Core concepts:

charges create fields,

fields apply force on othr charges

Electric field ($\vec{E}$)

$$\vec{E} = \frac{1}{4\pi\epsilon_0} \frac{q}{r^2} \hat{r}, \quad \vec{F} = q\vec{E}$$

Magnetic Field

$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}, \quad \vec{F} = q\vec{v} \times \vec{B}$$

What to know:

Ch 13

- Definition of $\vec{E}$

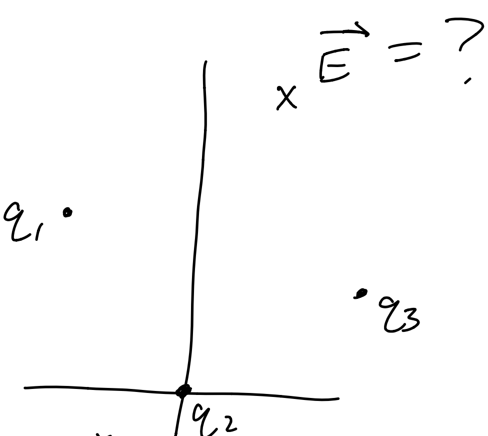
$$\vec{E} = \frac{\vec{F}}{q}$$

Direction of $\vec{E}$?

Direction of $\vec{F}$?

- Field of a point chg & superposition

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{|\vec{r}|^2}\hat{r}, \quad \vec{r} = \vec{r}_{obs} - \vec{r}_{src}$$

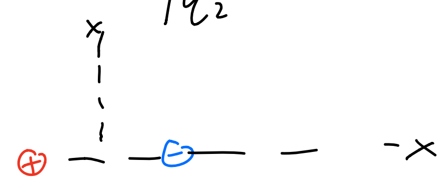


$$\vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 + \ldots$$

Vector sum!

Dipoles) $E_{axis} \approx \frac{1}{4\pi\epsilon_0}\frac{2p}{r^3}$

$E_{perp} \approx \frac{1}{4\pi\epsilon_0}\frac{p}{r^3}$



Ch 14

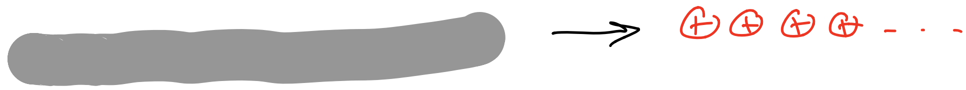
Conceptual

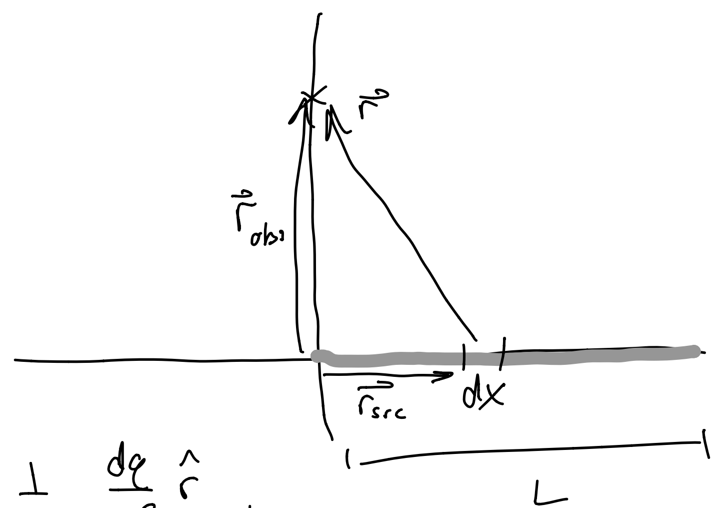
- How do charges behave on conductors & insulators?
- How to charge/dischg insulators & conductors?
- Static equilibrium in conductor ($\vec{E}_{net} = 0$)

	Insulators	Conductors
Mobile Chgs	No	Yes
Location of excess chg	Anywhere	Surface
Spreading of excess chg	None	Uniformly on surface
$\vec{E}_{net}$ inside	Can be anything	0, in equilibrium
Polarization	Induced dipoles ($p = \alpha E$)	Moving charges $\bar{v} = u\underline{E}$

Ch 15

Extension of superposition principle





$$d\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{dq}{r^2}\hat{r},$$

$$dq = \frac{Q}{L}dx$$

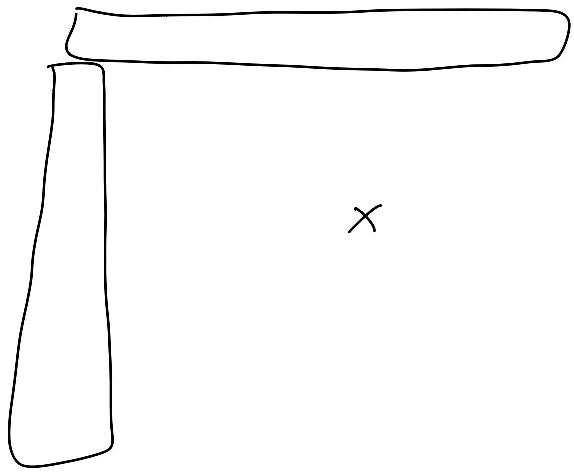
$$\vec{r}_{src} = \langle x, 0, 0\rangle$$

$$\vec{r}_{obs} = \langle 0, y, 0\rangle$$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{Q}{L}\int_0^L \frac{dx}{(x^2+y^2)^{3/2}}\langle -x, y, 0\rangle$$

