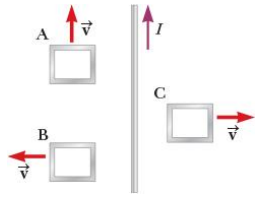
PHYS 1120 Discussion 7.
Faraday's law and Inductance

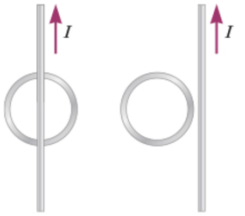
Problems

1. Consider a simple solenoid made of a loose helical coil. The current in any segment of the coil is affected by the magnetic field generated by the other segments.
   A. What is the direction of the force exerted on a segment of wire by the field generated by the segment on the other side of the coil (diametrically opposed)?
   B. What is the direction of the force exerted on a segment of wire by the field generated by the matching segment on an adjacent loop?
   C. How does increasing the current in a helical coil solenoid tend to reshape the coil?

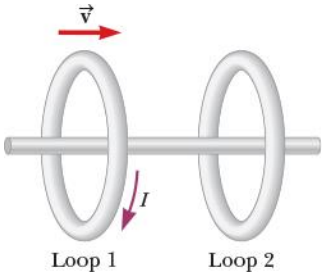
2. (This is question 20-9 from your textbook.) Three conducting loops move near a long straight wire carrying a current as shown. What is the direction of the induced current, if any, in each loop?



3. (This is question 20-17 from your textbook.) A circular conducting loop is near a long, straight wire carrying a current that is increasing. In one case, the loop is bisected by the wire; in the other, the loop is beside the wire. What is the direction of the current, if any, induced in each loop?

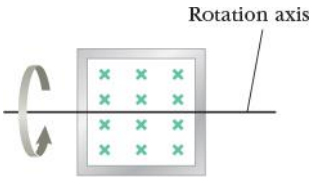


4. (This is question 20-53 from your textbook.) Two circular conducting loops loop around an insulating rod as shown. Loop 1 carries a current I in the clockwise direction as viewed from the left end. If loop 1 moves to the right toward loop 2, which remains stationary, what is the direction of the current induced in loop 2?



5. A solenoid with 50 windings per centimeter has a radius of 2.50 cm and a length of 15.0 cm.
   A. What is the magnitude of the magnetic field inside the solenoid when it carries a current of 2.0 A?
   B. What is the absolute value of the magnetic flux through one winding of the solenoid when it carries a current of 2.0 A?
   C. What is the total magnetic flux through all the windings of the solenoid when it carries a current of 2.0 A?
   D. If the current through the solenoid decreases from 2.0 A to zero in 2.0 s, what emf does the solenoid generate?
   E. The inductance L of a coil is defined as the voltage required to change the current I through the inductor at a rate of 1 A/s: $V = L\,\Delta I/\Delta t$. What is the inductance of this solenoid?
   F. If the current through the solenoid decreases from 2.0 A to zero in 2.0 s, how much total charge flows through the solenoid while it discharges?
   G. What is the total work done by the solenoid in decreasing its current from 2.0 A to zero?

6. (This is question 20-31 from your textbook.) A square coil of wire 2.80 cm on a side is placed in a uniform magnetic field of magnitude 1.25 T directed into the page as shown. The coil has 28 turns and a resistance of 0.780 Ω. The coil is rotated by 90° about a horizontal axis as shown in 0.335 s.



   A. What is the average emf induced in the coil?
   B. What is the average current induced in the coil?

7. (Adapted slightly from problem 21-44 in your textbook.) A step-down transformer is used to recharge a small electronic device. It has 13 times as many windings on the primary side as on the secondary side. When used with 120-V household service, the transformer draws a primary current of 250 mA.
   A. What is the output voltage of the transformer?
   B. What is the power drawn by the transformer?