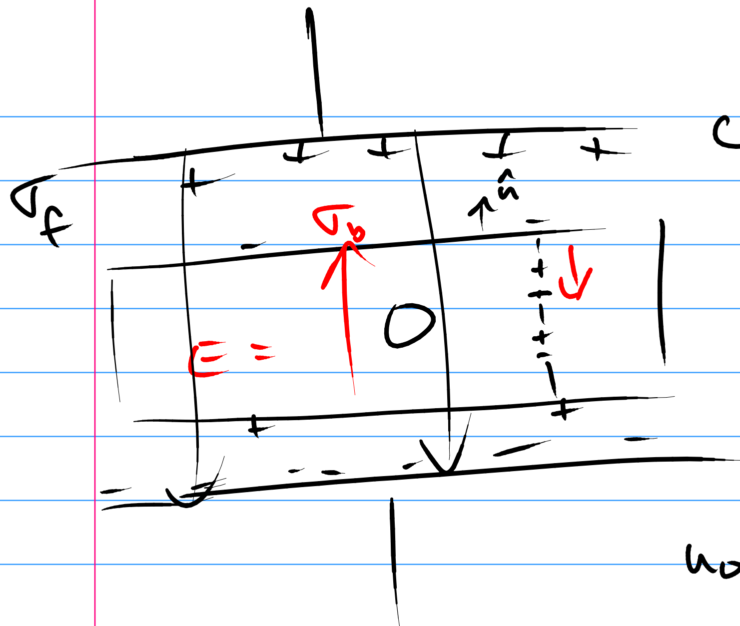


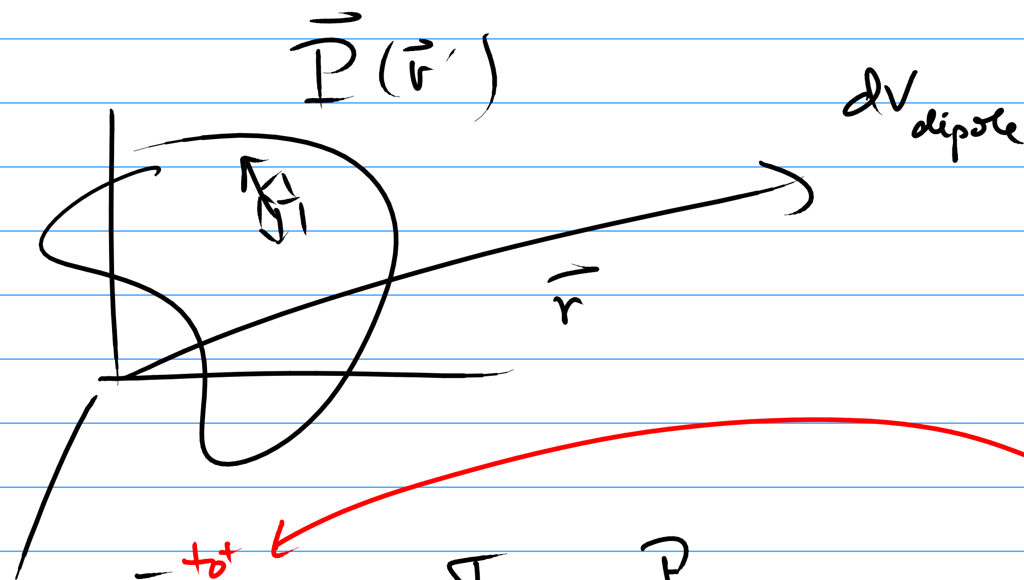
Q_{free} $\qquad \sigma_b = \vec{P}\cdot\hat{n}$

linear material

$$\vec{P} = \epsilon_0 \chi_e \vec{E}$$

no permanent dipole moments

$$E_{glass} = E_f + E_b = \frac{\sigma_f}{\epsilon_0} - \frac{\sigma_b}{\epsilon_0}$$



$$E_{glass}^{tot} = \frac{\sigma_f}{\epsilon_0} - \frac{P}{\epsilon_0} = \frac{\sigma_f}{\epsilon_0} - \frac{\epsilon_0 \chi E}{\epsilon_0}$$

