Physics II: 1702
Gravity, Electricity, & Magnetism

Professor Jasper Halekas
Van Allen 70 [Clicker Channel #18]
MWF 11:30-12:30 Lecture, Th 12:30-1:30 Discussion

Final Exam May 10th 12:30-2:30

- Exam covers all topics covered in class, and the following book chapters/sections:

13.1-5, 13.7	Not 13.6,13.8
21 all	
22 all	
23 all	
24 all	
25 all	
26 all	
27.1-2, 27.4	Not 27.3
28.1-2, 28.4, 28.6-8	Not 28.3, 28.5
29 all	
30.1-30.8	Not 30.9
31.1-31.5	Not 31.6
32.1-3	Not 32.4-8
33.1	Not 33.2-7

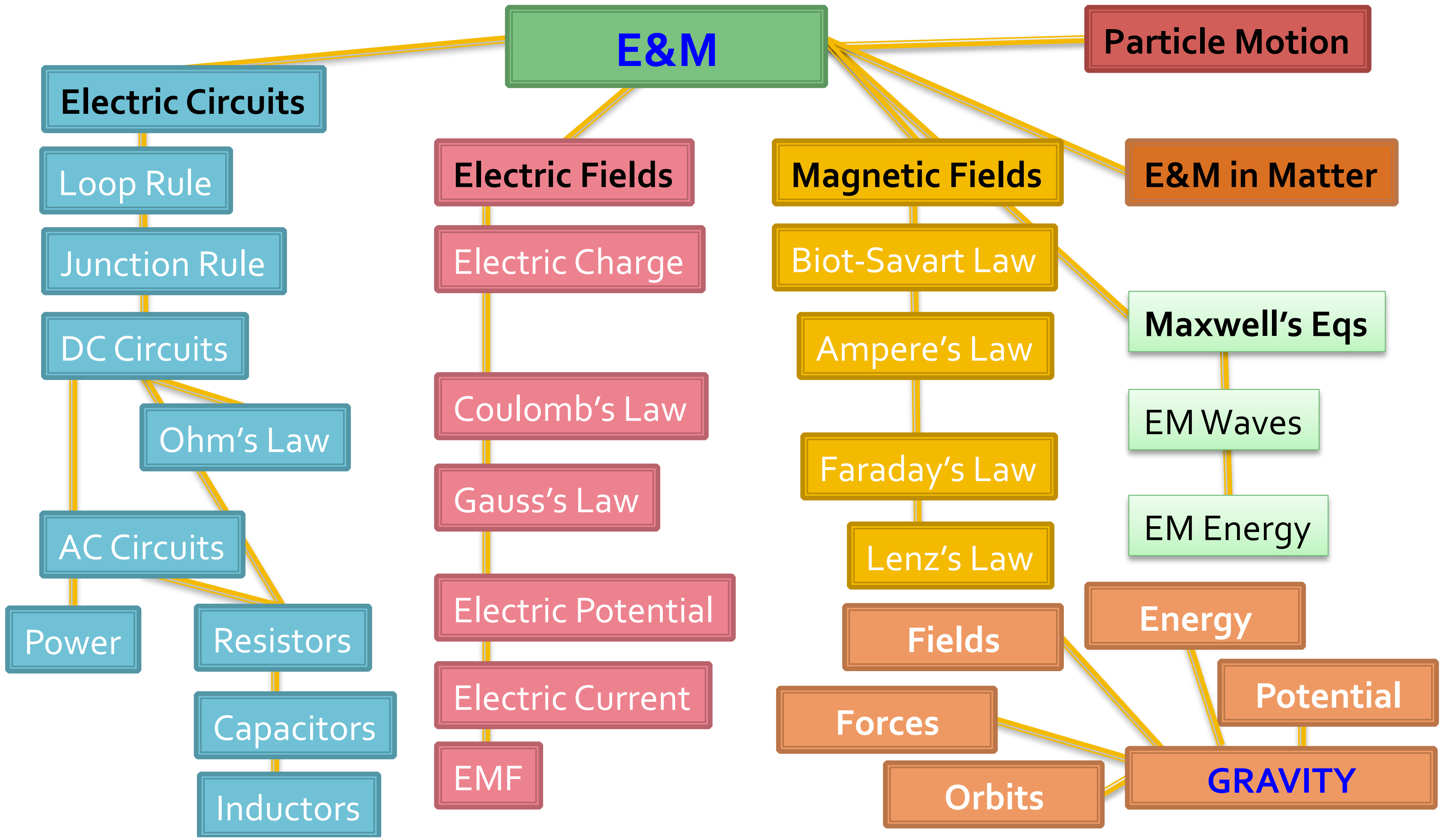
Final Exam

- A few new sample questions available
  - Also, look back at sample questions posted before the two midterms (which include questions from former midterms and finals)
- You may have both sides of a standard 8.5" x 11" piece of paper for your equation sheet for the final.

