

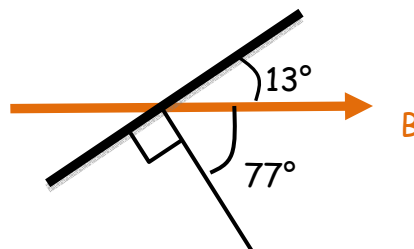
Lenz and Faraday Worksheet: Quantitative

1. (20:75) A uniform magnetic field of magnitude 0.29 T makes an angle of 13° with the plane of a circular loop of wire. The loop has a radius of 1.85 cm. What is the magnetic flux through the loop?

$$\Phi_B = BA \cos \theta \text{ where } \theta = \text{angle between } B \text{ and surface normal}$$

$$\begin{aligned} \Phi_B &= BA \cos \theta \\ &= (0.29 \text{ T}) \pi (0.0185 \text{ m})^2 \cos 77^\circ \\ &= 7.0 \times 10^{-5} \text{ Wb} \end{aligned}$$

$$\text{Area} = \pi r^2$$



2. A wire loop of radius 0.35 m lies so that an external magnetic field of magnitude 0.30 T is perpendicular to the loop. The field reverses its direction, and its magnitude changes to 0.20 T in 1.5 s. Find the magnitude of the average induced emf in the loop during this time.

$$\begin{aligned} \Phi_{B \text{ initial}} &= BA \cos \theta \\ &= (0.3 \text{ T}) \pi (0.35 \text{ m})^2 \cos 0^\circ \\ &= 0.115 \text{ Wb} \end{aligned}$$

$$\begin{aligned} \Phi_{B \text{ final}} &= BA \cos \theta \\ &= (0.2 \text{ T}) \pi (0.35 \text{ m})^2 \cos 0^\circ \\ &= 0.077 \text{ Wb in the opposite direction!} \end{aligned}$$

$$|EMF| = \left| -N \frac{\Delta \Phi}{\Delta t} \right| = \left| \left(\frac{\Phi_{B \text{ final}} - \Phi_{B \text{ initial}}}{\Delta t} \right) \right| = \left| \left(\frac{-0.077 \text{ Wb} - 0.115 \text{ Wb}}{1.5 \text{ s}} \right) \right| = 0.128 \text{ V}$$

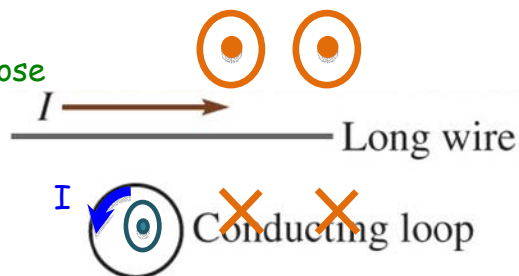
3. (20:15) A long straight wire carrying a steady current is in the plane of a circular loop of wire with a resistance of 20Ω .

a) If the loop is moved closer to the wire, what direction does the induced current in the loop flow?

b) at one instant, the current in the loop is 80 mA. What is the rate of change of the magnetic flux through the loop at that instant in Wb/s. $V = IR$

As the wire moves closer to the loop, the magnetic flux is increasing. Since the wire produces a B-field into the page at the loop, the current in the loop needs to produce a B-field out of the page to oppose the increasing flux. So I is counterclockwise.

$$EMF = -N \frac{\Delta \Phi}{\Delta t}$$



$$EMF = V = IR = -N \frac{\Delta \Phi}{\Delta t}$$

$$\frac{\Delta \Phi}{\Delta t} = \frac{-IR}{N} = (0.08 \text{ A})(20 \Omega) = 1.6 \text{ Wb / s}$$