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Welcome!

Physics 194 - Lecture 11

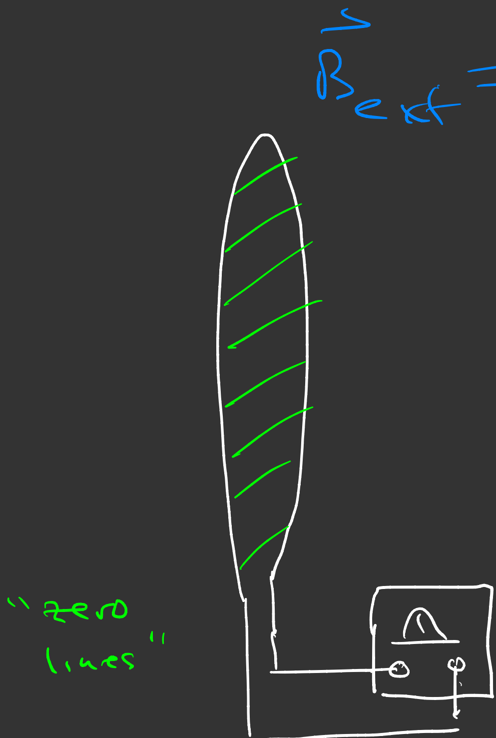
Have a question during class? Please ask it right away, even if it means interrupting in the middle of a thought. I want you to!

Agenda

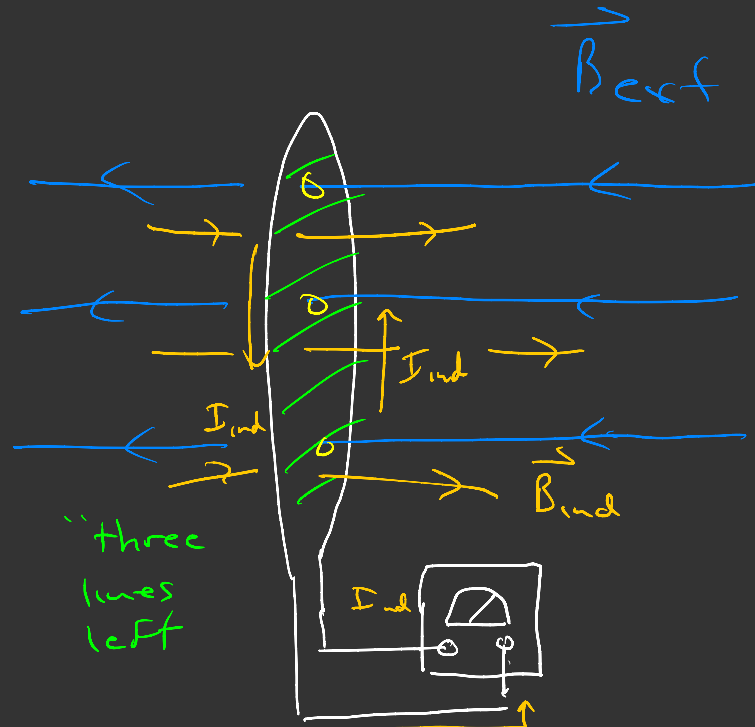
- Electromagnetic induction, magnetic flux, and Faraday's law
- Uniform circular motion and the magnetic force exerted on individual particles

Class starts @2:15 pm

Initial : No $\vec{B}$-field



Final



An induced current happens when : The total amount of magnetic field (# of $\vec{B}$-field lines) through a loop/coil of wire changes with time. This is called electromagnetic induction.

How you determine the direction of the induced current...

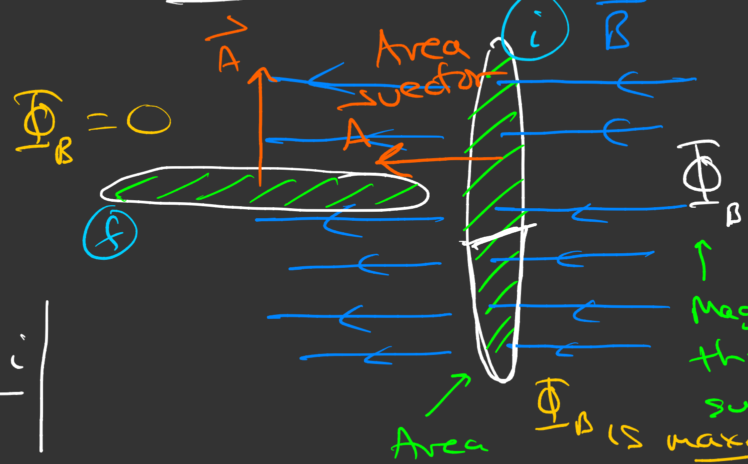
Lenz's law: The induced current I_{ind} will produce an induced $\vec{B}$-field B_{ind} that attempts to restore the total amount of $\vec{B}$-field through the coil to what it was a moment before.