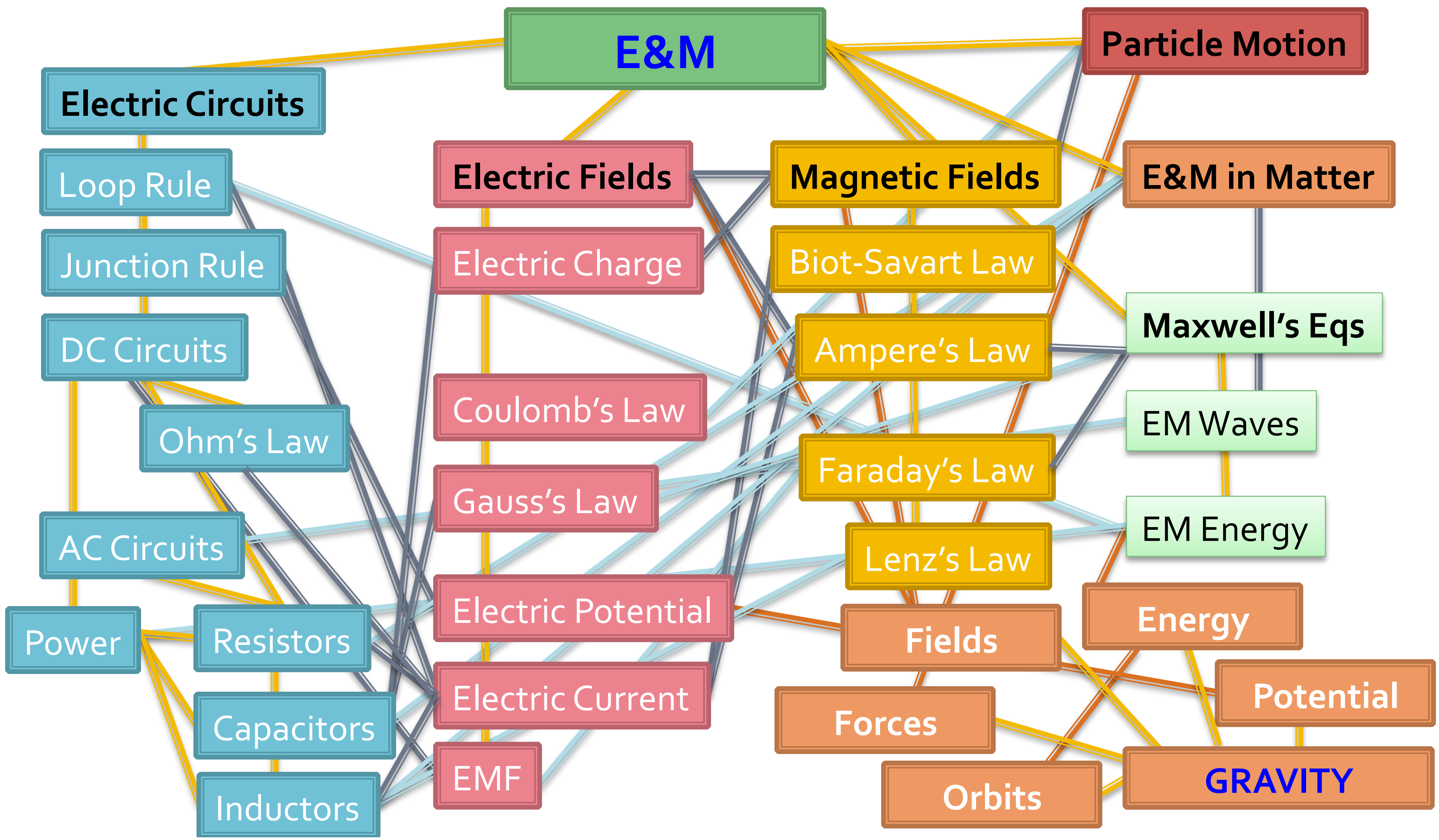
Evaluations

- Please fill out teaching evaluations
  - They are very valuable to me and I take them very seriously
  - I have in the past and will continue to change aspects of my teaching based on constructive feedback from you
- Would people like class time to do them?