- Be able to derive charged rod/ring (integral form)

- Use superposition with chg distributions



Ch 16

- Be able to calculate potential difference given $\vec{E}$

$$\Delta V = -\vec{E}\cdot\Delta\vec{r}$$

$$\Delta V = -\int \vec{E}\cdot d\vec{r}$$, path independence

$$\Delta V_{closed} = 0$$

- Know the connection btwn ΔV, ΔU, ΔK

$$\Delta K = -\Delta U$$
$$\Delta U = q\Delta V$$

P7 on exam I !

+ chgs want to move from higher to lower V

- chgs, opposite

V of a pt chg

$$V(r) = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$$

Superposition, etc

Ch 17

$$\vec{B} = \frac{\mu_0}{4\pi} \frac{q\vec{v} \times \hat{r}}{r^2}$$

$$d\vec{B} = \frac{\mu_0}{4\pi} \frac{I\, d\vec{l} \times \hat{r}}{r^2}$$

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int \frac{d\vec{l} \times \hat{r}}{r^2}$$

$$\vec{r} = \vec{r}_{obs} - \vec{r}_{src}$$

$d\vec{l}$ in direction of I

Know the difference & relationship between i + I

$$i = nA\bar{v}$$

$$I = |q|\, i$$

Ch 18

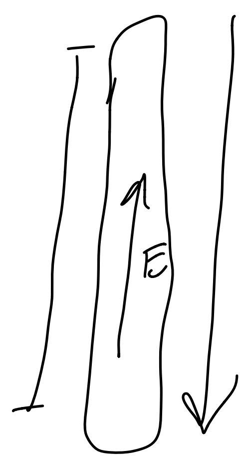
Conceptual

- What is steady state?
- What do $\vec{E}$, i, $\bar{v}$ look like in a wire during steady state?
- What is the source of steady state $\vec{E}$?
- What is the function of the battery?

Use loop rule & node rule to find $\vec{E}$ & i everywhere

$$\sum \Delta V = 0$$

$$i_{in} = i_{out}$$



$$\Delta V = EL$$

Ch 19

Macroscopic circuit analysis

Be able to solve for I & ΔV everywhere

Ohm's Law

$$I = \frac{\Delta V}{R}$$

$$R = \frac{L}{\sigma A}$$

Eq Resistance

Series	Parallel
$\Delta V = \Delta V_1 + \Delta V_2 + \Delta V_3 \ldots$	$\Delta V = \Delta V_1 = \Delta V_2 \ldots$
$I = I_1 = I_2 \ldots$	$I = I_1 + I_2 + I_3 \ldots$
$R_{eq} = R_1 + R_2 + R_3 \ldots$	$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} \ldots$

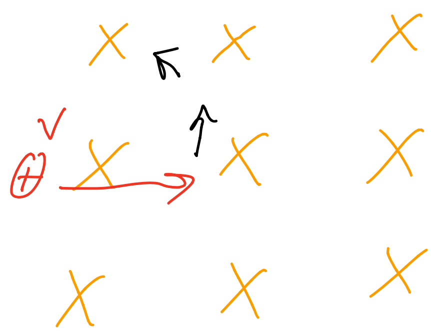
- internal resistance

Work with RC circuits

Ch 20

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

Force does no work, only deflects



For a current

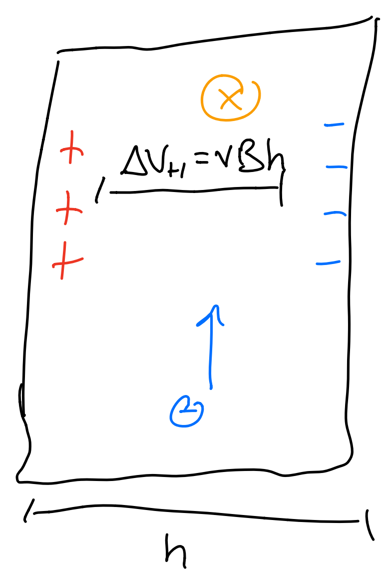
$$\Delta\vec{F} = I\Delta\vec{L} \times \vec{B}$$

