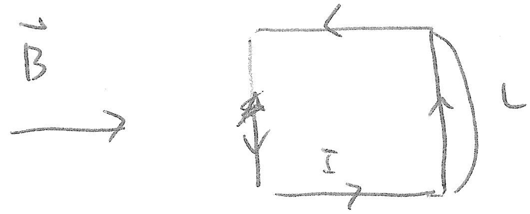
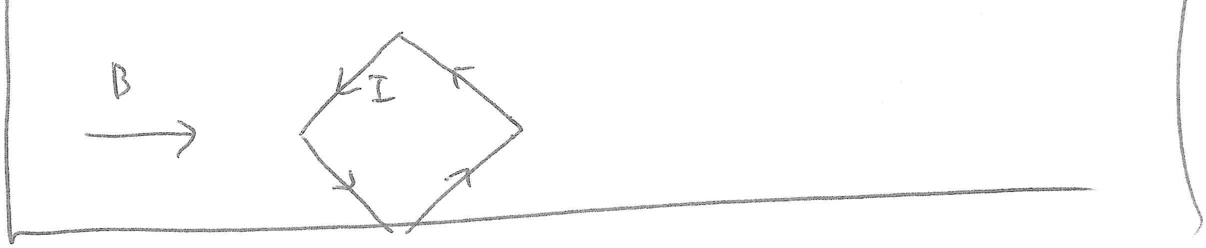
#1 MAGNETIC FORCE

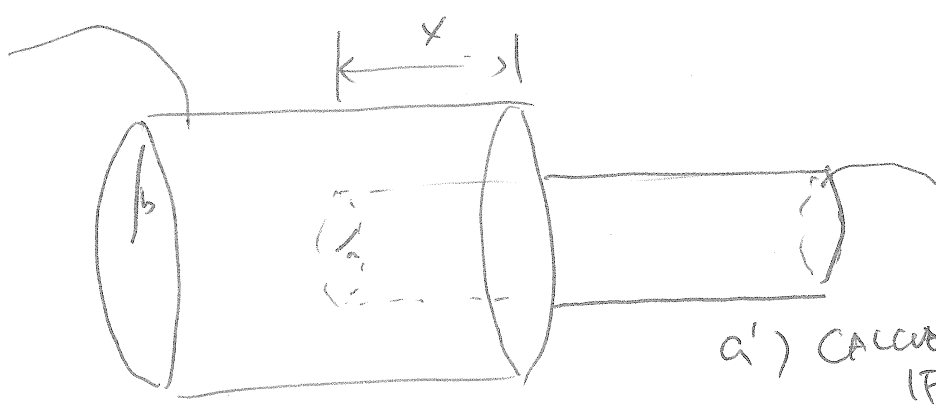
CALCULATE THE TOTAL FORCE ON THE LOOP



$\vec{F} = I\vec{L} \times \vec{B}$



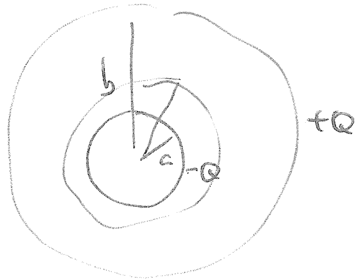
#2 CAPACITANCE



a') CALCULATE ENERGY STORED IF $V_{applied} = V$

a) CALCULATE CAPACITANCE ASSUMING NO FRINGE FIELD

b) CALCULATE FORCE BETWEEN THESE CYLINDERS IF $\vec{F}(x) = -\frac{\partial U}{\partial x}\hat{x}$



$Q_{ENCLOSED} = Q$

$$\frac{Q}{\varepsilon_0} = 2\pi r x \, E$$

$$E = \frac{Q}{2\pi\varepsilon_0 r x}$$

$$V(r) = \frac{Q}{2\pi\varepsilon_0 x} \ln\frac{b}{a}$$

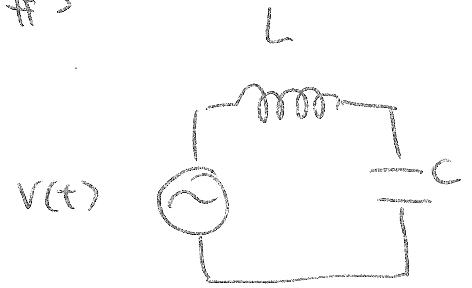
$$C = \frac{2\pi\varepsilon_0 x}{\ln\frac{b}{a}}$$