The Big Picture



Interconnections



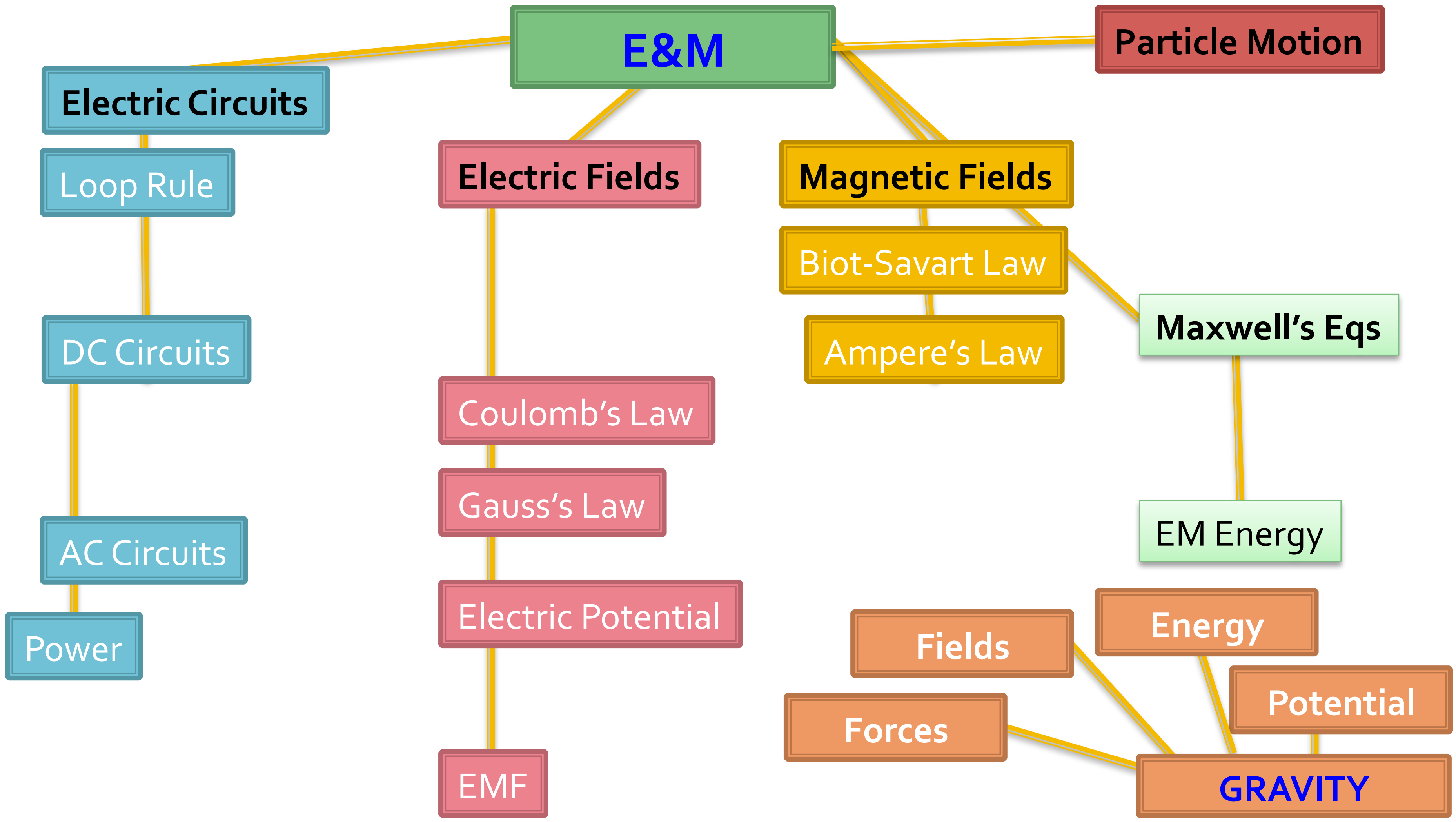
Three Reviews

I. Field, Forces, Energy (Today)

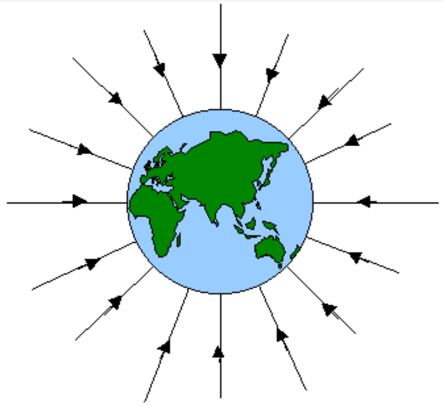
II. Electric Circuits (Wednesday)

III. Maxwell's Equations (Friday)

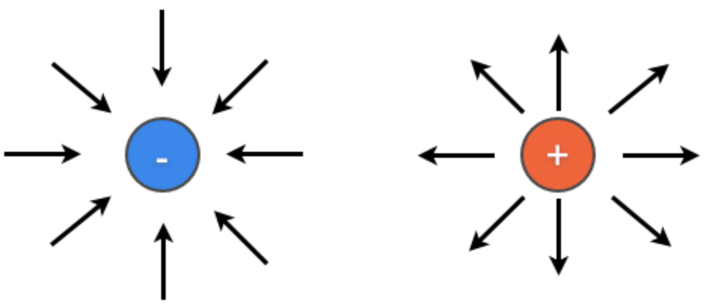
Fields, Forces, Energy



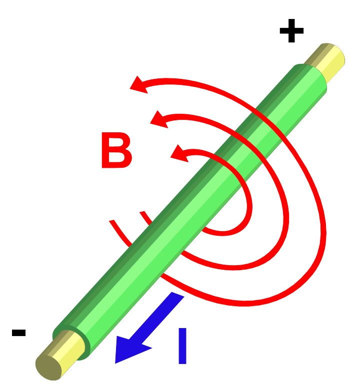
Sources



$$\vec{g} = \frac{\vec{F}_g}{m} = -G\frac{mM}{mr^2}\hat{r} = -\frac{GM}{r^2}\hat{r}$$