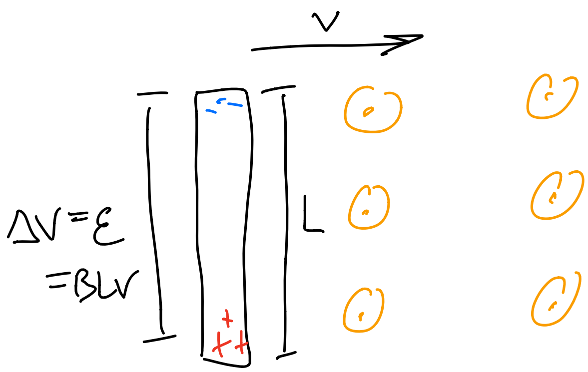
In general

$$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$$

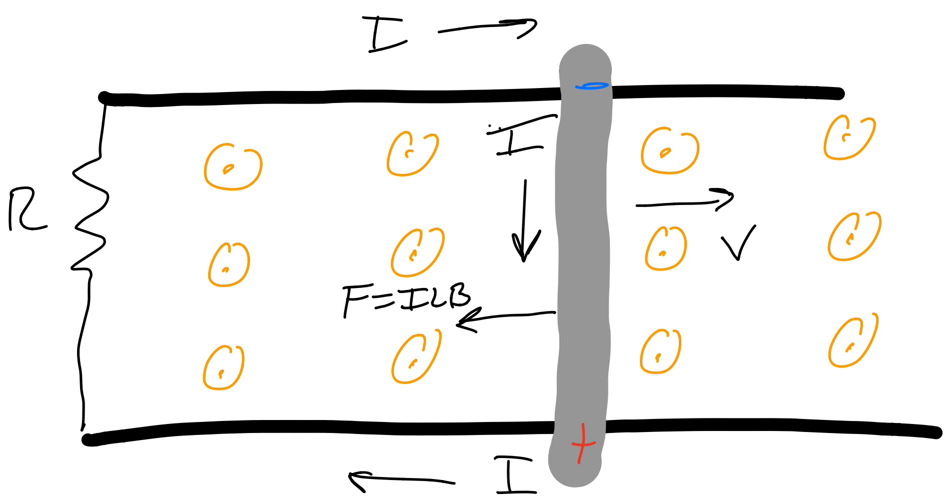
- Hall effect

- motional emf





v
ΔV=ε
=BLv
L



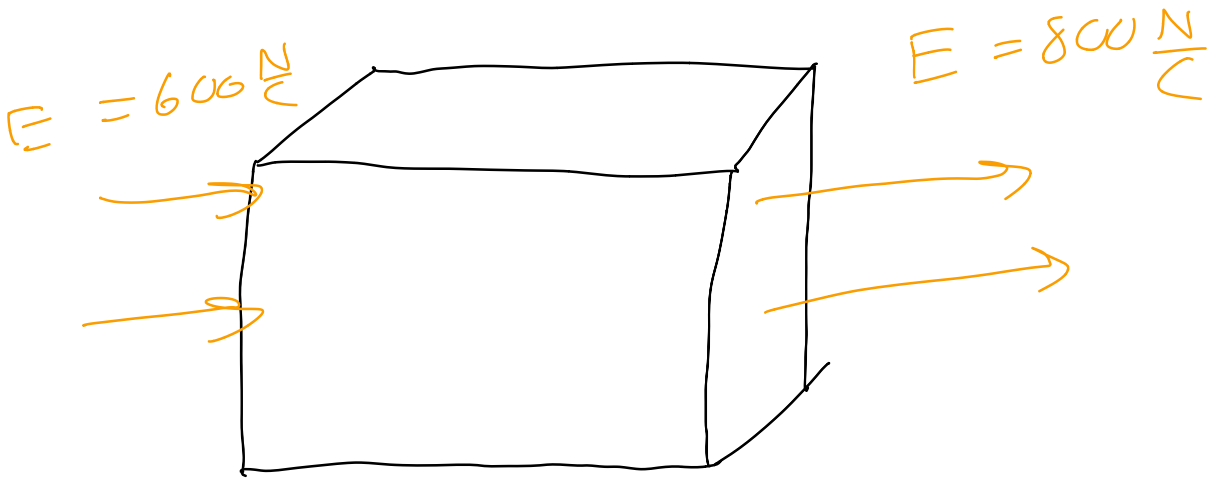
I
I
R
v
F=ILB
I

Ch 21

- Know electric Flux

$$\Phi_E = \vec{E} \cdot \hat{n} \Delta A$$

$$= \int \vec{E} \cdot \hat{n} \, dA$$



Use Gauss' Law

$$\Phi_E = \frac{q_{inside}}{\epsilon_0}$$

Use symmetry to find $\vec{E}$

$$\oint \vec{E}\cdot\hat{n}\,dA = E\int dA = EA$$

$$EA = \frac{q_{inside}}{\epsilon_0}$$

Ch 22

- Changing $\vec{B} \longrightarrow \vec{E}$

$$\oint \vec{E}\cdot d\vec{l} = \mathcal{E} = -\frac{d\Phi_{mag}}{dt}$$

$$\Phi_{mag} = \vec{B}\cdot\hat{n}\,\Delta A$$

$$= \int \vec{B}\cdot\hat{n}\,dA$$

Reminder!

Course Evals