ENERGY STORED $\quad U = \frac{1}{2} C V^2 = \frac{1}{2} \frac{2\pi\varepsilon_0 x}{\ln b/a} \left(\frac{Q \ln}{2\pi\varepsilon_0 x (\ln b/a)} \right)^2$

$$= \frac{1}{2} Q^2 \frac{\ln b/a}{2\pi\varepsilon_0 x}$$

$$-\frac{\partial U}{\partial x} = F \quad \text{CALCULATE FORCE}$$

3



a) FIND IMPEDANCE

b) FIND THE PHASE OF CURRENT ASSUMING $V(t) = V_M \cos \omega t$, $I(t) = V_M \cos(\omega t - \phi)$

c) PLOT PHASE V.S. FREQUENCE
LABEL $\omega_0 = \frac{1}{\sqrt{LC}}$

d) WHAT HAPPENS TO CURRENT AT $\omega_0 = \frac{1}{\sqrt{LC}}$

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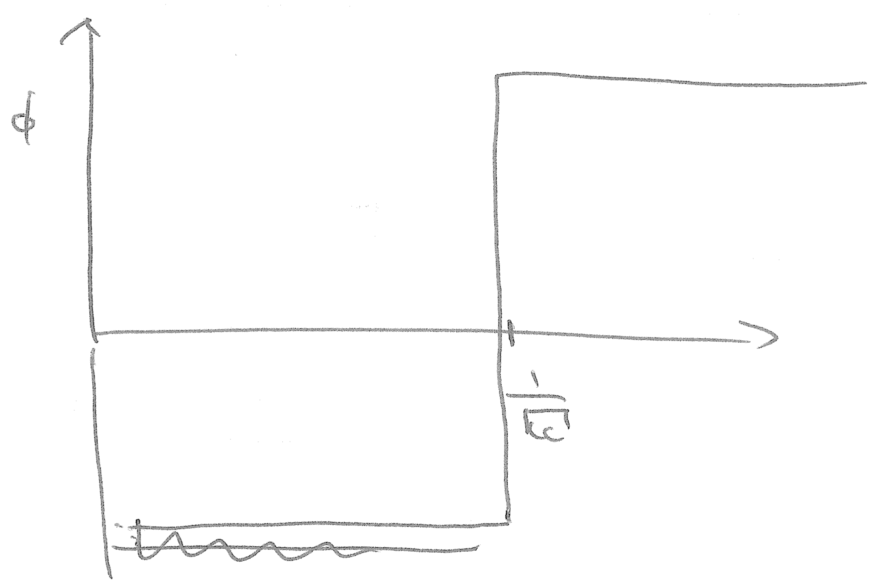
a) $Z_{TOTAL} = i\omega L + \frac{1}{i\omega C} = i\left(\omega L - \frac{1}{\omega C}\right)$

b) $\phi = 90^\circ \quad \omega L > \frac{1}{\omega C} \quad \omega^2 > \frac{1}{LC}$

$\phi = -90^\circ \quad \omega L < \frac{1}{\omega C} \quad \omega^2 < \frac{1}{LC}$

c)



$$i\left(\omega L - \frac{1}{\omega C}\right) = \qquad \underline{\underline{Z=0}}$$

$$\boxed{I \to \infty}$$

I EXPECT PEOPLE TO SOLVE THIS KIND OF QUESTION

$$E = \frac{Q}{4\pi\varepsilon_0 (b^3 - a^3)} \quad \frac{r^3 - a^3}{r^2}$$

$$V(r) = \frac{Q}{4\pi\varepsilon_0 (b^3 - a^3)} \left(-r^2 - \frac{a^3}{r} + 2b^3\right) \quad ✓$$

$$V(a) = \frac{Q}{4\pi\varepsilon_0 (b^3 - a^3)} \quad \frac{-b^2 - \frac{a^3}{b} + 2b^2}{\cancel{b^3 - a^3}}$$

$$V(a) = \frac{Q}{4\pi\varepsilon_0 (b^3 - a^3)} \quad \cancel{a^2 - \frac{a^2}{b}}$$