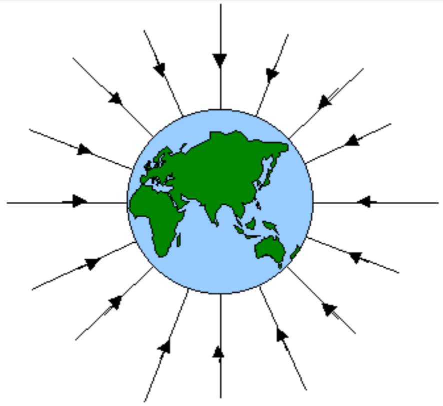


$$\vec{\mathbf{E}} = \frac{\vec{\mathbf{F}}_e}{q_o} = k_e\frac{q}{r^2}\hat{\mathbf{r}}$$

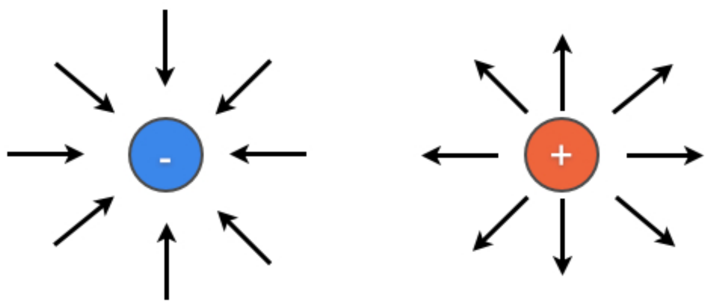


$$d\vec{B} = \frac{\mu_0 I d\vec{L} \, x \, \vec{1}_r}{4\pi r^2}$$

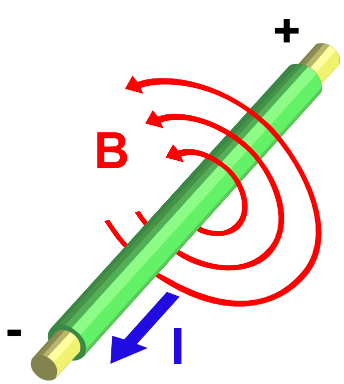
Integral Source Equations



$$\int_S \vec{g} \cdot d\vec{A} = 4\pi G M_{encl},$$

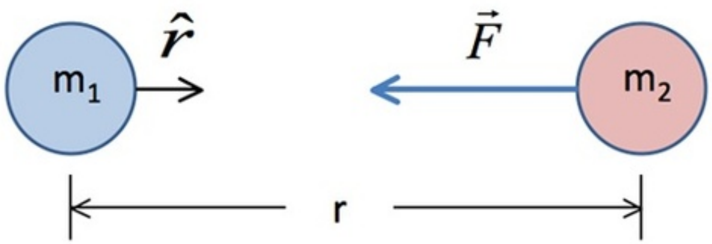


$$\oint \mathbf{E} \cdot d\mathbf{A} = \frac{q_{enc}}{\varepsilon_0}$$

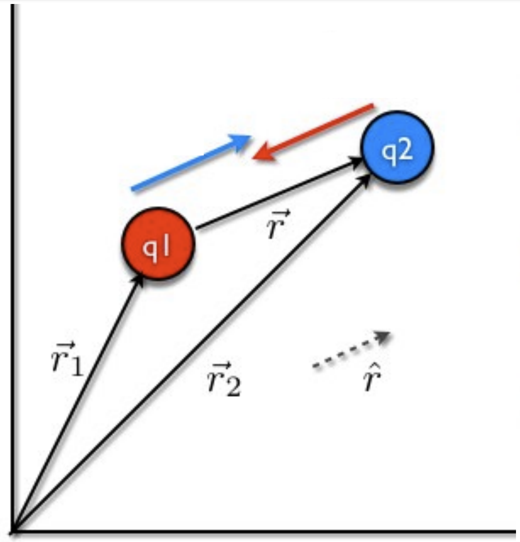


$$\oint_C \mathbf{B} \cdot \mathrm{d}\boldsymbol{\ell} = \mu_0 \iint_S \mathbf{J} \cdot \mathrm{d}\mathbf{S} = \mu_0 I_{\mathrm{enc}}$$

Forces and Fields



$$\vec{F} = -\frac{Gm_1m_2}{r^2}\hat{r}$$

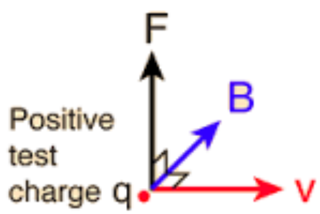


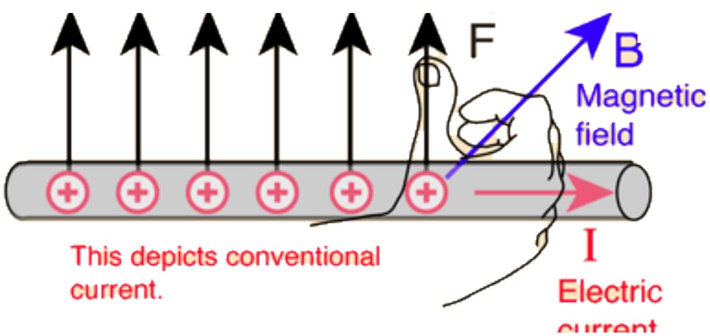
$$\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q_1q_2}{r^2}\hat{\mathbf{r}}$$

$$\mathbf{F}_{21} = \frac{1}{4\pi\varepsilon_0}\cdot\frac{q_1q_2}{r^3}\mathbf{r}$$

$$\mathbf{F}_{21} = \frac{q_1q_2}{4\pi\varepsilon_0}\cdot\frac{\mathbf{r}_2 - \mathbf{r}_1}{|\mathbf{r}_2 - \mathbf{r}_1|^3}$$

