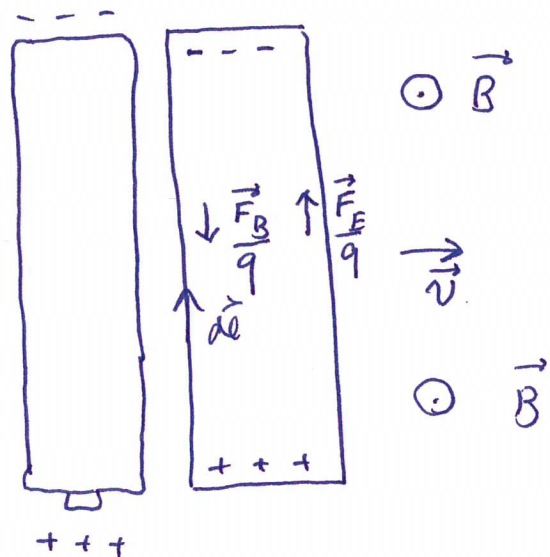


(1)

Smart physics

assume Equilibrium: $\vec{F} = 0 = q(\vec{E} + \vec{v} \times \vec{B})$



$$\vec{E} = -\vec{v} \times \vec{B}$$

$$\Delta V = - \int d\vec{l} \cdot \vec{E} = \int d\vec{l} \cdot (\vec{v} \times \vec{B})$$

$$\mathcal{E} = \int d\vec{l} \cdot \left(\frac{\vec{F}_B}{q} \right)$$

Don't assume equilibrium:

$\mathcal{E}$ = electromotive force

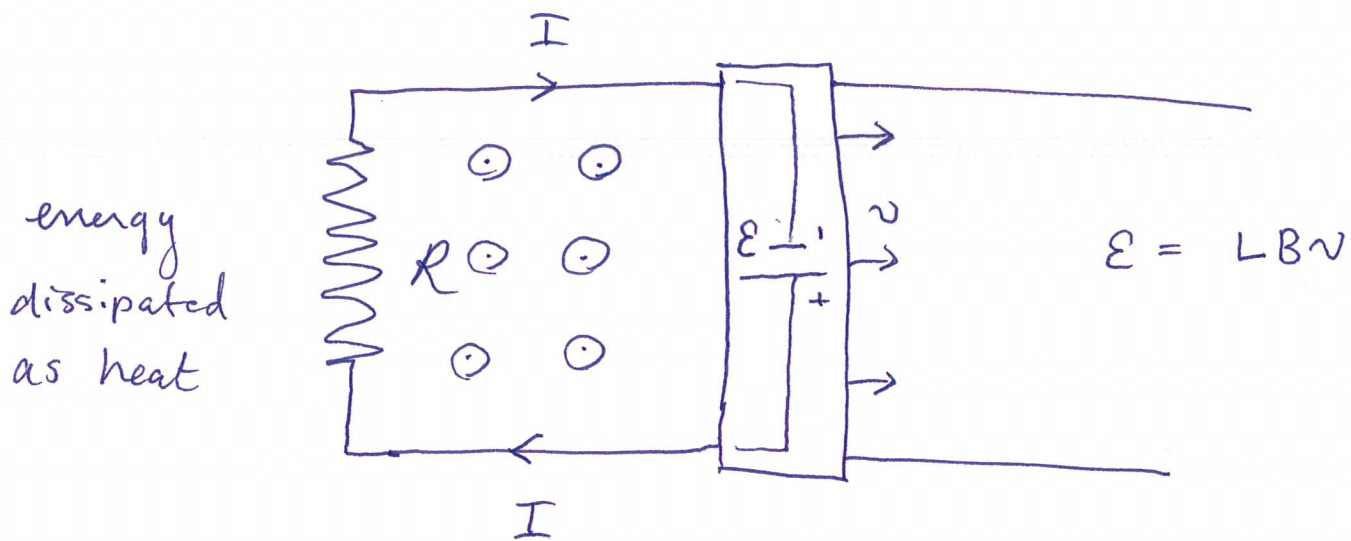
$$= \oint d\vec{l} \cdot \frac{\vec{F}}{q} \quad \leftarrow \text{Force per charge moving charge.}$$

