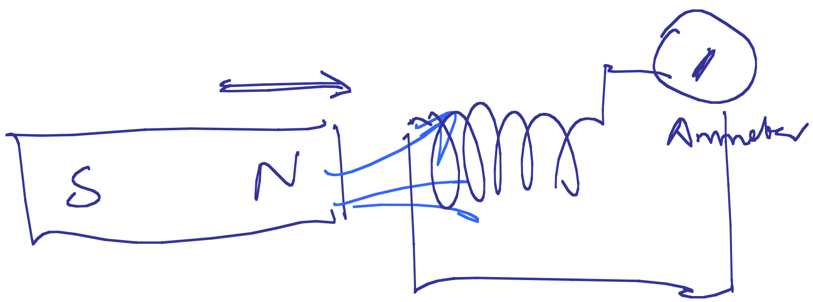
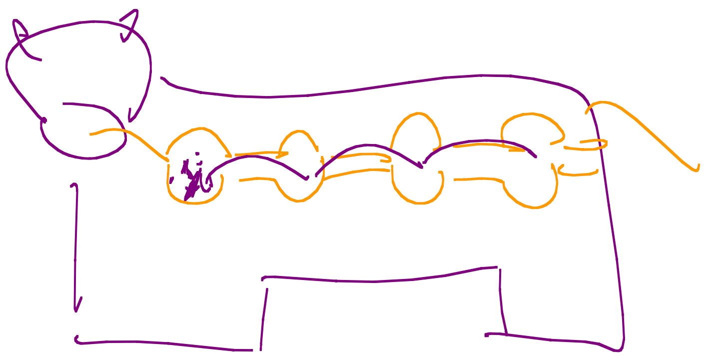
Phys 2120-4 10/17/12

Note Title 10/17/2012

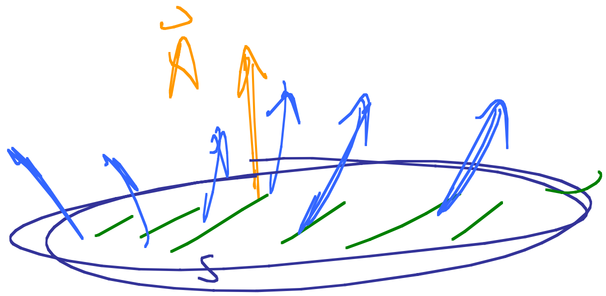
Chap 27 Induction

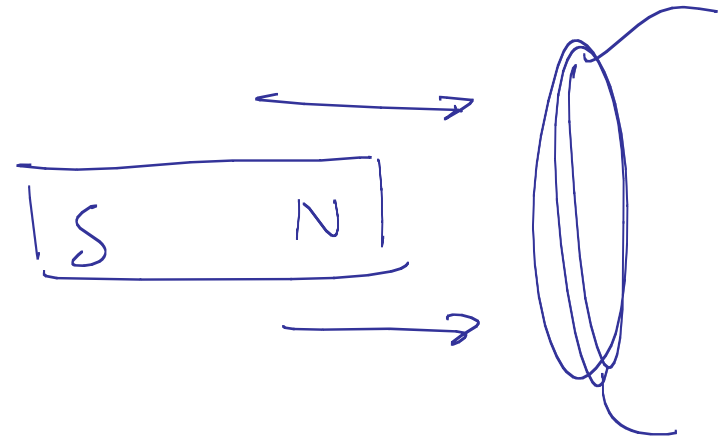




Get current only when mag field changes in vicinity of coil.

Magnetic flux





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Add up $\vec{B} \cdot d\vec{A}$

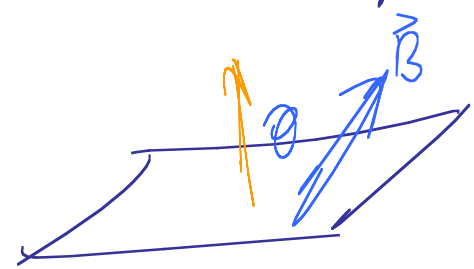
Units : $T\,m^2$

Uniform $\vec{B}$ field flat surface area A

$$\Phi_B = \int_S \vec{B} \cdot d\vec{A}$$

N turns $\times N$

$$\Phi = BA\cos\theta$$



Get "Volts" ("electromotive force") Volts

when the magnetic flux changes.