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

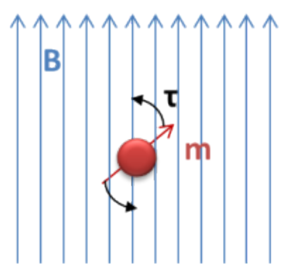




$$\vec{F} = \vec{I}L\,x\,\vec{B}$$

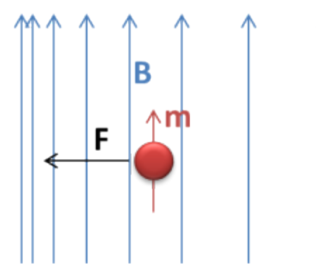
Force on straight wire of length L

$$\boldsymbol{\tau} = \mathbf{m} \times \mathbf{B}$$



$m = \mu = IA$

$$\mathbf{F} = \nabla(\mathbf{m}\cdot\mathbf{B})$$



Force <-> Potential Energy

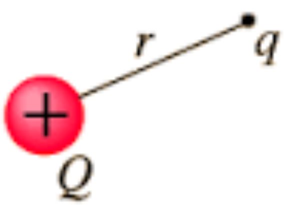
$$\Delta U = -\int_{x_1}^{x_2} F(x)dx = area$$

$$F(x) = \frac{-dU}{dx} = -slope$$

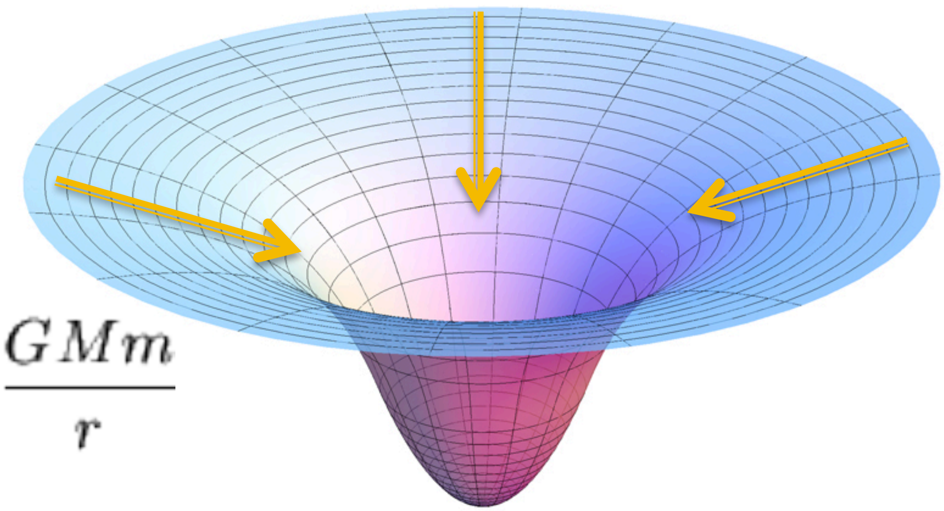
$$U = -\int \vec{F}_{conservative} \cdot d\vec{s} = -W_{conservative}$$

$$F_x = -\frac{\partial U}{\partial x} \; ; \; F_y = -\frac{\partial U}{\partial y}$$

