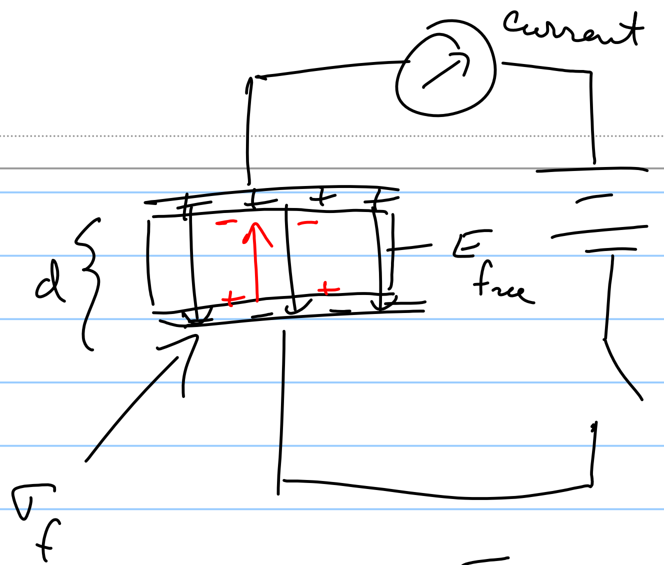
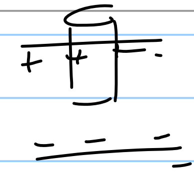
Note Title 2/27/2009



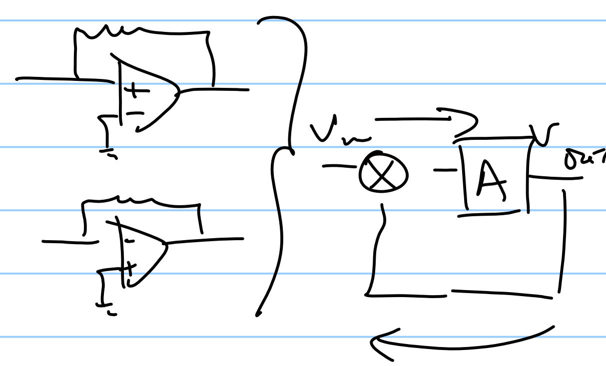


$EA = \frac{\sigma A}{\epsilon_0}$

Linear material $P = \epsilon_0 \chi_e E$

$$E = \frac{\sigma_f}{\epsilon_0} - \frac{\sigma_b}{\epsilon_0} = \frac{\sigma_f}{\epsilon_0} - \frac{P}{\epsilon_0}$$

$$E_{tot} = \frac{\sigma_f}{\epsilon_0} - \frac{\epsilon_0 \chi_e E_{tot}}{\epsilon_0}$$



$$E_{tot} = \frac{\sigma_f}{\epsilon_0} \frac{1}{1+\chi_e}$$

$V_{in} A \pm V_0 A = V_0$

pos neg feedback

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$$\sigma_b = P = \epsilon_0 \chi_e E_{tot} = \frac{\epsilon_0 \chi_e \sigma_f}{\epsilon_0 (1+\chi_e)}$$

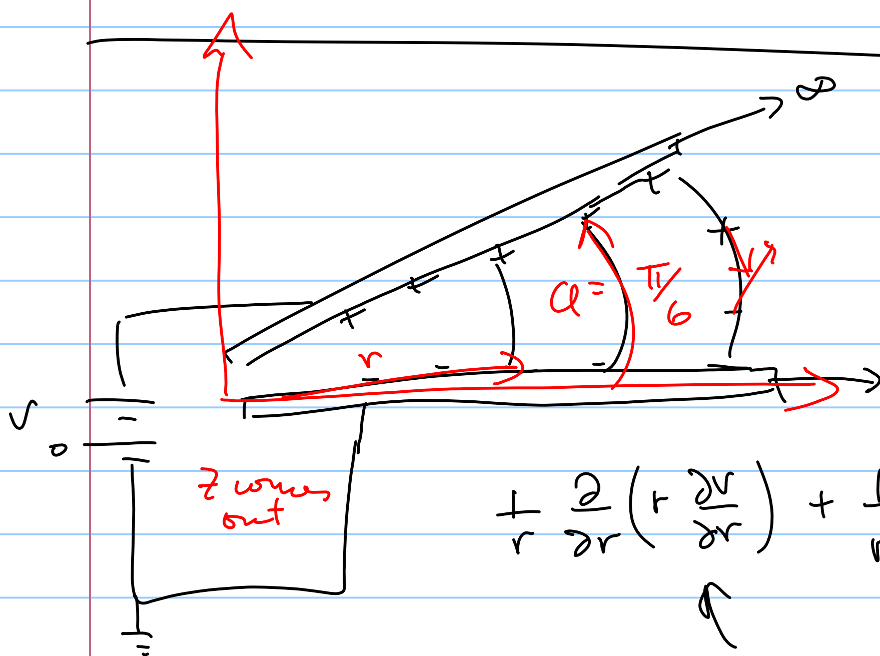
Capacitance?