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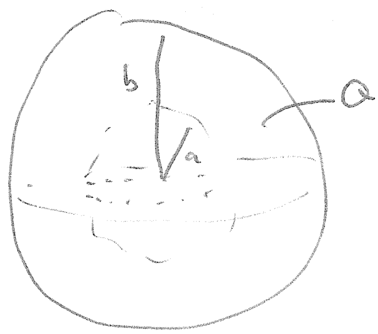
UNIFORMLY CHARGED HOLLOW SPHERE

CALCULATE E, ~~V~~ EVERYWHERE



E OUTSIDE $r > b$ $\frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$

E $a < r < b$ ~~$Q_{enc} = $~~

$$V = \frac{4\pi}{3}(b^3 - a^3)$$

$$Q_{enc} = Q\frac{(r^3 - a^3)}{b^3 - a^3}$$

$$4\pi r^2 E = \frac{Q_{enc}}{\varepsilon_0} = \frac{Q\frac{r^3 - a^3}{b^3 - a^3}}{\varepsilon_0}$$

$$E = \frac{Q}{4\pi\varepsilon_0 r^2}\frac{b^3 - a^3}{b^3 - a^3}$$

E $r < a$ 0

$V(r)$ $-\frac{\partial V}{\partial r} = E$ $V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{r}$

COMPENDIUM QUESTION

SPHERICAL SHELL

CALCULATE $V(r)$

$E(r)$ $\quad r > R$ $\quad \frac{1}{4\pi\varepsilon_0}\frac{Q}{r^2}$

$\Downarrow$

$$\frac{1}{4\pi\varepsilon_0}\frac{Q}{r} = V(r)$$

$E(r) <$ $\quad 0$

$r < R$

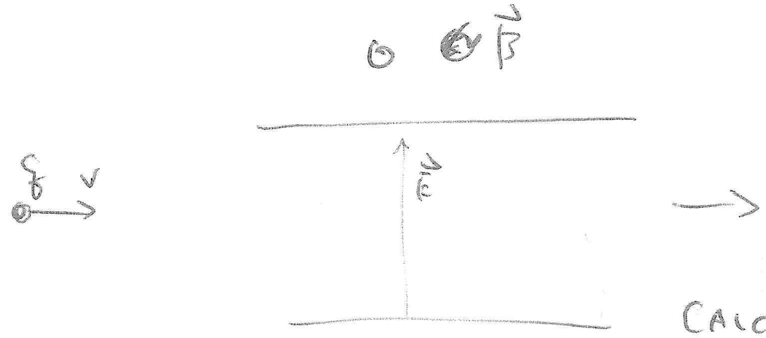
$$V(r) = \frac{1}{4\pi\varepsilon_0}\frac{Q}{R}$$

