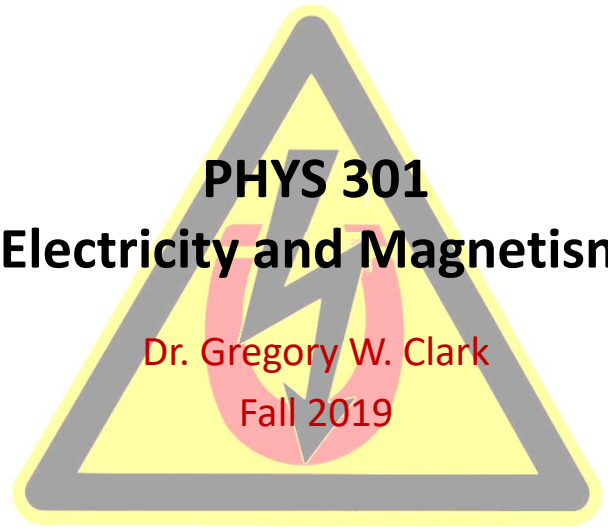
PHYS 301
Electricity and Magnetism



Dr. Gregory W. Clark

Fall 2019

Today!

- Quiz!
- Integral vector calculus:
  - Fundamental theorem of divergences
- Electric fields

Integral Calculus: Divergences

- The **fundamental theorem of divergences**:

$$\int_{\text{vol}} \left(\vec{\nabla}\cdot\vec{B}\right) dV = \oint_{\text{surface}} \vec{B}\cdot d\vec{A}$$

- Also called ***GAUSS' THM*** or ***GREEN's THM***

- NOTE:
  - $d\vec{A} = \hat{n}\, dA$ where $\hat{n}$ is $\perp$ the surface, pointing outward from the enclosed volume.
  - $\vec{B}\cdot\hat{n}$ = component of $\vec{B}$ $\perp$ surface.

ELECTROSTATICS

[Source charges at rest]

- **Basic problem**:
  Find forces on test charge due to source charges
- Superposition Principle holds for forces and vector fields

COULOMB'S LAW:

$$\vec{F} = \frac{1}{4\pi\varepsilon_o}\frac{qQ}{r^2}\hat{r}$$

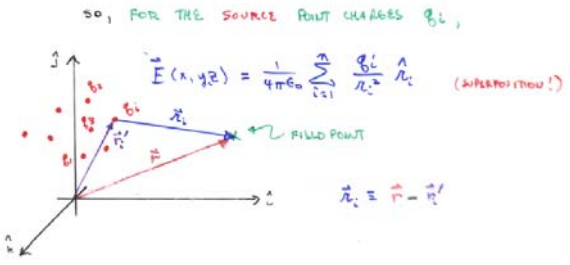
where

$\varepsilon_o = 8.85\times10^{-12} C^2/Nm^2$

for point charges q and Q

ELECTRIC FIELD:

$$\vec{E} = \vec{F}/Q$$



ELECTROSTATICS

[Source charges at rest]

- **Basic problem**:
  Find forces on test charge due to source charges
- Superposition Principle holds for forces and vector fields

THE ELECTRIC FIELD:

For a single point charge: $\vec{E} = \frac{1}{4\pi\varepsilon_o}\frac{q}{r^2}\hat{r}$

For a differentially small point charge: $d\vec{E} = \frac{1}{4\pi\varepsilon_o}\frac{dq}{r^2}\hat{r}$

For continuous charge distribution: $\vec{E} = \int d\vec{E} = \frac{1}{4\pi\varepsilon_o}\int \frac{dq}{r^2}\hat{r}$

where $\varepsilon_o = 8.85\times10^{-12} C^2/Nm^2$