# Lenz's Law

13.33 A singulair - turn circulair loop of wire of radius 50mm lies in a plane perpendicular to a spatially uniform magnetic field. During a 0.10s time interval, the magnetic field increases uniformly from 200 to 300 mT. ⓐ Determine the emf induced in the loop.

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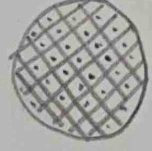
here $\mathcal{E} = -\frac{\partial \phi_B (N)}{dt}$, where the magnetic flux $\phi_B = B \cdot S = BS\cos\theta$ (surface Area)

$N=1$

here we are given a loop



B•

$r = 50 \times 10^{-3} m$

$\phi_B = BA$, $A = \pi r^2$

$\cos\theta = 1$ ∵ the area & magnetic field are in the same direction

$$\mathcal{E} = -\frac{\partial \phi_B}{dt} = \frac{-\partial BA}{dt}$$

$$= -A\frac{\partial B}{dt} = \frac{(B_2 - B_1)(-A)}{10s}$$

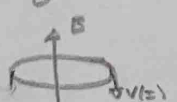
$$= \frac{\pi (50 \times 10^{-3} m)^2 [(300-200) \times 10^{-3} T]}{10s}$$

$$= 7.85 \times 10^{-5} \frac{m^2 T}{s}$$, $Tm^2 = Vs$, $\frac{Tm^2}{s} = V$

$$\boxed{\mathcal{E} = 7.85 \times 10^{-5} V}$$

ⓑ If the magnetic field is directed at of the page, what is the direction of the current induced in the loop.

Since the magnetic field is going through the loop & out of the page



The flux increased & the magnetic field now has to be adjusted. The current will be clock wise, because Lenz's law acts to oppose the flux that produced it.

## Electric Generators & Back Emf

13.55

Design a current loop that, when rotated in a uniform magnetic field strength of 0.10 T, will produce an emf $= \varepsilon_0 \sin(\omega t)$ where $\varepsilon_0 = 110V$ & $\omega = 120\pi$ rad/s. What will the area of the loop be?

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$\varepsilon = -N \frac{d\phi}{dt}$ , $\phi = BA\cos\theta$ , $\theta = \omega t$ , angle of frequency · t

$\phi = BA\cos(\omega t)$

$\varepsilon = -N \frac{dBA\cos(\omega t)}{dt}$

$\varepsilon = -NBA \frac{d\cos(\omega t)}{dt}$

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$\varepsilon = \varepsilon_0 \sin(\omega t)$ , $\varepsilon_0 = 110V$ , $\omega = 120\pi$ rad/s

$\Rightarrow$ $\varepsilon_0 \sin(\omega t) = -NBA \underbrace{\frac{d\cos(\omega t)}{dt}}$ $= -\sin(\omega t)\omega$

$\varepsilon_0 \sin(\omega t) = +NBA\omega \sin(\omega t)$

$\varepsilon_0 = NB\omega(A)$

$\frac{\varepsilon_0}{NB\omega} = A$

$A = \frac{\varepsilon_0}{NB\omega} = \frac{110V}{(1)(0.10)T(120\pi)rad/s} = 2.918 \frac{V}{T\,rad/s}$  $T = \frac{V \cdot s}{m^2}$

$\frac{V}{\left(\frac{V \cdot s}{m^2}\right) rad/s}$  $m^2/rad$  m  $rad = \frac{m^2}{m^2}$

$\boxed{A = 2.918\ m^2}$