NO DISCONTINUITY

$$\frac{\partial^2 V}{\partial r^2} = 0$$

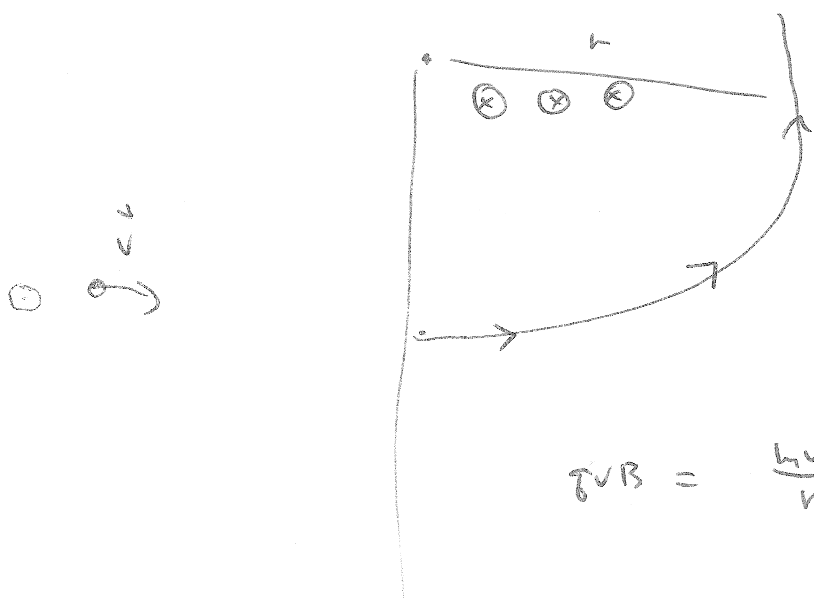
#5 FORCES / DIRECTION

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



PASSES THRU

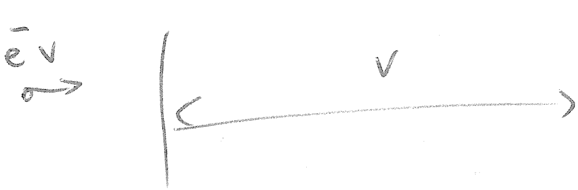
CALCULATE $\vec{V}$



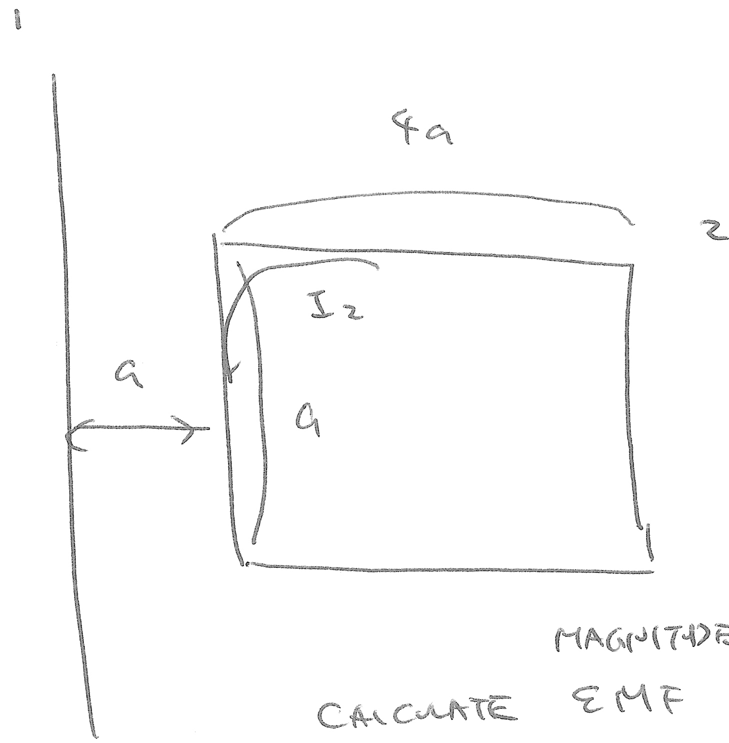
$qvB = \frac{mv^2}{r}$

WHAT IS RADIUS?

