REVIEW LECTURE

Follow-up
EXAM CHECKS MATERIALS

- DIELECTRICS
  - ENERGY IN CAPACITOR
  - RESISTANCE, CURRENT, CIRCUITS
    - KIRCHHOFF'S LAW
  - MAGNETIC FIELD
    FORCE ON MOVING CHARGE, FORCE ON WIRE

DIELECTRICS

DIELECTRIC CONSTANT $k$

INCREASES CAPACITANCE BY FACTOR OF $k$

EXAMPLE

\[ \text{Elec} = C_0 \times 2 \]

ELECTRIC FIELD INSIDE IS REDUCED BY FACTOR OF 2
\[ E_{\text{infinite}} = \frac{\sigma}{2 \varepsilon_0} \]

\[ V = \frac{\sigma d}{2 \varepsilon_0} \]

\[ Q = CV \]

\[ \phi_a = \frac{\sigma d}{2 \varepsilon_0} \frac{C}{2} \]

\[ \frac{2 \varepsilon_0}{d} \approx C \]

\[ \text{which is a factor of 2 larger} \]

\[ \text{Energy stored in capacitor} \]

\[ \frac{1}{2} CV^2 = \frac{1}{2} \frac{Q^2}{C} \]
CAPACITORS IN PARALLEL OR SERIES

\[ C_T = C_1 + C_2 \]

\[ \frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} \]

CAPACITANCE CALCULATIONS

CAPACITANCE MEANS IF YOU PUT VOLTAGE \( V \) ACROSS IT YOU MOVE EXACTLY \( Q \) TO CREATE IT

\[ Q = -Q \]

\[ CV = Q \] Always
CIRCUITS

KIRCHHOFF'S RULES AND RESISTANCE

\[ R = \frac{\sigma \ell}{A} \]

\[ \sigma = \frac{1}{\rho} \]

Given a wire:
- Resistance drops if area is increased.
- Resistance increases if length is increased.

KIRCHHOFF'S RULE

1) Voltage drop across the entire loop must equal zero.

2) Current must be conserved.
Time Dependent Voltage in Circuits

\[ V(t) = V e^{-\frac{t}{RC}} \]
\[ V_0 = V_0 e^{-\frac{t}{RC}} \]

Time constant is \( \tau = RC \).

\[ R = 2.73 \]

Think about this

At \( t = 0 \)

Capacitor voltage

Use a short circuit

At \( t = \infty \)

Resistor voltage

I = \( \frac{V}{R} \)

Capacitor voltage like open circuit.
MAGNETIC FIELD

1 TESLA = 10,000 GAUSS

EARTH ~ 0.5 GAUSS

\[ \vec{F}_B = q \vec{v} \times \vec{B} \]

WE ALSO SAY

\[ I = q v d n = n q v d \]

\[ \vec{F}_D = I \vec{L} \times \vec{B} \]

OR

\[ \vec{F} = I \vec{L} \times \vec{B} \]

RIGHT HAND RULE IS REQUIRED HERE
DIRECTION OF CURRENT:

\[ V \]

which way?

\[ \text{de}^- \]

\[ + \text{h}^+ \]

\[ \rightarrow \text{e}^- \]

\[ \text{I} \]

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Note on dependence.

**Example** How does capacitance dependent on area in a parallel plate capacitor

\[ C = \frac{\varepsilon_0 A}{d} \]

\[ C \propto A \]

**Dependence of Res is Twice on Length of the Wire**
How to measure resistance

Voltmeter, Ammeter

How to measure voltage?