The electromagnetic induction effect actually induces an EMF, and that is what results in a current.

Faraday's law

$$\mathcal{E}_{ind} = \left| \frac{\Delta \Phi_B}{\Delta t} \right|$$

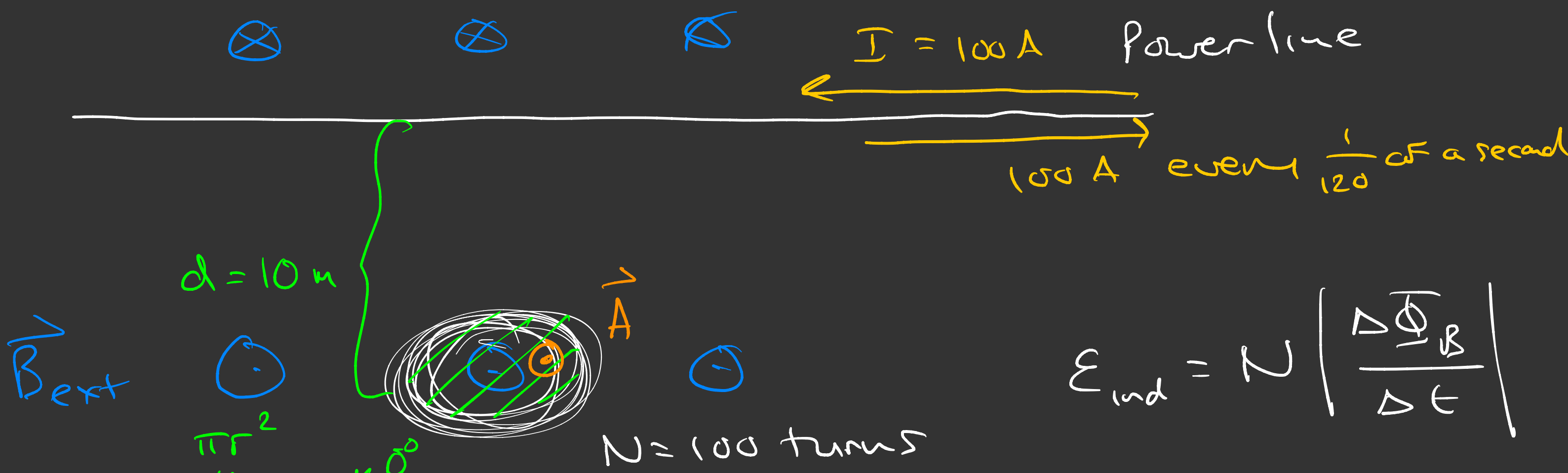
$$= \left| \frac{\Phi_{B,f} - \Phi_{B,i}}{\Delta t} \right|$$



Angle between $\vec{A}$ & $\vec{B}$

$$\Phi_B = BA\cos\theta$$

Magnetic flux through a surface



$$\mathcal{E}_{ind} = N\left|\frac{\Delta\Phi_B}{\Delta t}\right|$$

πr^2 → A_i, 0° → θ_i

$$\Phi_{B,i} = B_i A_i \cos\theta_i$$

$r = 0.2\ m$

$\frac{1}{120}$ of a second later the $\vec{B}$-field is ⊗

$\frac{\mu_0 I}{2\pi d}$ → B_i, B_f

$4\pi\times10^{-7}\ Tm/A$ → μ_0

$$K_m = \frac{\mu_0}{2\pi}$$

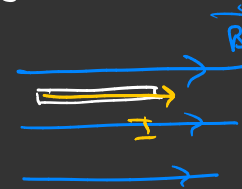
180° → θ_f

$$\Phi_{B,f} = B_f A_f \cos\theta_f$$

$N = 100$, $\Delta t = \frac{1}{120}\ s$

$$\mathcal{E}_{ind} = N\left|\frac{\Phi_{B,f}-\Phi_{B,i}}{\Delta t}\right| = 0.006\ V$$

What about the magnetic force exerted on a single charged particle?



$$F_{B\,on\,q} = |q|\,v\,B\sin\theta$$

↑ Between $\vec{v}$ and $\vec{B}$

Use uniform circular motion ideas!

$$a_r = \frac{1}{m}\sum F_{on\,q,\,r}$$

$$\frac{v^2}{r} = \frac{1}{m}\left(|q|\,v\,B\sin\theta\right) \quad \leftarrow 90^\circ$$

$$\frac{v^{\not 2}}{r} = \frac{|q|\not v B}{m} \longrightarrow \frac{v}{r} = \frac{|q|B}{m} \longrightarrow r = \frac{mv}{|q|B}$$