

3310 (1-2) - 1

Steven. Pollock @ colorado. edu

www.colorado.edu / physics / phys3310

Griffiths

Exam Dates x

Tues Feb 19 7:59:15
Mar 18

HW due every wed, start of class

- This week too, math review.

2 versions

Help sessions

Fri 4-5 ?

Mon: 4-5 ?

Tu: 4-5 ?

(IN BASEMENT)

T.B.D.

F419, later

← 11th floor

Reading for wed:

Advertisement (xi - xv)

2.1

Any/all of 1.1 - 1.3 you need to review

. Prereqs!

Stop me, Q's welcome. Get iclicker!

What's this course about? E+M

→ Think about its location (+ repetition) in curriculum

→ Basis for much of "experiential" physics

→ Model of mathematical rigor, completeness

→ Unification $E+M \Rightarrow$ relativity,
field theory

"Deep questions"

Is Coulomb's force law valid for *all* separation distances?

(Is it valid for $r=0$?)

What is the physics origin of the r^2 dependence of Coulomb's force law?

What is the physics origin of the $1/\epsilon_0$ dependence of Coulomb's force law?

What is the physics origin of the $1/4\pi$ factor in Coulomb's force law?

What really *is* electric charge?

Why is electric charge quantized (in units of e)?

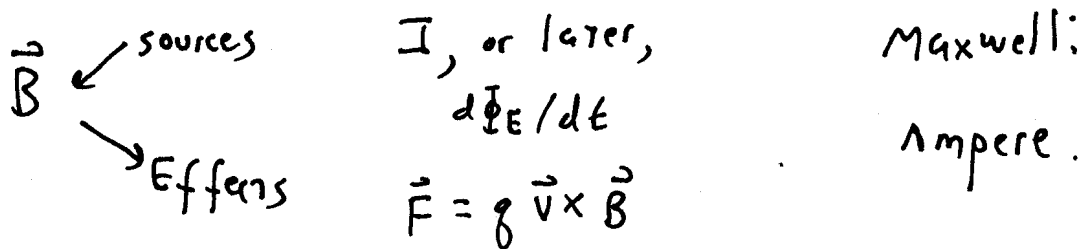
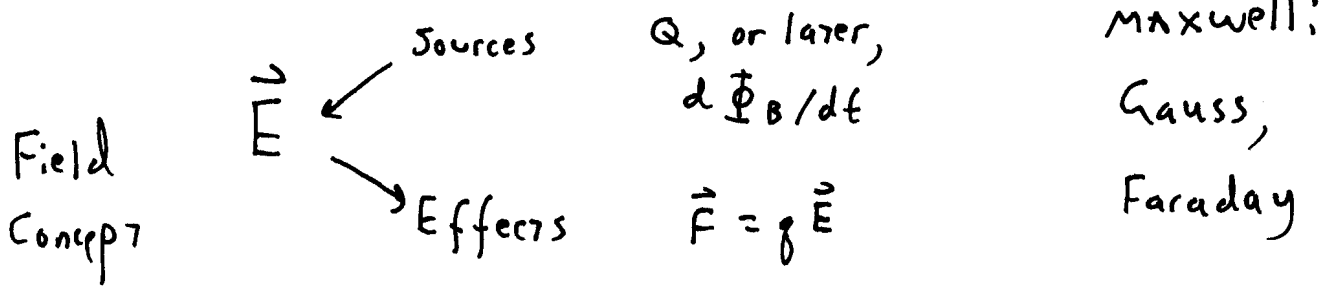
What really is *negative* vs. *positive* electric charge (i.e. $-e$ vs. $+e$)?

Why does the Coulomb force vary as the *product* of two electric charges q_1q_2 ?

What really is the E -field associated with e.g. a point electric charge, e ?

Are electric field lines real? Do they *really* exist in space and time?

E + M - construct your own concept map!



From $\vec{E} \rightarrow$ Voltage (potential)

Work + Energy

$\vec{E} + \vec{B}$ in matter

- conductors

And, newer this term:

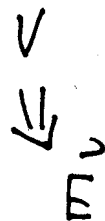
Applying vector calculus

Laplace's Eq'n

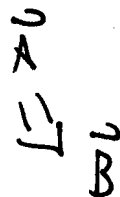
Vector Potential

Approximation Techniques

Solving for V



+ then, later,



+ Maxwell's Eq'ns.