$$U = \frac{kQq}{r}$$



$$U = -\frac{GMm}{r}$$



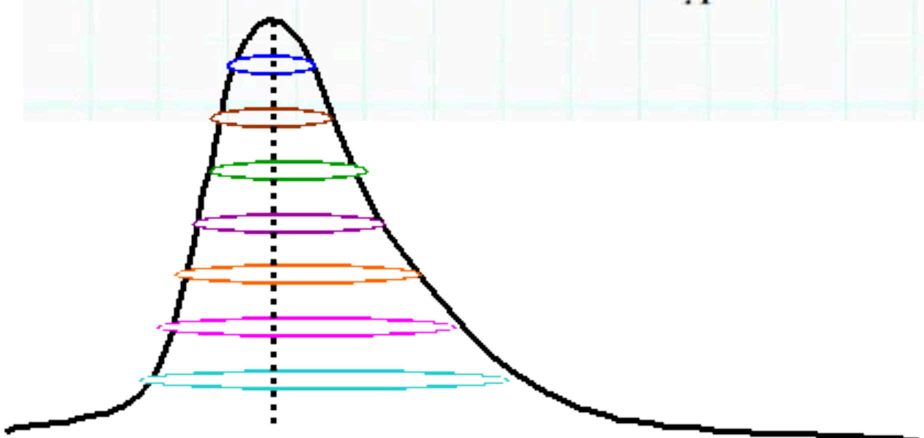
Field <-> Potential

$$\overline{E} = -\nabla V$$

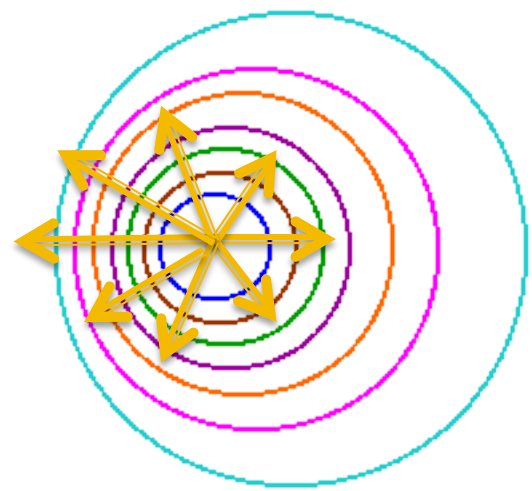
$$V_{BA} = V_B - V_A = -\int_A^B \overline{E} \bullet d\overline{\ell}$$

Field = Force per (m or q)

Potential = Potential Energy per (m or q)



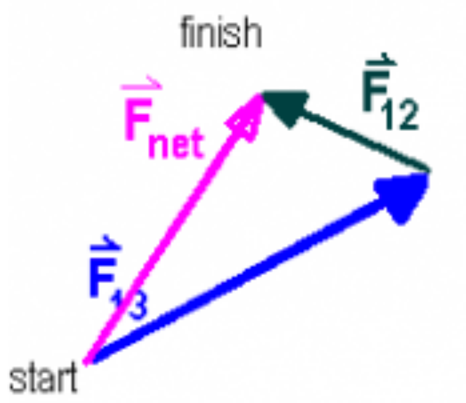
side view

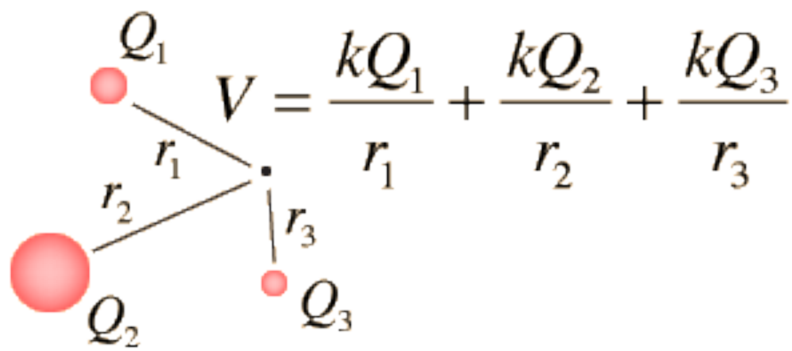


aerial view

Conservation of Energy

- $E = 1/2mv^2 + U_G + U_E + U_{EM} + \ldots = \text{constant}$





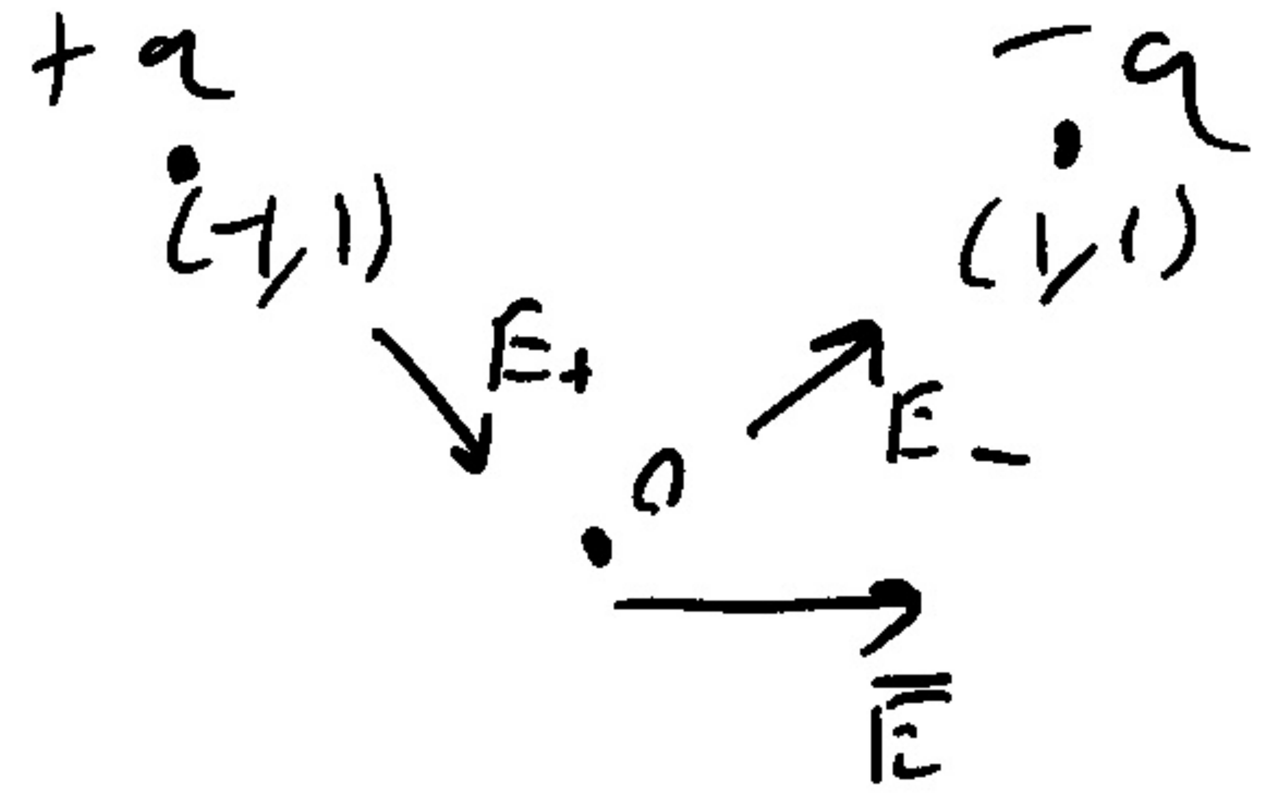
$$V = \frac{kQ_1}{r_1} + \frac{kQ_2}{r_2} + \frac{kQ_3}{r_3}$$

