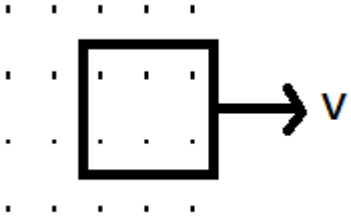
Electromagnetic Induction

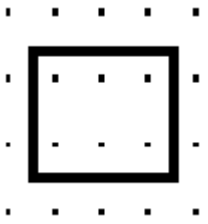
1. A magnetic field (B = 3.2×10^{-3}T) passes perpendicular through a circular loop of wire (radius = 5.0cm). What is the magnetic flux through the loop?
2. A circular coil with 200 turns and a radius of 6.0cm is rotated in a uniform magnetic field (B = 3.6×10^{-4}T). At t=0, the coil is perpendicular to the field, and at t = 0.015s, the coil is parallel to the field. What is the average emf induced in the coil?
3. A square loop of wire with an area of 2.5×10^{-3} m^2 is perpendicular to a uniform magnetic field (B = 2.2×10^{-2} T). If the square collapses (collapsed area=0) in a time of 0.100 s as shown in the diagram what is the average induced emf as it is collapsed and what is the direction of the induced current? (Remember to use conventional current)

4. Find the average emf induced in a circular coil (50 turns radius of 0.050 m) if the magnetic flux through the loops is changing at a rate of 15.0 Wb/s?
5. A square coil (100 turns area of each square loop = $4.0 \times 10^{-3} m^2$) is perpendicular to a uniform magnetic field. When the coil is rotated through 90° in 0.12 s, the average induced emf is 0.92 V. What is the magnetic field strength?
6. A circular coil (10 turns, diameter = 25 cm) is placed perpendicular to a uniform magnetic field (B = 2.7×10^{-3} T). If the direction of the magnetic field is reversed in 0.30s, what is the average emf induced in the coil?
7. A magnet is quickly removed from a circular coil (25 turns, area = 5.0×10^{-3} m^2) changing the magnetic field within the coil at a rate of 0.40 T/s. What is the average emf induced in the coil?
8. A square loop of wire (area= 7.2×10^{-3} m2) has a resistance of 12.0Ω. Assume that the magnetic field drops uniformly from 1.6 T to zero in 0.050 s as the loop is pulled from the magnetic field.

a) What is the average emf induced in the loop?
b) What is the current induced in the loop?
c) What is the direction of the electron flow in the loop?

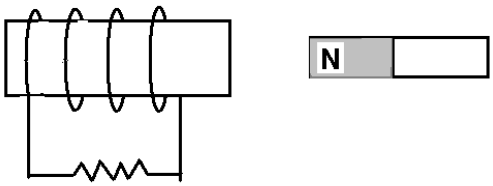


9. A square loop of wire (4.0 cm per side) is placed in a magnetic field (B= 0.20 T). The magnetic field is increased to 0.50 T in 0.30 s.
   a) Find the current through the loop if the resistance of the loop is 2.0 Ω.
   b) Find the direction of the electron flow through the loop.

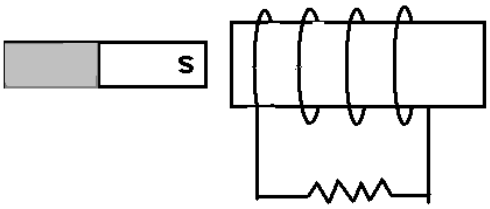


Lens' Law Practice

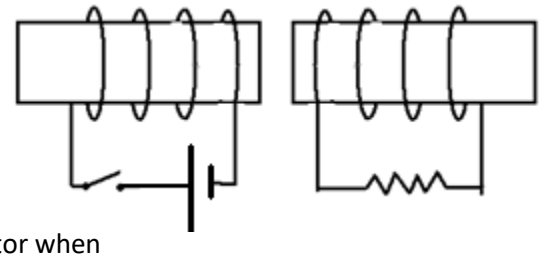
1. Find the direction of the current in the resistor if the magnet is moved (a) right, (b) left



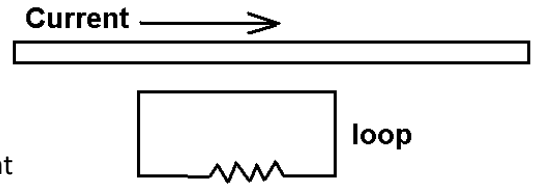
2. Find the direction of the current in the resistor if the magnet is moved (a) right, (b) left



3. What is the direction of the induced current in the resistor attached to the solenoid on the right when
a) the switch has just been closed
b) the switch has been closed a while
c) the switch has just been open



4. Find the direction of the current in the resistor when
a) the current is increasing
b) the current is decreasing
c) the current is constant and the loop is moved down
d) the current is constant and the loop is moved up
e) the current is constant and the loop is moved to the right



5. A circular loop of wire in sits on the floor on the south magnetic pole.
a) If the loop is suddenly pulled into a long oval, what is the direction (clockwise/ccw) of the induced current?
b) If the loop is suddenly shaped in to a square what is the direction (clockwise/ccw) of the induced current?

Electric Motors

1. An electric motor is operated from a 6.0 V power supply. When the armature is held still, the current is 4.0 A. When the motor turns freely the current is 2.4 A.
a) Find the resistance of the armature.
b) What is the back emf when the motor turns freely?
c) If the load on the motor is increased so that the frequency is reduced to ¾ of what it was, what will the back emf be then?
2. A motor has an armature resistance of 1.8Ω. Running at full speed it draws a current of 0.50 A when connected to a 12 V source.
a) Find the back emf.
b) Find the back emf if the motor runs at half speed.
3. The back emf of a motor is 4.2 V when operated from a 6.0 V source. When held stationary, the current in the armature is 5.0 A. Find
a) the resistance of the armature
b) the current if the motor runs at half speed
4. Why might overloading a motor ruin the armature?
5. Is an electric motor more efficient at high or low frequency? Explain.

Transformers (assume all transformers are 100% efficient)

1. Why won't a transformer work with direct current?
2. If a transformer has 120 turns in the primary coil and 600 turns in the secondary coil, and 120 V is applied to the primary coil, what is the secondary voltage?
3. The primary coil of a transformer has 5000 turns and is connected to a 120 V source, and the secondary coil has 50 turns. The current in the secondary coil is 10.0 A. Find
a) the secondary voltage
b) the primary current
4. A transformer has 50 primary turns and 2000 secondary turns. The primary is connected to 240 V AC, and the secondary current is 2.5 mA. Find
a) secondary voltage
b) primary current
c) power output
d) power input
5. Why is a step-down transformer inserted between your circuit box and your doorbell circuit?
6. Research why an iron core of a transformer is made of laminated layers of iron instead of one solid block. Refer to "eddy currents".

Answers

Electromagnetic Induction

1. 2.5×10^{-5} Wb,
2. 5.4×10^{-2}V,
3. 5.5×10^{-4}V, clockwise,
4. -7.5×10^{2}V,
5. 0.28T,
6. 8.8×10^{-3}T,
7. 5.0×10^{-2}V,
8. 0.23V, 1.9×10^{-2}A, clockwise,
9. 8.0×10^{-4}A, counter-clockwise

Electric Motors

1. 1.5Ω,2.4 V, 1.8 V,
2. 11.1 V, 5.6 V,
3. 1.2Ω, 1.5 A

Transformers

2. 600V,
3. 1.2 Ohms, 3.3 A,
4. 9600 V, 100 mA, 24 W, 24 W