(Deep Q's)

(1/2) - 4

Maxwell's Eq'ns

Integral form

$$\oiint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$

$$\oint \vec{E} \cdot d\vec{L} = - \frac{\partial}{\partial t} \Phi_{mag}$$

$$\oiint \vec{B} \cdot d\vec{A} = 0$$

$$\oint \vec{B} \cdot d\vec{L} = \mu_0 I_{thru} + \mu_0 \epsilon_0 \frac{\partial}{\partial t} \Phi_{el}$$

Differential Form

$$\vec{\nabla} \cdot \vec{E} = \rho / \epsilon_0$$

$$\vec{\nabla} \times \vec{E} = - \frac{\partial \vec{B}}{\partial t}$$

$$\vec{\nabla} \cdot \vec{B} = 0$$

$$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \epsilon_0 \frac{\partial \vec{E}}{\partial t}$$

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

+ Superposition: (\vec{E} 's, \vec{B} 's superpose.)

(1/2) - 5

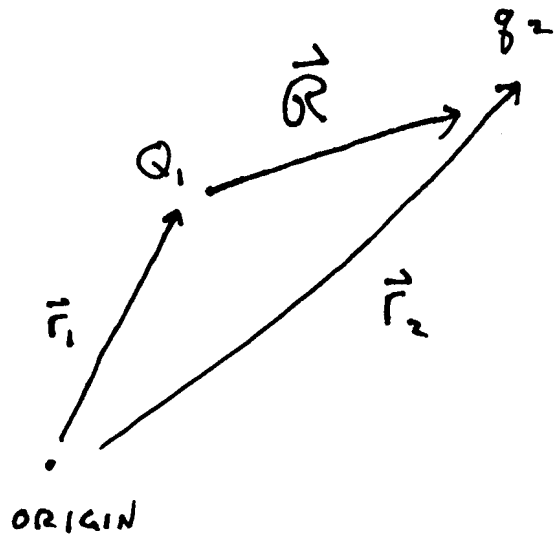
Where do we start?

ELECTROSTATICS

+ CONNECTIONS TO VECTOR CALCULUS

Coulomb's Law:

$$\vec{F}_{\text{on } q_2 \text{ by } Q_1} = \frac{1}{4\pi\epsilon_0} \frac{Q_1 q_2}{R^2} \hat{R}$$



Here

$$\vec{R} = \vec{r}_2 - \vec{r}_1$$

It points from source to object or point of interest

$$\hat{R} = \frac{\vec{R}}{|\vec{R}|} = \frac{\vec{R}}{R}$$

CT's.

Notes: $[Q] = \text{Coulombs (SI)}$

$$\epsilon_0 = \frac{1}{4\pi k} = 8.85 \cdot 10^{-12} \text{ C}^2 \text{ N/m}^2$$

$\vec{r}_1 = (x_1, y_1, z_1)$ in Cartesian, so

$$\vec{R} = (x_2 - x_1, y_2 - y_1, z_2 - z_1)$$

$$R = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2 + (z_2 - z_1)^2}$$

(1-2) - 6

Superposition: If you have multiple sources,

Q_1, Q_2, \dots, Q_N then

$$\vec{F}_{\text{on } q \text{ by } Q_i\text{'s}} = \sum_i \vec{F}_{\text{on } q \text{ by } Q_i}$$

No blocking!
Just (vector)
addition

So

$$\vec{F}_{\text{on } q} = \sum_{i=1}^N \frac{q Q_i}{4\pi\epsilon_0} \frac{1}{(\vec{r} - \vec{r}_i)^2} \hat{(\vec{r} - \vec{r}_i)}$$

if q is at position \vec{r}

$$= \sum_{i=1}^N \frac{q Q_i}{4\pi\epsilon_0} \frac{\vec{r} - \vec{r}_i}{|\vec{r} - \vec{r}_i|^3}$$

← Do you see why?

Remember, $\vec{R}_i = \vec{r} - \vec{r}_i$ goes from source Q_i to q (at \vec{r})

(57)