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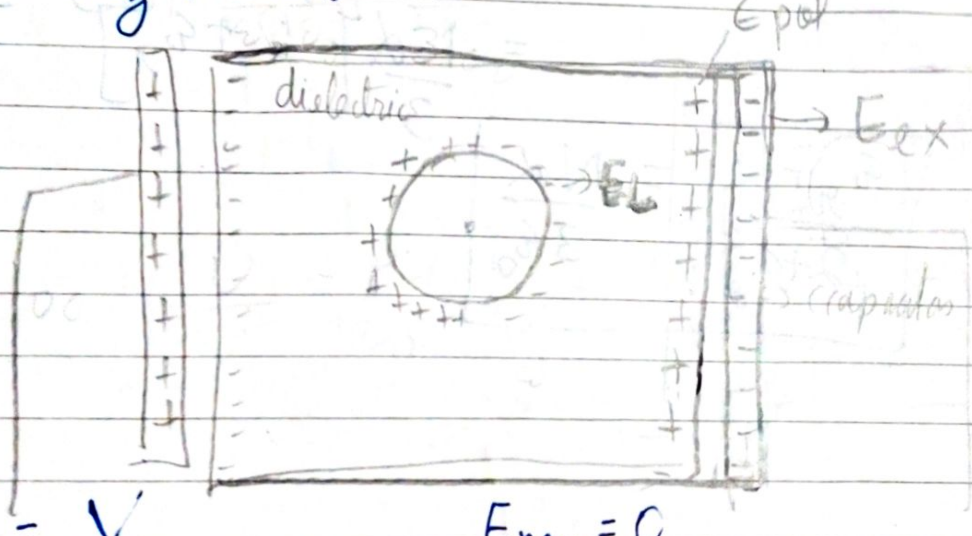
Physics Presentation

Derive Claussius Mosetti equation
⇒ relation between ε_r [relative permittivity and polarizability α of molecules constituting dielectric

$p = \alpha E_{local\ or\ internal}$
p [dipole moment]

$P = \varepsilon_0 \chi_e E_{macroscopic} = \varepsilon_0 [\varepsilon_r - 1] E_{macroscopic} = Np$
(polarizability)

Lorentz method



$E_{ex} = \frac{V}{d}$ $E_{near} = 0$

$E_{pol} = \frac{-P}{\varepsilon_0}$

$E_L = N_p \frac{P}{\varepsilon_r \varepsilon_0} = \frac{N_p P}{\varepsilon_0} = \frac{1}{3}\frac{P}{\varepsilon_0}$ [for sphere]

$E_{local} = E_{ex} + E_{pol} + E_L + E_{near}$

$= \frac{V}{d} - \frac{P}{\varepsilon_0} + \frac{P}{3\varepsilon_0} = E_{macroscopic} + \frac{P}{3\varepsilon_0}$

$$E_{local} = E_{macroscopic}\left[1 + \frac{\varepsilon_0(\varepsilon_r - 1)E}{3\varepsilon_0}\right]$$

$$E_{local} = E_{macro}\left[1 + \frac{\varepsilon_r - 1}{3}\right]$$

$$p = \alpha E_{local} = \alpha E_{macro}\left[1 + \frac{\varepsilon_r - 1}{3}\right]$$

Using $P = Np$

$$\varepsilon_0(\varepsilon_r - 1)E_{macro} = N\alpha E_{macro}\left[1 + \frac{\varepsilon_r - 1}{3}\right]$$

$$\varepsilon_0(\varepsilon_r - 1) = N\alpha\left[1 + \frac{\varepsilon_r - 1}{3}\right]$$

$$= \frac{N\alpha}{3}\left[2 + \varepsilon_r\right]$$

$$\boxed{\frac{\varepsilon_r - 1}{2 + \varepsilon_r} = \frac{N\alpha}{3\varepsilon_0}}$$