$$\sum_{loop} V = 0$$

$P_{in} = P_{out}$

$P = Fv + \tau\omega + \varepsilon i + Vi + \ldots$

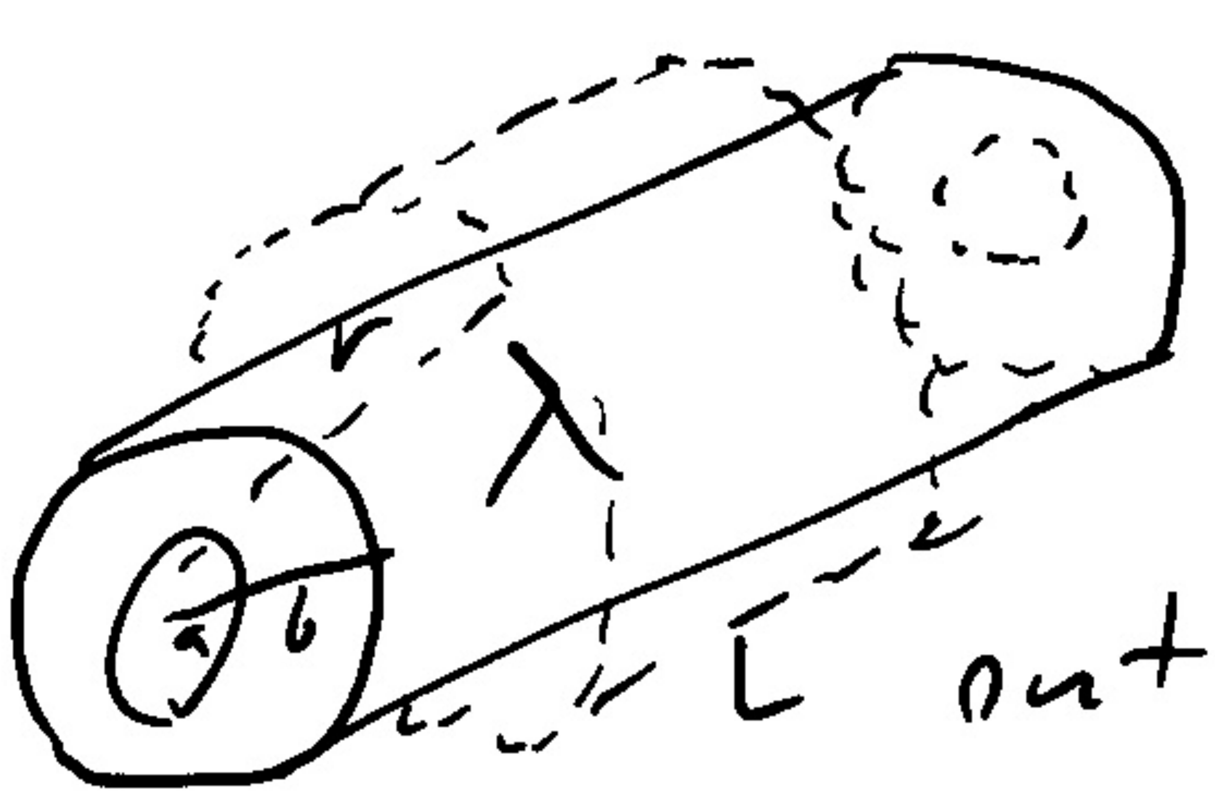
E.g. 1



$$\vec{E}(0,0) = \frac{kq}{(\sqrt{2})^2}\left[\frac{\hat{x}-\hat{y}}{\sqrt{2}}\right] + \frac{kq}{(\sqrt{2})^2}\left[\frac{\hat{x}+\hat{y}}{\sqrt{2}}\right]$$

$$= \frac{kq}{2}\cdot\frac{2\hat{x}}{\sqrt{2}} = \boxed{\frac{kq\hat{x}}{\sqrt{2}}}$$