A changes, B, θ

Faraday's Law

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

volts

Examples:

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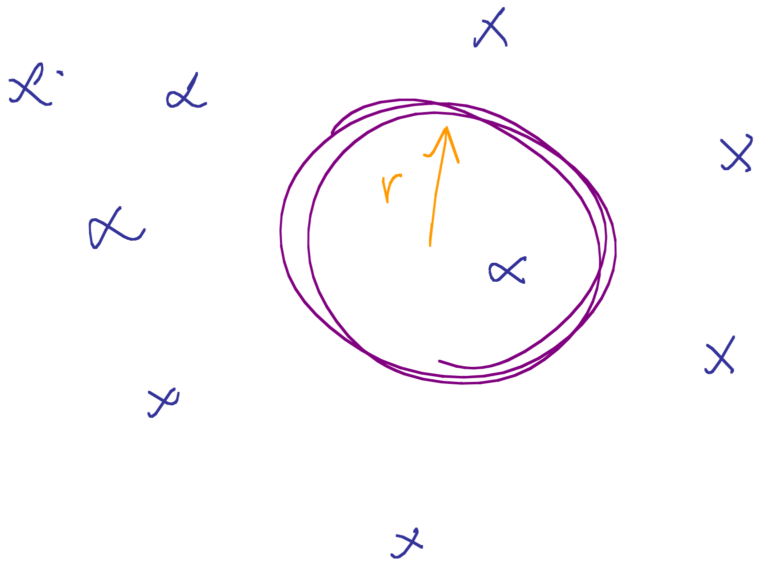
Induction



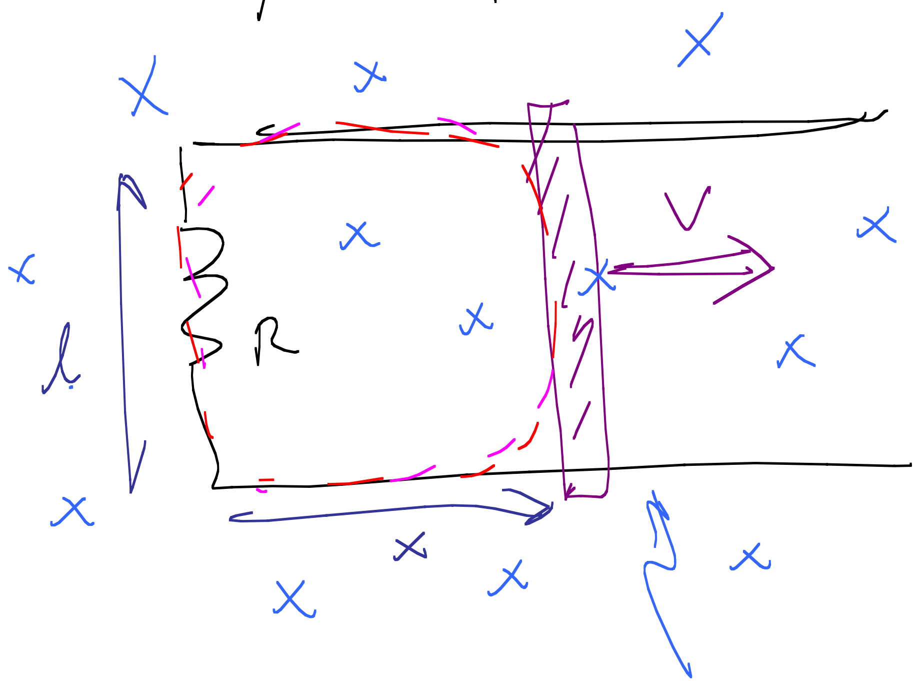
$\vec{B}$ field uniform, perp to ring. Mag field changes in time $\frac{dB}{dt}$

Find $\mathcal{E}$ induced in ring

$$\Phi_B = BA \qquad \mathcal{E} = -\frac{d\Phi}{dt} = -A\frac{dB}{dt} = -\pi r^2 \frac{dB}{dt}$$

