Lecture 38 outline: 11/16/2020

- Last Time:

- Today
- Exam
- Boundary conditions / Current sheet
- Magnetic fields and work
- Questions!
- Differential form of Ampere's Law
- Faraday's Law / Demo

Summary: Current/Conductivity/Drude Model

$$I \stackrel{\text{def}}{=} \frac{\Delta Q}{\Delta t} \qquad I = \lambda \vec{v}$$

$$I \stackrel{\text{def}}{=} \vec{J} \cdot \vec{A} \qquad \vec{J} = \rho \vec{v} = Nq \vec{v} \qquad \vec{J} = N q^2 \tau \frac{E}{m}$$

$$\vec{J} = \sigma \vec{E} = \frac{\vec{E}}{\rho}$$

$$R = \rho \frac{L}{A}$$

$$V = I R$$

Exam

- Chapter 3 and 4
- HW4, 5, 6, 7 and #1-4 of HW8

Chapter 3

- Uniqueness theorems
- Method of Images
- Separable PDEs (Cartesian and Spherical)
- Fourier series and Legendre Polynomials
- Matching of solutions inside and outside sphere
- $\Delta \vec{E} \cdot \vec{n} = \frac{\sigma}{\epsilon_0}$
- Relaxation method (no coding)
- Multipole expansion

Chapter 4

- polarizability
- Polarization
- $\vec{D}, \vec{P}, \chi, \epsilon_r, \rho_B, \sigma_B$
- Torque and force on dipoles
- Permittivity χ_E
- Susceptibility ϵ
- Multilayer capacitors
- Energy in a capacitor
- Energy of an electric field $u = \epsilon_0 \frac{E^2}{2}$

$$u = \frac{\vec{D} \cdot \vec{E}}{2}$$

Clicker

$\vec{J} = \sigma \vec{E}$

σ represents:

A) Surface charge density

B) Volume charge density

C) Resistivity

D) Conductivity

Clicker

$\vec{J} = \rho \, \vec{v}$

ρ represents:

A) Surface charge density

B) Volume charge density

C) Resistivity

D) Conductivity

Clicker

$$\vec{J} = \frac{\vec{E}}{\rho}$$

ρ represents:

