Name: ______________________________ Phys 12

6.7 Electromagnetic Induction part 2

Last class we looked at how to induce a current in a wire by changing the magnetic field around the wire. Today we will quantize the amount of current using Lenz's Law.

The EMF produced by a changing magnetic flux through a coil (you can think of it as magnetic field) is:

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

Φ = magnetic flux (Weber, Wb)

t = time (s)

N = # of loops

"-" sign describes the opposing effect of the current in Lenz's Law

Magnetic flux Φ can be calculated as:

$$\Phi = BA\sin\theta$$

Φ = Magnetic flux (Wb, or Tm^2)

B = Magnetic field (T)

Area = cross sectional area of coil (m^2)

Θ = angle between B and A

Ex. 1: A square loop of wire is perpendicular to a 1.50 T magnetic field. If each side of the wire is 2.10 cm, what is the magnetic flux through the loop? (ANS: 6.6×10^{-4} Wb)

90°

$B = 1.50\ T$ $\quad \sin 90 = 1$

2.10 cm = 0.0210 m $\quad A = 0.021\ m^2$

$\Phi = ? = BA\sin 90 = 1.50\,T\,(0.021\,m)^2 = 6.6 \times 10^{-4}\ Wb$

Ex. 2: A 1.80 m diameter circular coil that contains 50 turns of wire is perpendicular to a 0.250 T magnetic field. If the magnetic field is reduced to zero in a time of 0.100s what is the average induced EMF in the coil? (ANS: 320V)

$A = \pi r^2 = \pi\left(\frac{1.8}{2}\right)^2 = 2.54\ m^2$

$\sin 90 = 1$

$$\varepsilon = \frac{N\Delta\Phi}{\Delta t} = \frac{N\Delta BA\sin\theta}{\Delta t} = \frac{50(0.250)\left(\pi \times \left(\frac{1.8}{2}\right)^2\right)}{0.100\,s} = 320\ V$$

Ex. 3: A circular loop of wire radius 2.5 cm is placed in a magnetic field B = 0.020 T into the page. The field is then reduced to 0.010 T into the page in 0.10 s.

r = 2.5 cm; B_i = 0.020 T; B_f = 0.010 T; t = 0.10 s; one loop ∴ N = 1

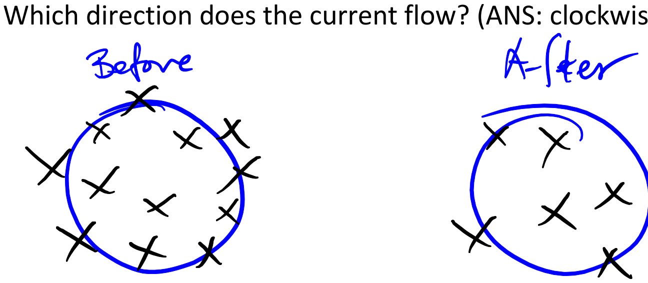
a. What is the average induced EMF? (ANS: 2.0×10^{-4} V)

$$\varepsilon = \frac{N\Delta\Phi}{\Delta t} = \frac{N\Delta BA\sin\theta}{\Delta t} = \frac{1(\vec{B}_f - \vec{B}_i)\pi r^2}{0.10\,s} = \frac{1(0.010T - 0.020T)\pi(0.025)^2}{0.10\,s}$$

$= 2.0 \times 10^{-4}\ V$

(don't worry about the "-'ve sign")

b. Which direction does the current flow? (ANS: clockwise)



∴ need $\vec{B}$-field into page so induced current is clockwise

HW: Worksheet 6.7 #ALL