$$= \int_{\text{Bottom}}^{\text{Top}} d\vec{l} \cdot \underbrace{\left(\vec{E} + \vec{v} \times \vec{B} \right)}_{\text{Motional EMF}} \frac{q}{q} = \int d\vec{l} \cdot \frac{\vec{F}_B}{q}$$

$$= -BvL \quad \frac{\text{Top}}{\text{Bottom}} \quad BvL$$

Where does the energy come from?

(2)



We must be doing work on the system!

Power dissipated:

Resistor

$$P = VI = \frac{V^2}{R} = \frac{(LBv)^2}{R}$$

Lenz's Law

Current is induced to oppose change which produced it!

Work per unit time done on the system:

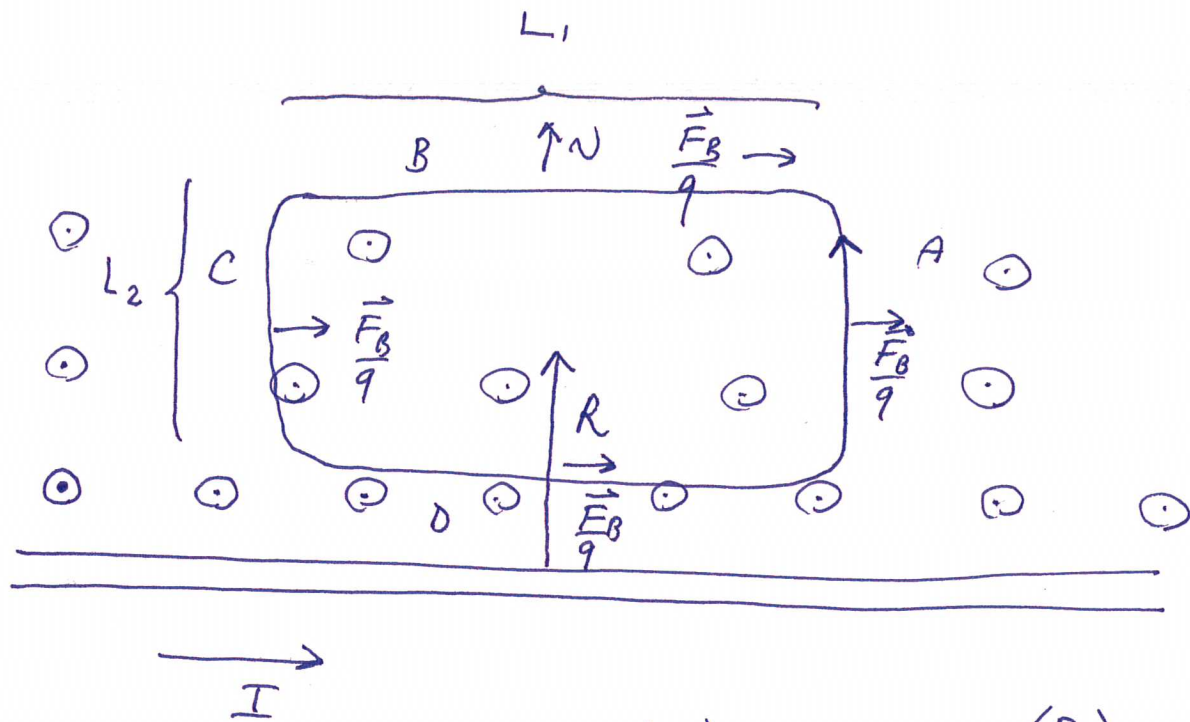
$$P = - \frac{\vec{F} \cdot d\vec{l}}{dt} = \overset{\epsilon/R}{I} LBv$$

