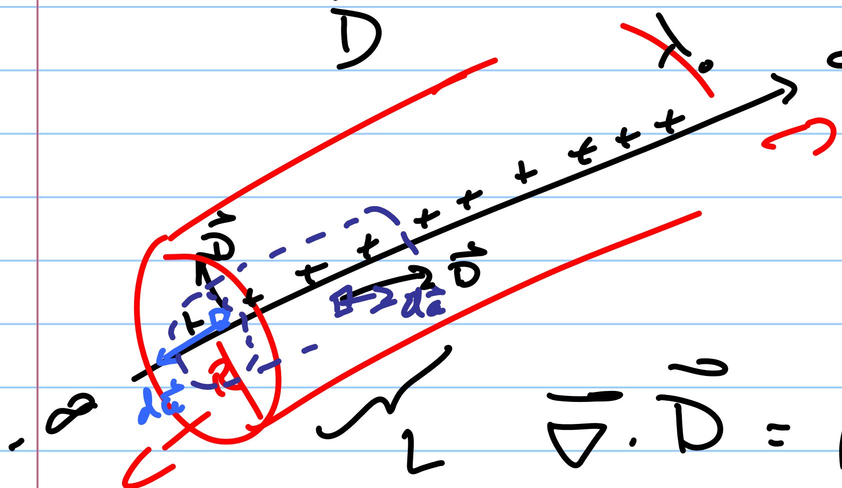
$$\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0} = \frac{\rho_f + \rho_b}{\epsilon_0}$$

$$\rho_b = -\vec{\nabla}\cdot\vec{P}$$

$$\vec{\nabla}\cdot\underbrace{(\epsilon_0\vec{E} + \vec{P})}_{\vec{D}} = \rho_f$$ Gauss's Law diff. form



rubber coat of thickness R

$$\vec{\nabla}\cdot\vec{D} = \rho_f$$

$$\int \vec{\nabla}\cdot\vec{D}\, d\tau = \int \rho_f\, d\tau$$

$$\| $$

$$\oint \vec{D}\cdot d\vec{a} = \frac{Q_{encl}}{1}$$

$$\int_{cap1}^{\nearrow 0} + \int_{body} \vec{D}\cdot d\vec{a} + \int_{cap}^{\nearrow 0} = \int |\vec{D}||d\vec{a}| \overset{1}{\cos\phi}$$

$$D\int da = D\, 2\pi r L = Q_{f_{enclos}} = \int_0^L \lambda_0\, dx$$

$$D\, 2\pi r \cancel{L} = \lambda_0 \cancel{L} \qquad D_{in} = \frac{\lambda_0}{2\pi r}$$

$$D_{outside} = D_{inside}$$

$$D = \frac{\lambda_0}{2\pi r} = \epsilon_0 E + P$$

Assume P is linear in $\vec{E}$

$$\vec{P} \propto \vec{E}$$

$$\boxed{\vec{P} = \epsilon_0 \chi_e \vec{E}} + \epsilon_0 \chi_{e2} \vec{E}\cdot\vec{E} + \dots$$

electric suscep --

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P} = \epsilon_0 \vec{E} + \epsilon_0 \chi_e \vec{E} = \underbrace{\epsilon_0(1+\chi_e)}_{\epsilon}\vec{E}$$

$$\frac{\epsilon}{\epsilon_0} \equiv K \quad \text{dielectric const}$$

$$3 < K < 5$$

---

back to rubber problem: linear material

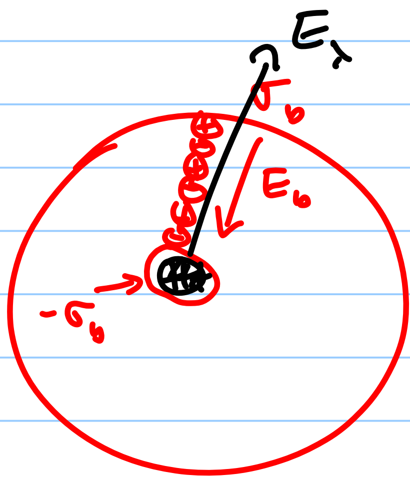
$$D_{in} = \frac{\lambda_0}{2\pi r} = \underset{\epsilon_0(1+\chi_e)}{\overset{\parallel}{\epsilon}} E \qquad \boxed{E_{in} = \frac{\lambda_0}{2\pi \epsilon r}}$$

tot E from free + bound charge

outside $\chi_e = 0$ since no rubber outside

$$D_{out} = \frac{\lambda_0}{2\pi r} = \epsilon_0 E_{out} \qquad E_{out} = \frac{\lambda_0}{2\pi\epsilon_0 r}$$

$$E_{in} = \frac{1}{3} E_{out}$$



$$\sigma_b = \vec{P} \cdot \hat{n}$$

$$\rho_b = -\vec{\nabla} \cdot \vec{P}$$

linear

$$\vec{P} = \epsilon_0 \chi_e \vec{E} = \epsilon_0 \chi_e \frac{\lambda_0}{2\pi\epsilon r} \hat{r}$$

tot E from both free & bound charge