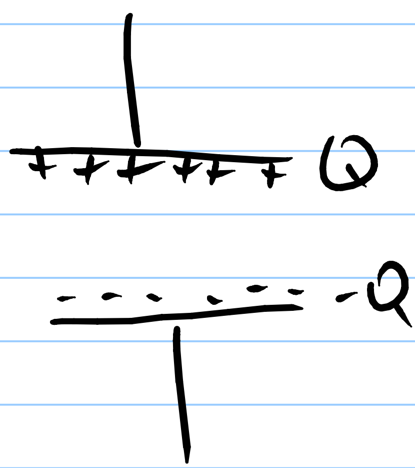
# APPLICATION OF Gauss's Law

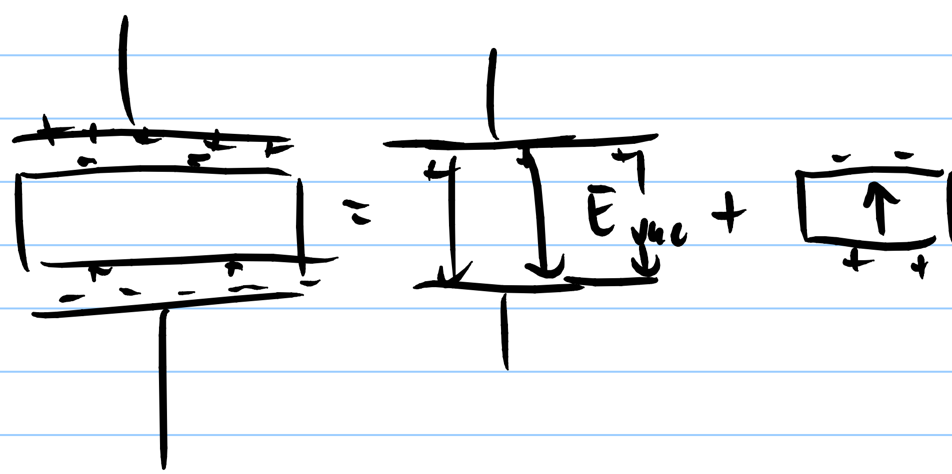
Note Title 2/27/2011

$$\vec{\nabla} \cdot \vec{D} = \rho_f \quad \text{or} \quad \oint \vec{D} \cdot d\vec{a} = Q_f^{\text{enclosed}}$$




What do I need to know to calculate $E$ in the glass?

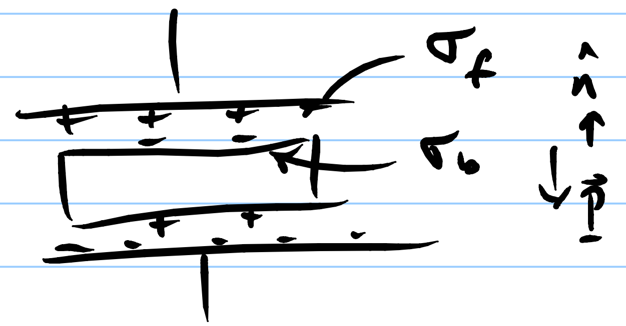
Is $E_{glass} > E_{vac}$ or $E_{glass} < E_{vac}$?




$\Rightarrow E_{glass} < E_{vac}$

Assume $\begin{cases} \text{no permanent electric dipole moments} \\ \text{no non-linear terms in } \vec{P} \text{ or } \vec{p} \end{cases}$

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




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

$$\sigma_b = \vec{P} \cdot \hat{n} = -\epsilon_0 \chi_e E$$

What E? Is it $E_{\text{free charge}} = \dfrac{\sigma_f}{\epsilon_0}$

$E_{\text{bound charge}} = \dfrac{\sigma_b}{\epsilon_0}$ or is <u>else</u>?

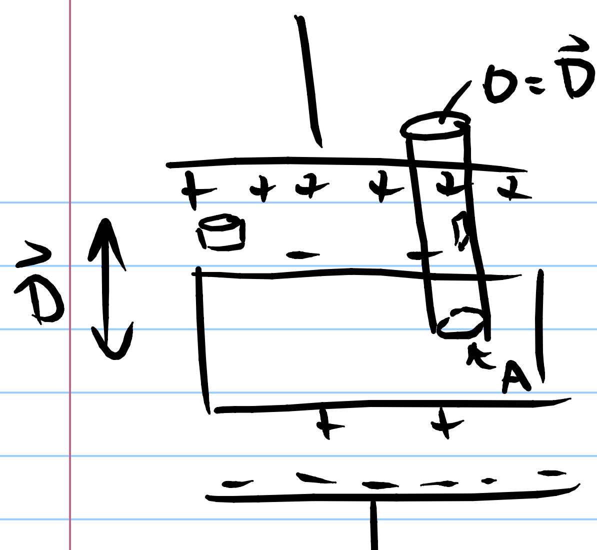
$$\sigma_b = -\epsilon_0 \chi_e E_{tot} \qquad E_{tot} = \frac{\sigma_f - \sigma_b}{\epsilon_0}$$

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

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

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

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




$\vec{\nabla}\cdot\vec{D} = \rho_f$ $\quad \oint \vec{D}\cdot d\vec{a} = Q_f^{enc}$

to apply easily Gauss's law need the direction of $\vec{D}$

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P}$$

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

$$D = \epsilon_0 E + \epsilon_0 \chi_e E = \epsilon E_{tot} = \sigma_f$$

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