$$= \frac{(LBv)^2}{R} \quad \checkmark$$

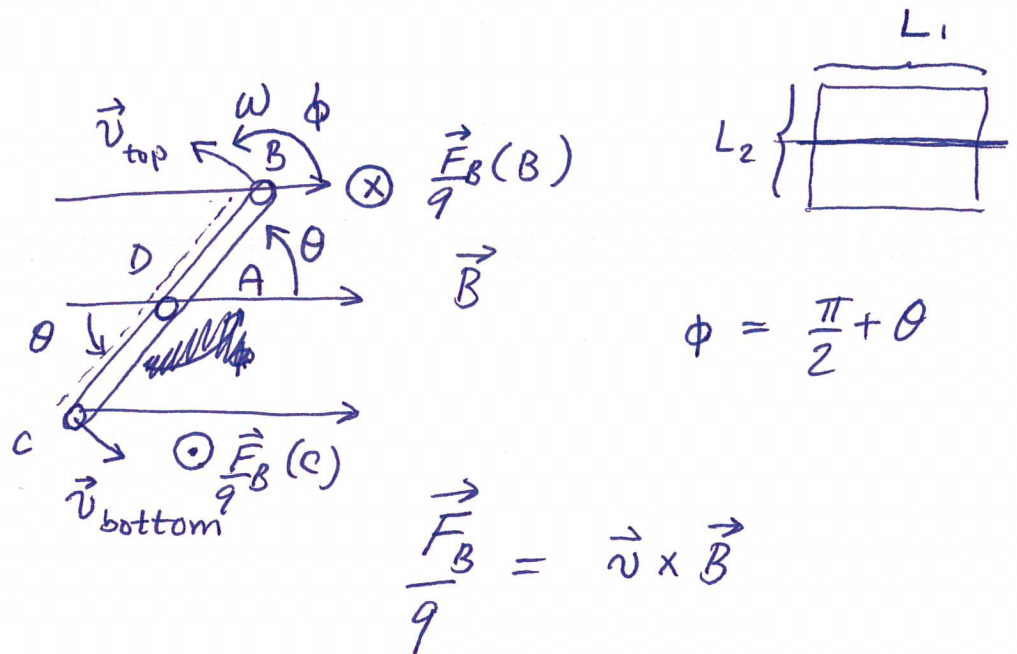
$$\vec{F} = I \vec{L} \times \vec{B}$$

Loop moving through non-uniform $\vec{B}$

(3)



$$\begin{aligned}
 \mathcal{E} &= \oint d\vec{\ell} \cdot \frac{\vec{F}}{q} = \quad (A) \quad (B) \\
 &= 0 + + (B_{\text{top}} v \hat{j}) \cdot (L(-\hat{i})) \\
 &\quad + 0 + (B_{\text{bottom}} v \hat{i}) \cdot (L\hat{i}) \\
 &\quad (C) \\
 &= (B_{\text{bottom}} - B_{\text{top}}) v L
 \end{aligned}$$

Generator

$$\frac{\vec{F}_B}{q} = \vec{v} \times \vec{B}$$

$$\mathcal{E} = \int d\vec{l} \cdot \frac{\vec{F}}{q} = 2L_1 v B \sin\left(\underbrace{\frac{\pi}{2} + \theta}_{\phi}\right)$$

$$\begin{aligned} \sin(\alpha + \beta) &= \sin\alpha \cos\beta + \sin\beta \cos\alpha \\ &= \cos\theta \end{aligned}$$

$$\begin{aligned} &\frac{1}{2} \omega L_2 \\ &\downarrow \\ &= 2L_1 v B \cos\theta \end{aligned}$$

$$= \frac{2}{2} L_1 L_2 (\omega \cos \omega t) \cdot B$$

$$= B A \frac{d}{dt} \sin \omega t = B A \frac{d}{dt} \sin\left(\phi - \frac{\pi}{2}\right)$$

$$= - \frac{d}{dt} \vec{B} \cdot \hat{n} A = - B A \frac{d}{dt} \cos \phi$$

$$= - \frac{d}{dt} \Phi_B //$$