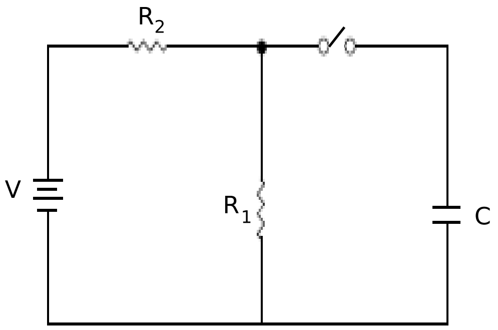
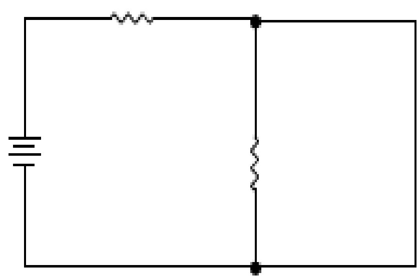
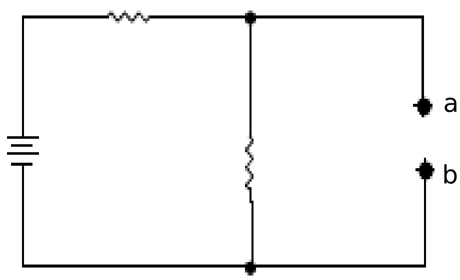
8.022 Lecture Notes Class 33 - 11/15/2006



If we want to find out rate capacitor will charge at when switch is closed, use Thevenin's to simplify left side.





$$Q(t) = CV_{oc}(1 - e^{-\frac{t}{R_{Th}C}})$$

$$I_{SC} = \frac{V}{R_1} \qquad \text{(Thevenin's Current)}$$

$$V_{oc} = V(a) - V(b) = V_{R_2} = IR_2 = \frac{V}{R_1 + R_2}R_2 \qquad \text{(Thevenin's Voltage)}$$

$$R_{Th} = \frac{V_{oc}}{I_{SC}} = \frac{V}{R_1 + R_2} \cdot \frac{R_2 R_1}{V} = \frac{R_2 R_1}{R_1 + R_2}$$

$$\begin{aligned} Q(t) = &\quad C \cdot V_\alpha \left(1 - e(-\tfrac{t}{R_{Th}C})\right) \\ &= C \cdot \tfrac{VR_2}{R_1+R_2} \left(1 - e^{(} - \tfrac{t}{\frac{R_1R_2C}{R_1+R_2}})\right) \end{aligned}$$

σ is the conductivity, ρ is the resistivity, and $\vec{J}$ volume current density .

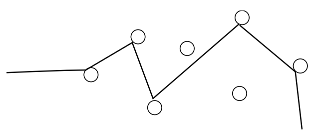
$$\vec{J} = \sigma \cdot \vec{F}$$

This says : applied force is proportional to velocity

$$\sigma = \frac{1}{\rho}$$

mean free path is λ

$$t = \sqrt{\frac{2\lambda}{a}} \quad , \quad v_{avg} = \frac{1}{2}at = \frac{1}{2}a\sqrt{\frac{2\lambda}{a}} = \sqrt{\frac{a\lambda}{2}}$$



$$t = \frac{\lambda}{v_T}$$

$$\begin{aligned} v_{avg} = &\quad \tfrac{1}{2}at = \tfrac{1}{2}\tfrac{a\lambda}{v_T} \propto a \\ \vec{J} = &\quad n_q \vec{v_{avg}} = n_q \cdot \tfrac{a\lambda}{2v_T} \\ = &\ \tfrac{nq\lambda}{2v_T} \cdot \tfrac{\vec{F}}{m} = (\tfrac{nq\lambda}{2mv_T})\vec{F} \end{aligned}$$

$$\vec{J} = \sigma(\vec{E} + \vec{v} \times \vec{B})$$

In CGS, $\vec{F} \propto (\vec{E} + \frac{\vec{v}}{c} \times \vec{B})$

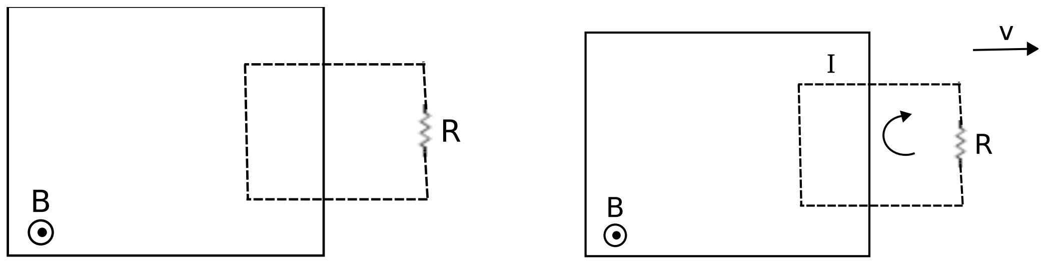
$$\vec{J} \simeq \sigma\vec{E} \qquad \text{Microscopic Ohm's Law}$$

$$\vec{E} = \frac{\vec{J}}{\sigma} = \rho\vec{J}$$

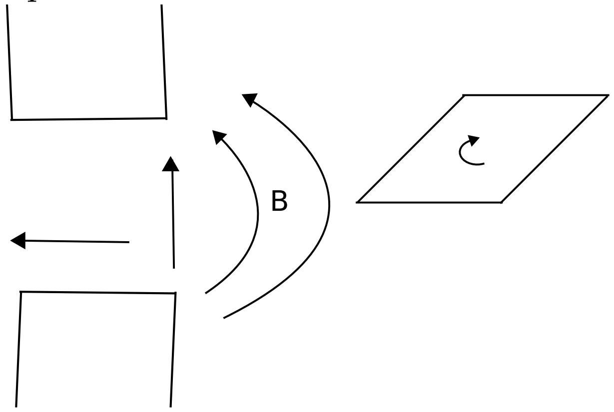
$$\int \vec{E}\cdot d\vec{l} = \int \rho\vec{J}d\vec{l} \begin{cases} R = \int dl \cdot \frac{\rho}{A} \\ I = \int d\vec{l}\cdot\vec{J} \\ \iint dadl \frac{\rho\vec{J}}{A} \\ \int dl\rho\vec{J} \end{cases}$$

$$V = IR$$

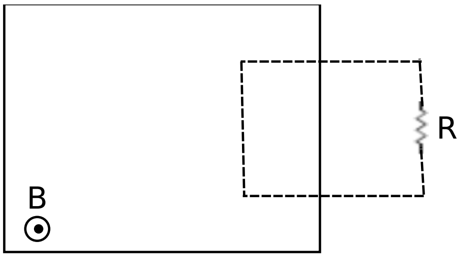
<u>Faraday's Law</u>



Pulling loop out of $\vec{B}$ creates velocity and $\therefore$ current, so resistor heats up.



Moving magnet also gets current.



decrease N - works too

$$\varepsilon = -\frac{d\Phi_0}{dt} \qquad \underline{\text{Lenz's Law}} \text{ (negative sign)}$$