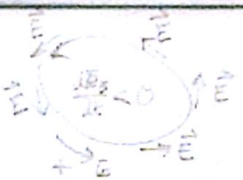
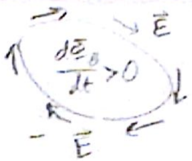
$\Phi_B = \iint \vec{B} \cdot d\vec{A} = BA\cos\theta$

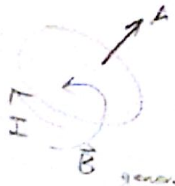
↳ if $\vec{B}$ & $d\vec{A}$ uniform





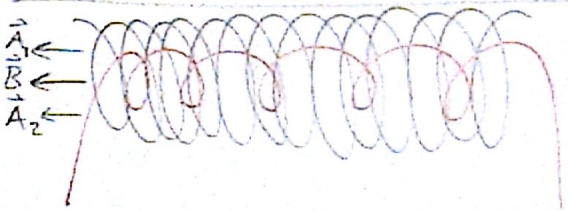
$\oint \vec{E} \cdot d\vec{l}$ induced emf $\mathcal{E} = -\frac{d\Phi_B}{dt}$ (has units of voltage)

$I = \frac{\mathcal{E}}{R}$ R = resistance



opposes $\frac{d\Phi_B}{dt}$

Lenz's Law



N_1 loops

N_2 loops

$\Phi_{B1} = N_1 B A_1$

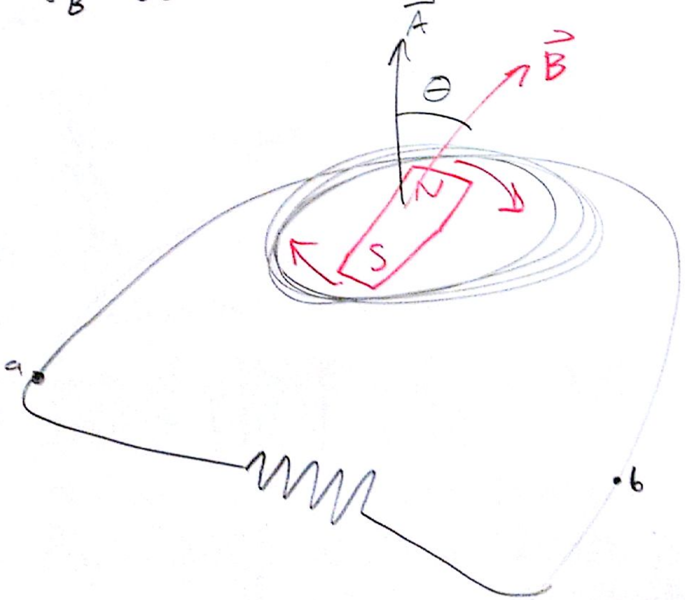
$\Phi_{B2} = N_2 B A_2$

More loops ⇒ more emf

α β γ δ ε ζ
η θ ι κ λ μ
ν ξ ο π ρ σ
τ υ φ χ ψ ω

Α Β Γ Δ Ε Ζ
Η Θ Ι Κ Λ Μ
Ν Ξ Ο Π Ρ Σ
Τ Υ Φ Χ Ψ Ω

$$\Phi_B = \iint \vec{B}\cdot d\vec{A} = BA\cos\theta$$



Magnet rotates with constant angular velocity $\omega = \frac{d\theta}{dt}$

$$1\ \text{rpm} = \frac{2\pi}{60\ \text{s}}$$

$\theta = \omega t$ (with $t=0$ chosen to be when $\theta = 0$)

N loops

$$\Phi_B = BA\cos\omega t$$

$$\mathcal{E} = -\frac{d\Phi_B}{dt} = -\left[BA\cdot(-\sin\omega t)\,\omega\right] = BA\omega\sin\omega t$$

If $R = 5\Omega$, $B =$ ~~5×10^{-2} T~~ 5 T, $A = 10^{-1}\ \text{m}^2$, $\omega = 1000$ rpm,

$P = VI = \frac{V^2}{R}$ (VI: use rms)

$$P = \frac{B^2A^2\omega^2}{2R} = \text{~~}2.7\times10^{-2}\ \text{W~~}\ \ 270\ \text{W}$$

$$V_{rms} = \frac{BA\omega}{\sqrt{2}}$$

With $N=10^2$ loops:

$\Phi_B = N BA\cos\omega t$

$\mathcal{E} = NBA\omega\sin\omega t$

$$P = \frac{N^2B^2A^2\omega^2}{2R} = 2.7\times10^6\ \text{W}$$

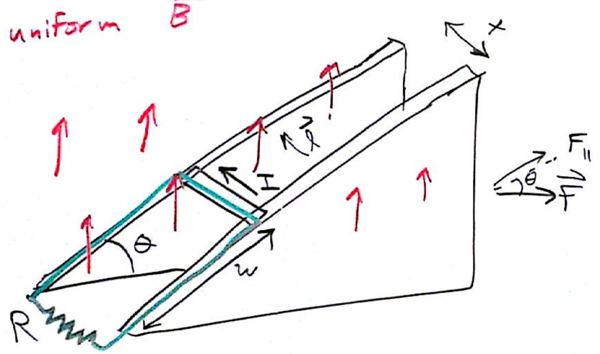
no accel. $\Leftrightarrow F_{G\parallel} = F_{B\parallel} \Leftrightarrow mg\sin\theta = IBx\cos\theta$

$\Leftrightarrow \dfrac{mg\tan\theta}{xB} = I = \dfrac{\mathcal{E}}{R}$

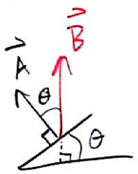
bar mass = m

$F_{G\parallel} = mg\sin\theta$, $mg = F_G$

uniform $\vec{B}$



A = xw



$$\mathcal{E} = -\frac{d\Phi_B}{dt} = -\frac{d}{dt}\left(Bxw\cos\theta\right) = -\left(Bx\cos\theta\right)\frac{dw}{dt}$$ if B constant

if B not constant: $$\mathcal{E} = -\left[\frac{dB}{dt}w + B\frac{dw}{dt}\right]x\cos\theta$$

$$I = \frac{\mathcal{E}}{R}$$

$\vec{F}_B = I\vec{\ell}\times\vec{B}$ $\quad F_B = IxB$ $\quad F_{B\parallel} = \overbrace{F\cos\theta}^{IBx\cos\theta}$

magnetic force on sliding bar