WW01-02 Outline

- Electrostatics
  - Coulumb's Law
  - Gauss's Law

Interested Readers:

- Textbook 1.2
- Textbook 1.3, 1.4

$\boxed{\text{Maxwell's Equations}}$

Fundamental postulates:

$$\oint_C \vec{E} \cdot d\vec{l} = -\frac{\partial}{\partial t} \iint_S \vec{B} \cdot d\vec{s} - K$$ Faraday's law

$$\oint_C \vec{H} \cdot d\vec{l} = \frac{\partial}{\partial t} \iint_S \vec{D} \cdot d\vec{s} + I$$ Ampère's law

$$\oiint_S \vec{D} \cdot d\vec{s} = Q$$ Gauss's law

$$\oiint_S \vec{B} \cdot d\vec{s} = Q_m$$ Gauss's law-magnetic

$\boxed{\text{Maxwell's equations in integral form}}$

Basic quantities:

$\vec{E}$: V/m $\vec{H}$: A/m

$\vec{D}$: C/m^2 $\vec{B}$: webers/m^2

K : V I : A

Q : coulumbs Q_m : webers

Chapter I

Electrostatics

Coulumb's law

$$\vec{f} = \frac{q_1 q_2}{4\pi \varepsilon r^2} \hat{r}$$

$\vec{f}$ (Force): Newton

q (Charge): Coulumbs

ε (permittivity): farads/meter

r (distance between q_1 and q_2): m

$\hat{r}$: unit vector pointing away from the charge

Electric Field $\vec{E}$

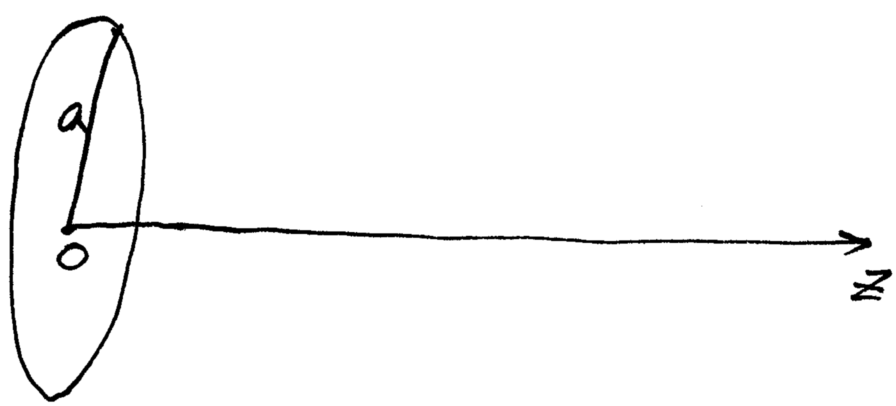
$$\vec{E} = \frac{\vec{F}}{\Delta q} \qquad (V/m)$$

$\vec{E}$ from a point charge q

$$\vec{E} = \frac{q}{4\pi\varepsilon r^2}\,\hat{r}$$

Example

Field of a ring of charge of density ρ_l c/m



Question: What is $\vec{E}$ along z axis?

Gauss's law

$$\oint\!\!\!\oint_S \vec{D} \cdot d\vec{s} = Q$$

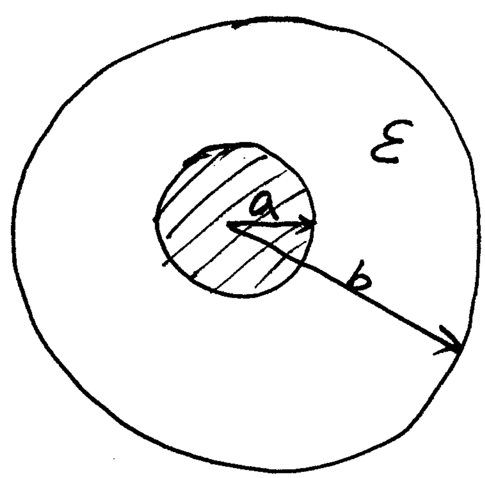
$\vec{D}$: Electric flux density C/m^2

$d\vec{s}$: normal to S

pointing outward

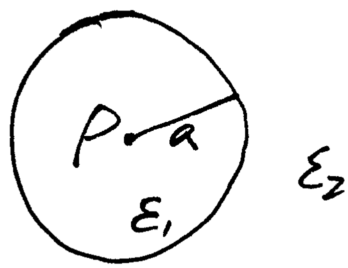
Example

Field Between Coaxial Cylinders



Question: What is $\vec{E}$?

Example: Fields of a sphere of uniform charge density



Question: What is $\vec{E}$?