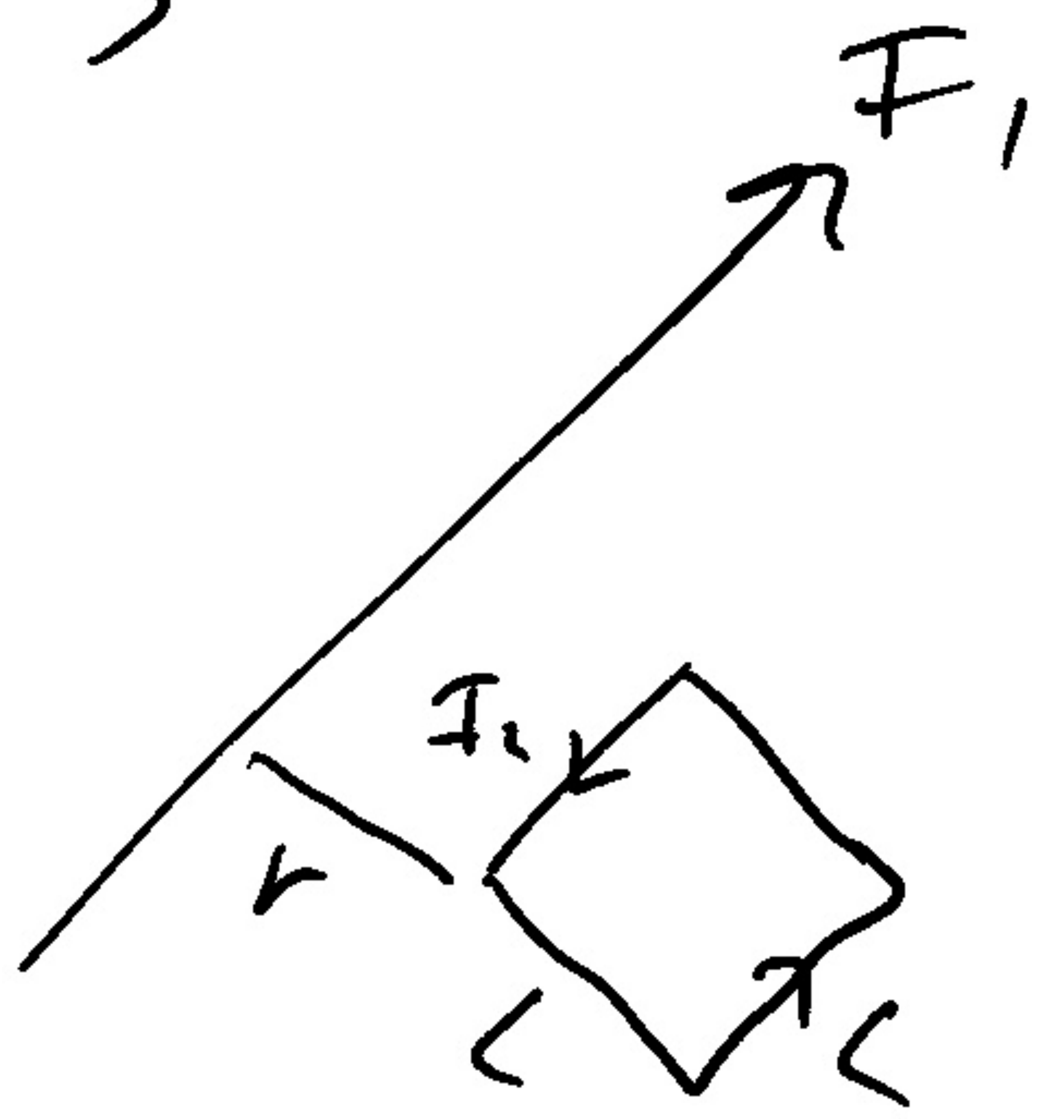
E.g. 2



outside b put gaussian cylinder w/ length L and radius r

$$\oint \vec{E}\cdot d\vec{A} = E_r \cdot 2\pi r L$$
$$= \frac{1}{\varepsilon_0} q_{enc}$$
$$= \frac{1}{\varepsilon_0}\cdot \lambda L \Rightarrow \boxed{\vec{E} = \frac{\lambda \hat{r}}{2\pi\varepsilon_0 r}}$$

E.g. 3



$$F \text{ on outer} = I_2 \vec{L} \times \vec{B}(r+L)$$
$$= I_2 L \cdot \frac{\mu_0 I_1}{2\pi (r+L)} \quad \text{left}$$

$$F \text{ on inner} = I_2 \vec{L} \times \vec{B}(r)$$
$$= I_2 L \frac{\mu_0 I_1}{2\pi r} \quad \text{right}$$

$$F_{tot} = \frac{\mu_0 I_1 I_2 L}{2\pi} \left[1/r - 1/(r+L) \right]$$
$$= \boxed{\frac{\mu_0 I_1 I_2 L}{2\pi} \frac{L}{r(r+L)}}$$

E.g. 4. $V = V_y \hat{j}$ $\quad B = B_x \hat{i}$
$E = E_y \hat{j}$

$$F = q\vec{E} + q\vec{v} \times \vec{B}$$
$$= qE_y \hat{j} + qV_y B_x \hat{j} \times \hat{i}$$
$$= \boxed{qE_y \hat{j} - qV_y B_x \hat{k}}$$