Practice for Lenz's Law

Lenz's Law

1) You have a loop of wire and a bar magnet. List at least three different ways to change the magnetic flux through your loop (and hence to induce a current in it).

Remove magnet   Reshape loop

Rotate loop

2) A single circular loop of radius 20 cm and resistance 12 Ω lies in the plane of your page and has a zero magnetic field through it. If the field is uniformly increased to 0.50 T out of the page in 2.0 s, then stays constant for 4.0 s, then decreases to 0 T again in 2.0 s determine the current flowing in the loop during each interval.

$I = \frac{V}{R} \leftarrow \mathcal{E} = -n\frac{\Delta\phi}{\Delta t} = -n\frac{(BA - 0)}{\Delta t} = \frac{(-1)(.5\pi \cdot .2^2)}{2} = -\pi \times 10^{-2} V$

$\frac{-\pi \times 10^{-2}}{12} =$

$0 - BA$

3) A coil of 50 turns and square shape has side length 4.0 cm, it is rotated from parallel to magnetic field lines to perpendicular resulting in a potential difference of 0.16 V between the ends of the coil. What is the magnetic field strength if the rotation occurred in 0.20 s and what is the flux?

$\mathcal{E} = -n\frac{\Delta\phi}{\Delta t} = \frac{-50\,(B\,.0016 - 0)}{.2} = .16 \qquad \frac{.16 \times 2}{-50\ .0016} \times 10^{2} = B$

$-.4T = B$

4) In the question above the coil is rotated another 90°, what is the flux in this new position? $\phi = 0$

5) If the coil is again rotated another 90°, compare the flux now with your answer to #3.

$\phi = -\phi_3$

6) If the coil is again rotated 90°, to its original position, with each interval of rotation the same, what is the period and frequency of the rotation?

$T = .80s \qquad f = \frac{1}{T} = 1.25Hz$

7) Make a statement relating frequency f with change in time Δt in Faraday's Law.

$4\Delta t = T \qquad 4\Delta t = \frac{1}{f} \qquad 4f = \frac{1}{\Delta t} \qquad \mathcal{E} = -n\Delta\phi \times \frac{1}{\Delta t}$

$f = \frac{1}{4\Delta t} \qquad \mathcal{E} = -n\Delta\phi\, 4f$

8) An air ~~core solenoid~~ of length 20 cm and 1000 turns per meter is lined up with a coil of wire of 20 cm radius and 20 turns. If the solenoid has ~~resistance 12 Ω~~ and is connected to a 36 V source, what EMF is created in the coil if current in the solenoid reaches its maximum value in 0.50 seconds?

B generated in solenoid

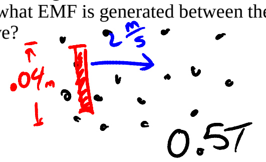
$B = \mu_0 n I \leftarrow \frac{36}{12} = 3.77 \times 10^{-3} T$ (n = 200)

$\mathcal{E} = \frac{-n\Delta\phi}{\Delta t} = \frac{-20\,(3.77\times10^{-3} \times \pi(2)^2)}{.5} = -0.019V$

1. The solenoid in #8 operates for one minute, during that minute the current in the solenoid remains constant, what happens to the EMF in the coils and why?

If I is constant then B is constant and $\Delta\phi = 0$ so no EMF

1. A wire of length 4.0 cm moves east at 2.0 m/s in a magnetic field of 0.5 T out of the page, what EMF is generated between the ends and which end of the wire becomes positive?



$\mathcal{E} = Blv = (.5)(.04)2 = .040V$

1. A loop of area 0.30 m^2 has flux 0.90 Wb, what is the magnetic field, and if the field is reversed in 1.2 s what EMF is induced in the loop?

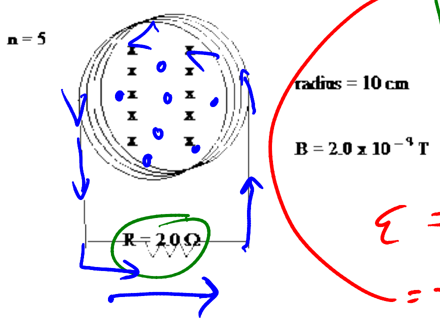
$\Phi = BA$

$\frac{\Phi}{A} = B = \frac{.9}{.3} = 3.0\,T$

$\mathcal{E} = -n\frac{\Delta\Phi}{\Delta t}$

$\mathcal{E} = \frac{-1(-3-3).3}{1.2} = 1.5V$

1. In the diagram below, if the magnetic field is doubled in 0.10 s, what current will exist in the wire and which way will it flow in the resistor?



$\frac{V}{R} = I = 1.6\times10^{-3}A$

$\mathcal{E} = -n\frac{\Delta\Phi}{\Delta t}$

$\mathcal{E} = \frac{-5(4\times10^{-3}-2\times10^{-3})\pi(.1)^2}{.1}$

$= -.1\pi\times10^{-3}V$

$R - I$