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

$$E_{glass}^{tot}(1 + \chi_e) = \frac{\sigma_f}{\epsilon_0}$$

$$\boxed{E^{tot}_{glass} = \frac{\sigma_f}{\epsilon_0(1+\chi_e)}}$$

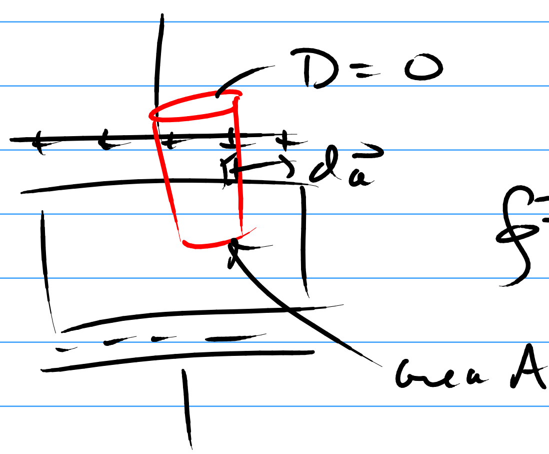
$$\sigma_b = P = \epsilon_0 \chi_e E^{tot}_{glass} = \epsilon_0 \chi_e \frac{\sigma_f}{\epsilon_0(1+\chi_e)}$$

$$\vec{\nabla}\cdot\vec{E} = \rho/\epsilon_0 = \frac{\rho_f + \rho_b}{\epsilon_0} = \frac{\rho_f}{\epsilon_0} - \frac{\vec{\nabla}\cdot\vec{P}}{\epsilon_0}$$

$$\epsilon_0 \vec{\nabla}\cdot\vec{E} + \vec{\nabla}\cdot\vec{P} = \rho_f$$

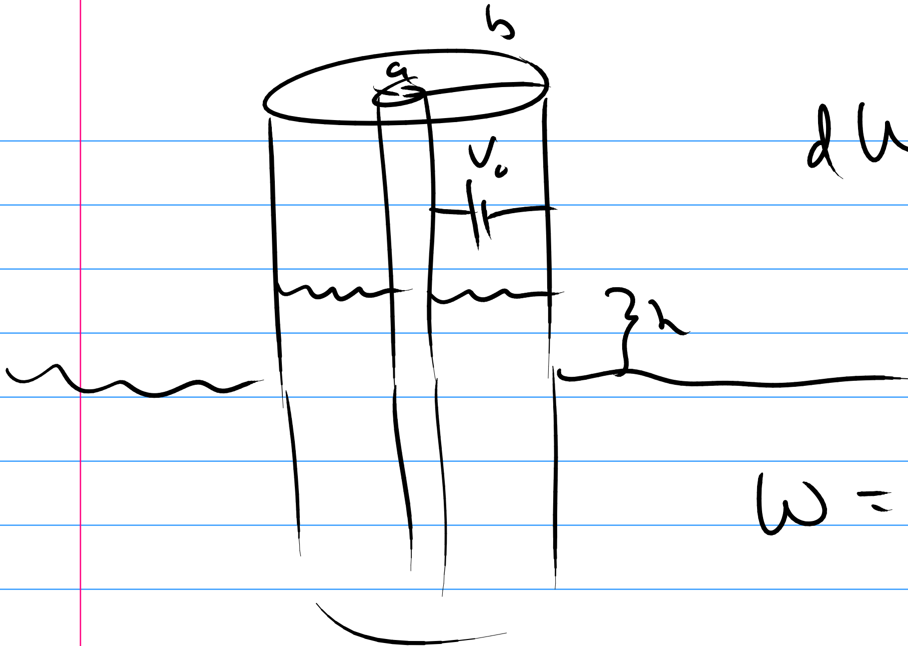
$$\vec{\nabla}\cdot\underbrace{(\epsilon_0\vec{E} + \vec{P})}_{\vec{D}} = \rho_f \qquad \vec{\nabla}\cdot\vec{D} = \rho_f$$

$$\oint \vec{D}\cdot d\vec{a} = Q_f^{enclosed}$$



$$\oint \vec{D}\cdot d\vec{a} = D\cancel{A} = \sigma_f \cancel{A}$$

$$\vec{D} = \epsilon_0\vec{E} + \vec{P} \,; \quad \epsilon E = \sigma_f \qquad E = \frac{\sigma_f}{\epsilon}$$



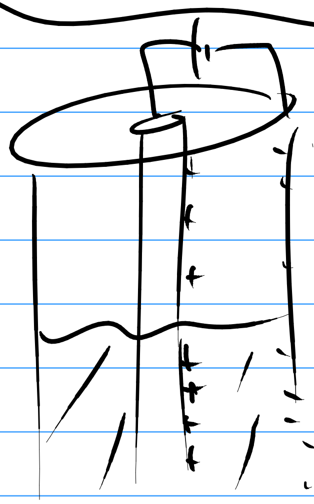
$$dW = -F\,dx$$

$$F = -\frac{dW}{dx}$$

$$W = \frac{1}{2}CV^2 = \frac{1}{2}\frac{Q^2}{C}$$

Check: $V_0 \to 0$ $\quad h \to 0$

$g \to 0$ $\quad h \to \infty$



$$C = \frac{Q}{V} = \frac{Q_{vac} + Q_{oil}}{V}$$

$$V_0 = \int_a^b E_{oil}\,dr = \int_a^b E_{vac}\,dr$$

Gauss's law to relate E & λ_{oil} λ_{vac}