to the plane of the page.
(*d*) Moving the loop farther from the wire without rotating it.
(*e*) Moving the loop farther from the wire while rotating it.

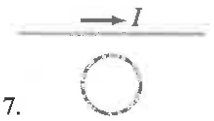

FIGURE 21–55
MisConceptual Question 7.

8. Two separate but nearby coils are mounted along the same axis. A power supply controls the flow of current in the first coil, and thus the magnetic field it produces. The second coil is connected only to an ammeter. The ammeter will indicate that a current is flowing in the second coil
(*a*) whenever a current flows in the first coil.
(*b*) only when a steady current flows in the first coil.
(*c*) only when the current in the first coil changes.
(*d*) only if the second coil is connected to the power supply by rewiring it to be in series with the first coil.

9. When a generator is used to produce electric current, the resulting electric energy originates from which source?
(*a*) The generator's magnetic field.
(*b*) Whatever rotates the generator's axle.
(*c*) The resistance of the generator's coil.
(*d*) Back emf.
(*e*) Empty space.

10. Which of the following will *not* increase a generator's voltage output?
(*a*) Rotating the generator faster.
(*b*) Increasing the area of the coil.
(*c*) Rotating the magnetic field so that it is more closely parallel to the generator's rotation axis.
(*d*) Increasing the magnetic field through the coil.
(*e*) Increasing the number of turns in the coil.

11. Which of the following can a transformer accomplish?
(*a*) Changing voltage but not current.
(*b*) Changing current but not voltage.
(*c*) Changing power.
(*d*) Changing both current and voltage.

12. A laptop computer's charger unit converts 120 V from a wall power outlet to the lower voltage required by the laptop. Inside the charger's plastic case is a diode or rectifier (discussed in Chapter 29) that changes ac to dc plus a
(*a*) battery.
(*b*) motor.
(*c*) generator.
(*d*) transformer.
(*e*) transmission line.

13. Which of the following statements about transformers is false?
(*a*) Transformers work using ac current or dc current.
(*b*) If the current in the secondary is higher, the voltage is lower.
(*c*) If the voltage in the secondary is higher, the current is lower.
(*d*) If no flux is lost, the product of the voltage and the current is the same in the primary and secondary coils.

14. A 10-V, 1.0-A dc current is run through a step-up transformer that has 10 turns on the input side and 20 turns on the output side. What is the output?
(*a*) 10 V, 0.5 A.
(*b*) 20 V, 0.5 A.
(*c*) 20 V, 1 A.
(*d*) 10 V, 1 A.
(*e*) 0 V, 0 A.

15. The alternating electric current at a wall outlet is most commonly produced by
(*a*) a connection to rechargeable batteries.
(*b*) a rotating coil that is immersed in a magnetic field.
(*c*) accelerating electrons between oppositely charged capacitor plates.
(*d*) using an electric motor.
(*e*) alternately heating and cooling a wire.

*16. When you swipe a credit card, the machine sometimes fails to read the card. What can you do differently?
(*a*) Swipe the card more slowly so that the reader has more time to read the magnetic stripe.
(*b*) Swipe the card more quickly so that the induced emf is higher.
(*c*) Swipe the card more quickly so that the induced currents are reduced.
(*d*) Swipe the card more slowly so that the magnetic fields don't change so fast.

*17. Which of the following is true about all series ac circuits?
(*a*) The voltage across any circuit element is a maximum when the current is a maximum in that circuit element.
(*b*) The current at any point in the circuit is always the same as the current at any other point in the circuit.
(*c*) The current in the circuit is a maximum when the source ac voltage is a maximum.
(*d*) Resistors, capacitors, and inductors can all change the phase of the current.