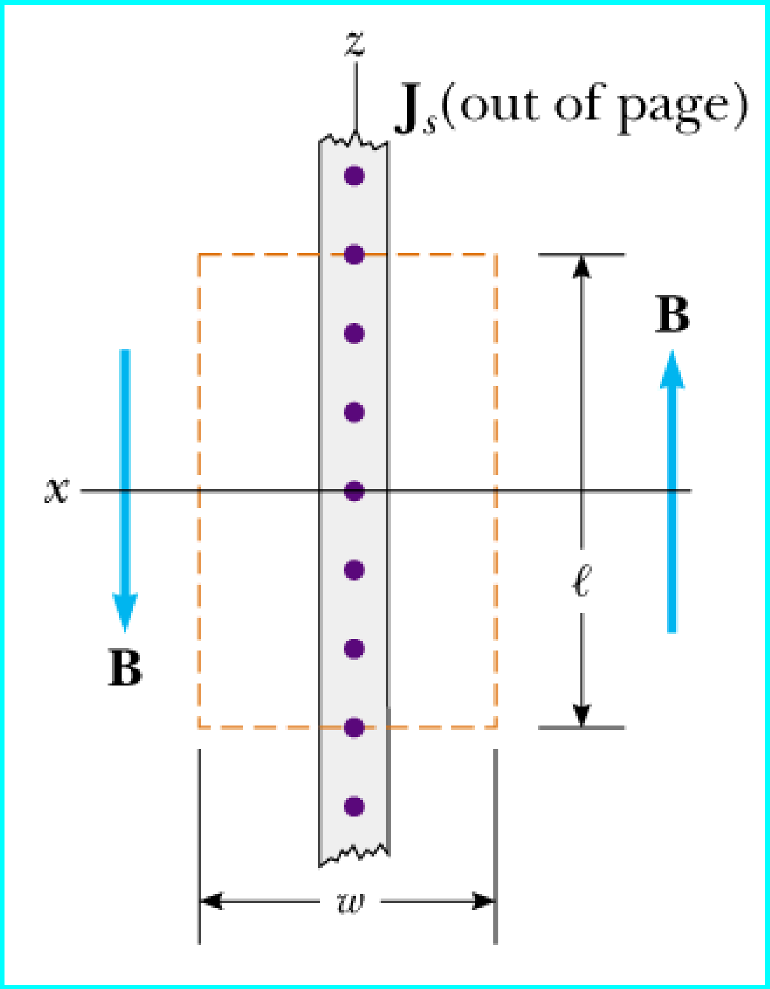
A) Surface charge density

B) Volume charge density

C) Resistivity

D) Conductivity

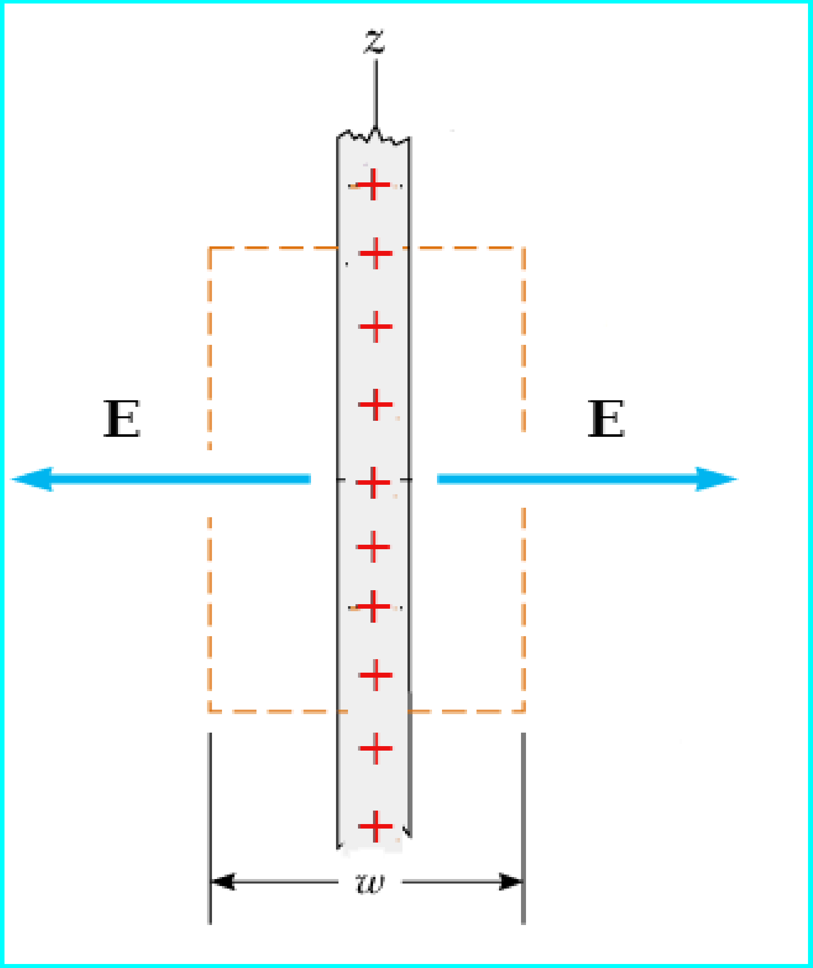
Infinite Current Sheet



$$\Delta B_{\parallel} = \mu_0 J t$$

$$\Delta B_{\parallel} = \mu_0 K$$

Infinite Charge Sheet



$$\Delta E_n = \frac{\sigma}{\epsilon_0}$$

Ch 5 Questions:

Magnets snap together. How can you say B does no work? (Edelman)

- Magnetic forces change particle's direction, how can this not do work?
- What's going on on p 218?
- Is Lorentz force really "empirical"?
- Is there magnetic potential energy? (Reed)
- J? (Taylor)
- What is relativistic Lorentz Force? (Smith)
- Is f_electrostatic E? (Privett)
- Why does Griffith's call water an insulator? (Sahd)
- How can you say E=0 in a conductor? (Pedrozza, Kelso, Gandarilla)

Ch 5 Questions:

Magnets snap together. How can you say B does no work? (Edelman)

- Magnetic forces change particle's direction, how can this not do work?

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

- What's going on on p 218?

Ch 5 Questions:

- Why does Griffith's call water an insulator? (Sahd)
- How can you say E=0 in a conductor? (Pedrozza, Kelso, Gandarilla)

Maxwell's Equations

Gauss's Law

$$\oiint \vec{E}\cdot d\vec{a} = \frac{Q}{\epsilon_0}$$

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

The "no monopole" equation

$$\oiint \vec{B}\cdot d\vec{a} = \mu_0 Q_{monopole} = 0$$

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

Ampere's Law

$$\oint \vec{B}\cdot dl = \mu_0 I$$

$$\nabla\times\vec{B} = \mu_0 \vec{J}$$

Faraday's Law

$$\varepsilon = -\frac{\partial}{\partial t}\int \vec{B}\cdot d\vec{a}$$

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

Ampere's Law

$$\oint \vec{B} \cdot dl = \mu_0 I$$

$$\nabla \times \vec{B} = \mu_0 \vec{J}$$

Faraday's Law

$$\varepsilon = -\frac{\partial}{\partial t} \int \vec{B} \cdot d\vec{a}$$

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