Thought expt

Uniform $\vec{B}$ field into page



conducting rails

$$A = \ell x \qquad B$$

$$\frac{d\Phi_B}{dt} = \frac{d}{dx} BA$$

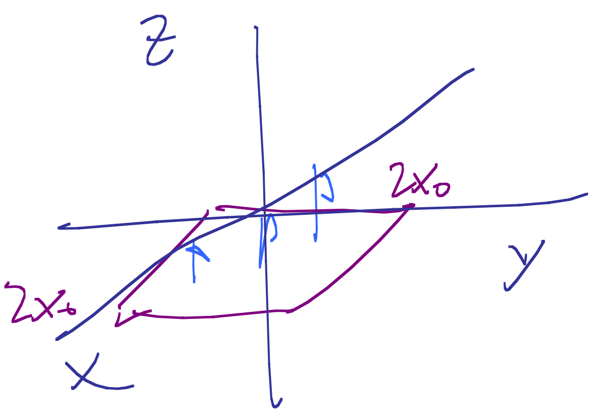
$$= B\ell \frac{dx}{dt} = B\ell v$$

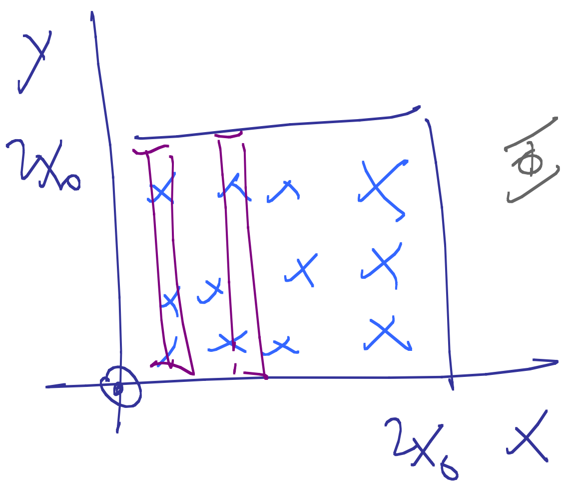
signs

$$= \mathcal{E} = IR$$

27.36 A magnetic field given by $\vec{B} = B_0 \left(\frac{x}{x_0}\right)^2 \hat{k}$

B_0, x_0 constants. Find magnetic flux thru square of side $2x_0$ in x-y plane (pos x, y axes)





$$\Phi = \int_0^{2x_0} dy \int_0^{2x_0} dx \; B_0 \left(\frac{x}{x_0}\right)^2 \hat{k}$$

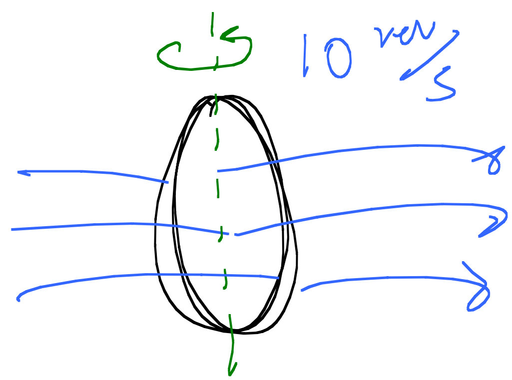
$$\Phi = \int_0^{2x_0} dy \int_0^{2x_0} dx \; \frac{B_0}{x_0^2} x^2 = (2x_0) \frac{B_0}{x_0^2} x^2 \Big|_0^{2x_0}$$

$$= (2x_0) \frac{B_0}{x_0^2} \frac{x^3}{3} \Big|_0^{2x_0} = \frac{16}{3} B_0 x_0^2$$

Do math

29.35 A 5 turn coil 1.0 cm in diameter is rotated at 10 rev/s about axis perpendicular to mag field. Voltmeter connected to coil read a peak value of 360 μV. What's field strength

Flux is changing



$r = 0.0050$ m

Φ_B = Flux = $BA\cos\Theta$ $\Theta = \omega t$

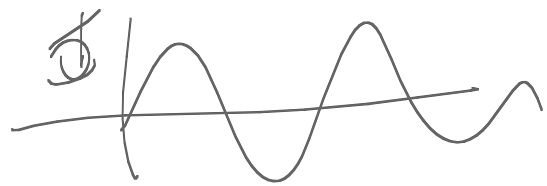
ω = angular velocity

$= 2\pi f$

$= 62.8 \ \frac{\text{rad}}{s}$

$= NBA\cos(\omega t)$

$N = 5$ turns



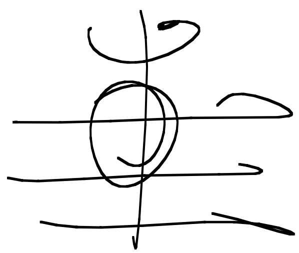
$$\varepsilon = \frac{d\Phi}{dt} = -NBA\omega\sin(\omega t)$$

peak value

$$\mathcal{E}_{peak} = 360\,\mu V = \omega B A N$$

$$B = \frac{\mathcal{E}}{N\omega A} = \frac{360 \times 10^{-6}\,V}{5\,(62.8/s)\,(7.85 \times 10^{-5}\,m^2)}$$

$$= 1.46 \times 10^{-2}\,T = 15\,mT$$



Which way does current

Lenz's law.