VOLTAGE



#6 MUTUAL INDUCTANCE



MAGNITUDE OF

CALCULATE EMF INDUCED IF I_2 IS CHANGING AT RATE $\frac{dI_2}{dt}$

IF I_1 IS CHANGING

$$\Phi_2 = \qquad 2\pi r B = \mu_0 I_1$$

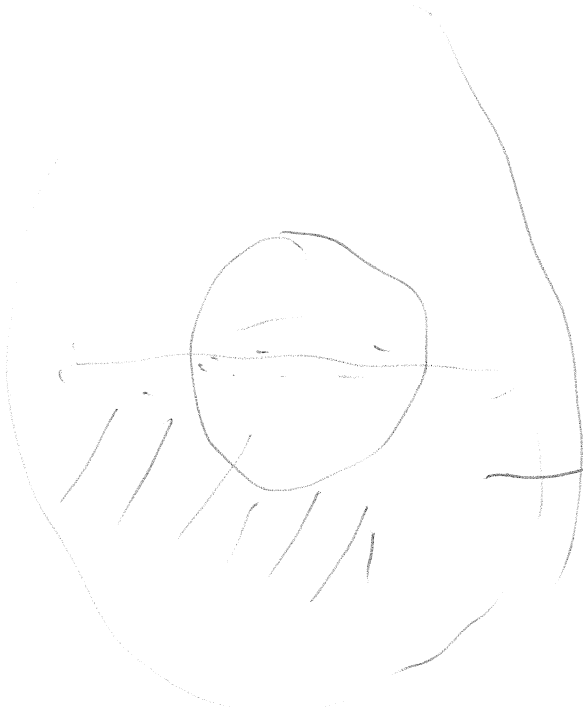
$$B = \frac{\mu_0 I_1}{2\pi r}$$

$$\Phi_2 = \frac{\mu_0 I_1 a}{2\pi} \ln 5$$

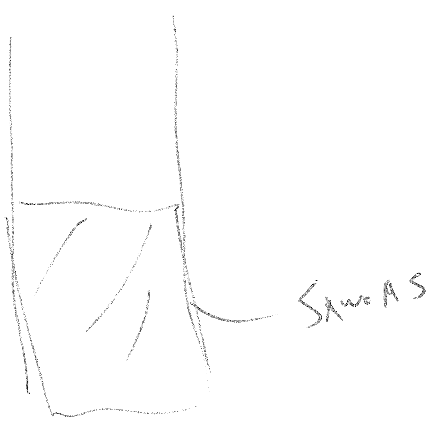
$$\frac{d\Phi_2}{dt} = \underbrace{\frac{\mu_0 a}{2\pi} \ln 5}_{\text{SAME}} \frac{dI_1}{dt}$$

$$\boxed{\mathcal{E} = -\frac{\mu_0 a}{2\pi} \ln 5 \frac{dI_2}{dt}}$$

#7



FILL HALF USING
DIELECTRIC $K = 4$
CALCULATE CAPACITANCE



$$C = 4\pi\varepsilon_0 \frac{ab}{b-a}$$

$$C_1 = 2\pi\varepsilon_0 \frac{ab}{b-a}$$

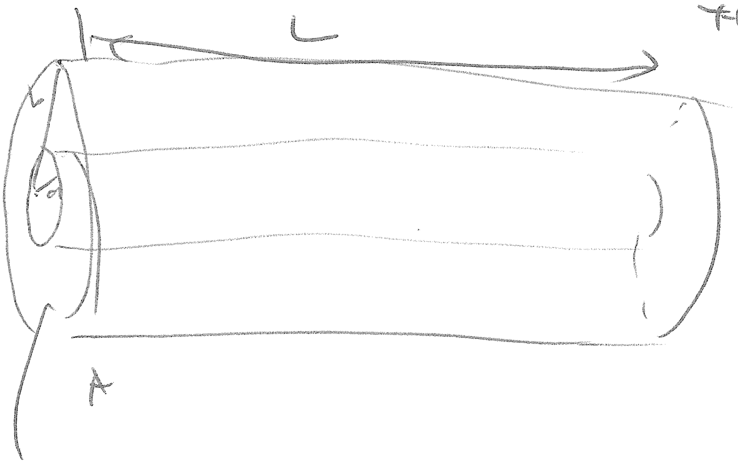
$$C_2 = 8\pi\varepsilon_0 \frac{ab}{b-a}$$

$$\boxed{C_{TOTAL} = 10\pi\varepsilon_0 \frac{ab}{b-a}}$$

8

CALCULATE RESISTANCE OF THIS ~~CIRC~~ WIRE GIVEN THAT THE VOLUME RESISTIVITY IS

$\rho(\Omega \cdot m)$



$$A = \pi(b^2 - a^2)$$

$$R = \frac{\rho L}{A} = \frac{\rho L}{\pi(b^2 - a^2)}$$

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KIRCHHOFF'S LAW QUESTION