$$C = \frac{Q_f}{|\Delta V|} = \frac{\sigma_f A}{\int \vec{E}_{tot} \cdot d\vec{l}} = \frac{\sigma_f A}{E_{tot} d} = \frac{\sigma_f A}{\frac{\sigma_f}{\epsilon_0} \frac{1}{(1+\chi_e)}}$$

$$C = \underbrace{\frac{\epsilon_0 A}{d}}_{C_0 \text{ w/o dielectric}} (1+\chi_e) \quad \leftarrow \text{property of atoms}$$

$$\underset{\uparrow \text{ density}}{P} = \epsilon_0 \chi_e \vec{E} \qquad \frac{\text{dipole mom}}{\text{vol}}$$

$$\underset{\uparrow \text{ per atom}}{p} = \alpha E$$



Newton's Law

free body diagram

$$\vec{F} = q\vec{E}$$

$$\frac{1}{r}\frac{\partial}{\partial r}\left(r\frac{\partial V}{\partial r}\right) + \frac{1}{r^2}\frac{\partial^2 V}{\partial \varphi^2} + \frac{\partial^2 V}{\partial z^2} = 0$$

$$V(r,\varphi,z) = R(r)\,\Phi(\varphi)\,Z_1(z)$$

$Z_1(z) =$ const

$$\underbrace{\frac{\cancel{\Phi(\varphi) Z_1(z)}}{R\,\cancel{\Phi Z_1}}\frac{1}{r}\frac{d}{dr}\left(r\frac{dR}{dr}\right)}_{} + \underbrace{\frac{\cancel{R(r) Z_1(z)}}{\cancel{R Z_1}\,\Phi}\frac{1}{r^2}\frac{d^2\Phi}{d\varphi^2}}_{} + \underbrace{\frac{\cancel{R(r)\Phi(\varphi)}}{\cancel{R Z_1 \Phi}}\frac{d^2 Z_1}{dz^2}}_{} = 0$$

$$C_1 + C_2 + C_3 = 0$$

$C_3 = 0$

$$C_1 = \frac{1}{R}\frac{r^2}{r}\frac{d}{dr}\left(r\frac{dR}{dr}\right) \qquad C_2 = \frac{1}{\Phi}\frac{d^2\Phi}{d\varphi^2}$$

Assume $R(r)$ does not depend on r

$\Rightarrow C_1 = 0$ since $C_1 + C_2 + C_3 = 0$

$$\Rightarrow C_2 = 0$$

$$0 = \frac{1}{\Phi}\frac{d^2\Phi}{d\varphi^2} \Rightarrow \Phi(\varphi) = m\varphi + b$$

at $\varphi = 0$ $V = 0$ $b = 0$

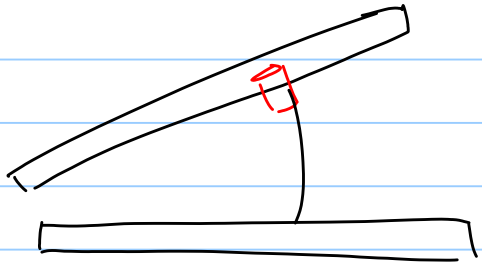
at $\varphi = \pi/6$ $V = V_0$ $V_0 = m\pi/6$ $m = \frac{6V_0}{\pi}$

$$V(r,\varphi,z) = \underbrace{Z(z)R(r)}_{\text{const}}\Phi = m\varphi = \frac{6V_0}{\pi}\varphi$$

$$\vec{E} = -\vec{\nabla} V = -\left(\underset{\overset{\parallel}{0}}{\frac{\partial V}{\partial r}}\hat{r} + \frac{1}{r}\frac{\partial V}{\partial \varphi}\hat{\varphi} + \underset{\overset{\parallel}{0}}{\frac{\partial V}{\partial z}}\hat{z}\right)$$

$$\vec{E} = -\frac{1}{r}\frac{6V_0}{\pi}\hat{\varphi}$$

Capacitance $\equiv \frac{Q}{V}$ $\leftarrow$ 12V $\qquad Q = \int \sigma \, da$



$EA = \frac{\sigma A}{\epsilon_0}$

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