PHYS 51W - Chapter 29

These problems are for April 13-April 19.

1. The magnetic flux through a certain loop of wire is given by

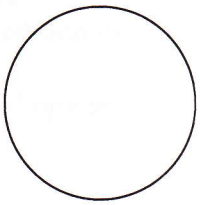
$$\Phi_B = (0.056\ T \cdot m^2)\cos(\omega t)$$

where the frequency f = 60 Hz.

a. What is the emf in the loop?

b. The resistance of the loop is 15 ohms. What is the maximum current in the loop?

2. In the loop shown, we define a positive emf to be clockwise. (Alternatively, you could say that a positive emf would cause a clockwise current.) We adapt the convention that a vector out of the page is represented by a dot •, while a vector into the page is represented by ×. Determine the direction of the induced emf if magnetic fields at the location of the loop are



a. $B_{initial}$ →

B_{final} ←

b. $B_{initial}$ •

B_{final} •

$B_{initial} > B_{final}$

c. $B_{initial}$ •

B_{final} ×

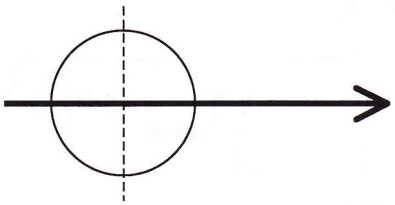
d. $B_{initial}$ •

B_{final} →

e. Over the loop, I hold a strong neodymium iron boron magnet its north pole down. I pull the magnet upward away from the loop. What is the direction of the induced emf?

3. a. Consider the loop of the previous problem. A constant magnetic field points out of the page. The loop is shrinking in area. What is the direction of the emf?

b. Consider that loop again. A constant magnetic field of 0.15 T points into the page. Meanwhile, the radius of the loop shrinks from 7.5 cm to 5.0 cm in 1.23 seconds. Find the direction and magnitude of the induced emf.

4. 

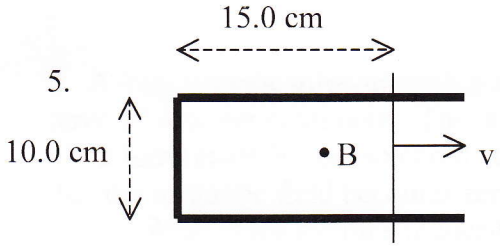
The circle above represents 120 tightly wound loops of wire with a radius of 5.0 cm. The arrow represents the direction of a magnetic field whose magnitude is 2.10 T. The dashed line represents the axis of rotation of the loops. Starting in this position, the loops rotate around the axis 40 times per second.

a. What is the maximum emf induced in the loop?

b. What is the emf at the instant when t = 0 sec? When t = 0.38125 sec?

c. How would your answers change if the magnetic field were directed into the page?

d. How would your answers change if the magnetic field were directed upward, parallel to the axis?

5. 

In the picture above you see a U-shaped wire which is at rest. A sliding wire, which completes a loop with the U-shaped wire, moves the right with a speed of 35 cm/s as shown. A magnetic field B = 0.32 T points out of the page. The width of the U is 10.0 cm; the length (when t = 0) is 15.0 cm.

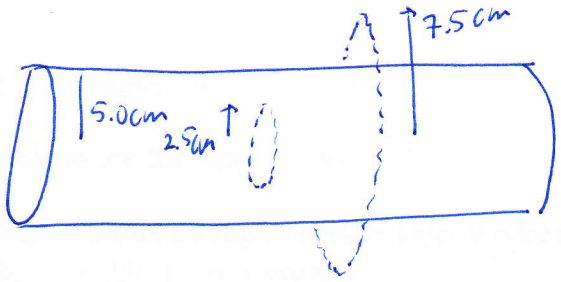
a. Find an expression for the flux through the loop as a function of time.

b. Determine the induced emf.

c. What direction does current move through the moving wire?

6. At a particular location, the magnetic field of the earth is about 6.0×10^{-5} T, pointed downward. A Boeing 747 is flying due north at 900 km/hr. The wingspan is 68.5 m. What is the emf from one wingtip to the other? Which wing is at a higher potential, the east one or the west one?

7.



In the picture above you see a solenoid. It is quite long; its radius is 5.0 cm. It has 100 turns of wire per cm. The current in the solenoid increases from zero at a rate of 2.5 amp/sec. For a positive current, the magnetic field in the solenoid points to the right.

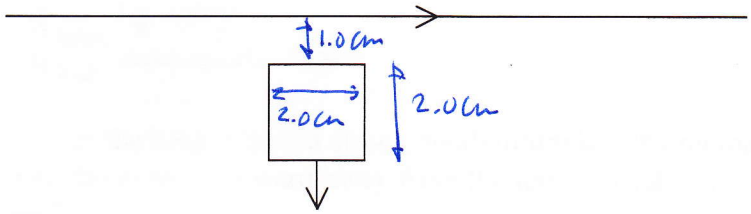
a. Inside the solenoid is a wire loop with a radius of 2.5 cm. Find the emf induced in the loop; what is the direction of the current?

b. Outside the solenoid is another loop concentric with the solenoid. The loop has 25 coils of wire. It has a radius of 7.5 cm. Find the emf induced in this second loop. What is the direction of the current?

8. A long straight solenoid with a cross-sectional area of 8.00 cm^2 is wound with 90 turns of wire per centimeter. The windings carry a current of 0.450 A. A second winding of 12 turns encircles the solenoid at its center. The current n the solenoid is turned off so that the magnetic field becomes zero in 0.025 sec.

What is the average induced emf in the windings?

9. An infinitely long wire carries a current of 2.5 A to the right.



A square loop of wire has sides of 2.0 cm. Initially the square loop is 1.0 cm away from the infinitely long wire. The loop is pulled away at a speed of 80 m/s.

a. What is the direction of current caused by the changing magnetic flux through the square loop?

b. Find the emf induced by the motion of the loop when the loop is 1.0 cm from the wire. (Hint: determine the flux through the loop as a function of time; then take the time derivative.)