3310 (1-2) - 1

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} Griffiths
Exam Dates ×
Tues Feb 19 7:15-9:15
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 "experiental" physics

→ Model of mathematical rigor, completeness

→ Unification E+M ⇒ 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/ε0 dependence of Coulomb's force law?

What is the physics origin of the 1/4π 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 $q1q2$?

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!

Field Concept

$\vec{E}$ — Sources: Q, or later, $d\Phi_B/dt$ — Maxwell: Gauss, Faraday

$\vec{E}$ — Effects: $\vec{F} = q\vec{E}$

$\vec{B}$ — sources: I, or later, $d\Phi_E/dt$ — Maxwell: Ampere.

$\vec{B}$ — Effects: $\vec{F} = q\vec{v} \times \vec{B}$

From $\vec{E}$ → Voltage (potential)

work + Energy

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

And, <u>newer</u> this term:

- Applying vector calculus
- Laplace's Eq'n
- Vector Potential
- Approximation Techniques

} Solving for $V \Rightarrow \vec{E}$

+ then, later, $\vec{A} \Rightarrow \vec{B}$

+ Maxwell's Eq'ns.

(Deep Q's)

Maxwell's Eq'ns

Integral form	Differential Form
$\oiint \vec{E} \cdot d\vec{A} = \frac{Q_{enc}}{\varepsilon_0}$	$\vec{\nabla} \cdot \vec{E} = \rho / \varepsilon_0$
$\oint \vec{E} \cdot d\vec{L} = -\frac{\partial}{dt} \Phi_{MAG}$	$\vec{\nabla} \times \vec{E} = -\frac{\partial \vec{B}}{\partial t}$
$\oiint \vec{B} \cdot d\vec{A} = 0$	$\vec{\nabla} \cdot \vec{B} = 0$
$\oint \vec{B} \cdot d\vec{L} = \mu_0 I_{thru} + \mu_0 \varepsilon_0 \frac{\partial}{\partial t} \Phi_{El}$	$\vec{\nabla} \times \vec{B} = \mu_0 \vec{J} + \mu_0 \varepsilon_0 \frac{\partial \vec{E}}{\partial t}$

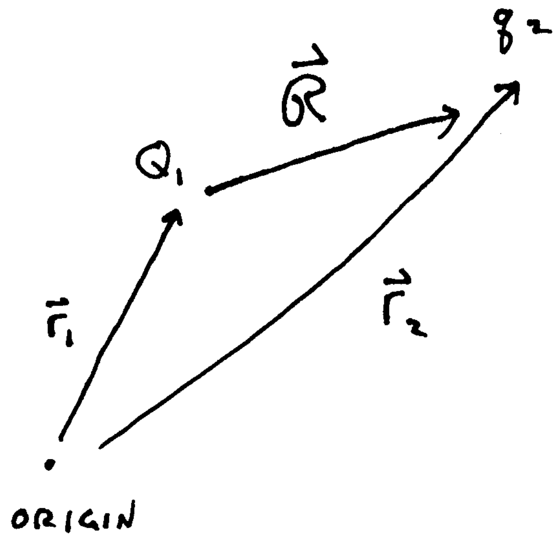
+ $\vec{F} = q\vec{E} + q\vec{v} \times \vec{B}$
+ Superposition : ($\vec{E}$'s, $\vec{B}$'s superpose.)

where do we start? **Electrostatics**

+ Connections to Vector Calculus

Coulomb's Law:

$$\vec{F}_{\substack{\text{on } q_2 \\ \text{by } Q_1}} = \frac{1}{4\pi\varepsilon_0} \frac{Q_1 q_2}{\mathcal{R}^2} \hat{\mathcal{R}}$$



Here

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

It points from source to object or point of interest

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

CT's.

Notes: $[Q]$ = Coulombs (SI)

$$\varepsilon_0 = \frac{1}{4\pi K} \simeq 8.85 \cdot 10^{-12} \; C^2 N/m^2$$

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

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

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

Superposition: If you have multiple sources, $Q_1, Q_2, \ldots Q_N$ then

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

No blocking! Just (vector) addition

So

$$\vec{F}_{\text{on } q} = \sum_{i=1}^{N} \frac{q Q_i}{4\pi\varepsilon_0} \frac{1}{(\vec{r} - \vec{r}_i)^2} (\widehat{\vec{r} - r_i})$$

$\downarrow$ if q is at position $\vec{r}$

$$= \sum_{i=1}^{N} \frac{q Q_i}{4\pi\varepsilon_0} \frac{\vec{r} - \vec{r}_i}{|\vec{r} - \vec{r}_i|^3}$$

$\leftarrow$ Do you see why?

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