$$\nabla \times \bar{E} = 0$$

CONSERVATIVE

$$\bar{E} = -\nabla V$$

$$\nabla \cdot \bar{D} = \rho_v$$

$$\varepsilon_0 \bar{E}$$

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$$

$$-\varepsilon_0 \overbrace{\nabla \cdot \nabla} V = \rho_v$$

$$\nabla^2 V = -\frac{\rho_v}{\varepsilon_0}$$

POISSON

$$V(\bar{R})$$

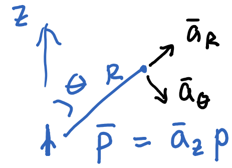
NO CHARGES: $\nabla^2 V = 0$

LAPLACE

$$V_d = \frac{qd\cos\theta}{4\pi\varepsilon_0 R^2}$$

(DIPOLE MOMENT)

$$\bar{E}_d = -\nabla V_d = \frac{\overbrace{qd}^{p}}{4\pi\varepsilon_0 R^3}\left(2\cos\theta\,\bar{a}_R + \sin\theta\,\bar{a}_\theta\right)$$



$$\frac{As\,m\;Vm}{As\;\;m^3} = \frac{V}{m}$$

$\bar{E}_d$

$$\nabla \times \bar{E}_d = 0$$

$$\nabla\cdot\bar{E}_d = \frac{1}{\varepsilon_0}\nabla\cdot\bar{D}_d = \rho_v$$

$$\bar{f} = A\;R^{-3}\left(2\cos\theta\,\bar{a}_R + \sin\theta\,\bar{a}_\theta\right)$$

$$\frac{1}{A}f_R = 2\cos\theta\,R^{-3}$$

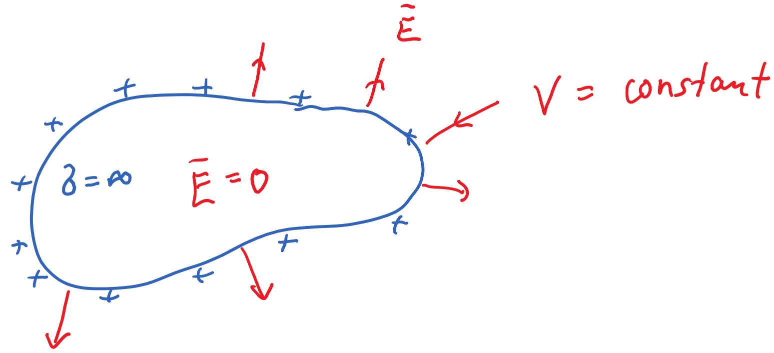
$$\frac{1}{A}f_\theta = \sin\theta\,R^{-3}$$

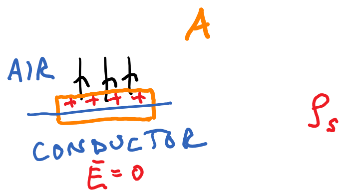
$$\nabla\cdot\bar{f} = \frac{1}{R^2}\frac{\partial}{\partial R}\underbrace{\left(R^2 f_R\right)}_{-R^{-2}\,2\cos\theta} + \frac{1}{R\sin\theta}\frac{\partial}{\partial\theta}\underbrace{\left(\sin\theta\, f_\theta\right)}_{R^{-3}\,2\sin\theta\cos\theta}$$

$$\frac{\partial}{\partial\theta}\sin^2\theta = 2\sin\theta\cos\theta$$

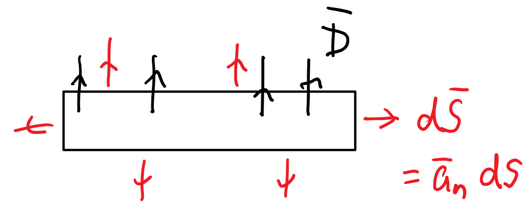
$$-2\cos\theta\,R^{-4} \qquad 2\cos\theta\,R^{-4} \qquad = 0 \qquad (R\neq 0)$$

CONDUCTOR





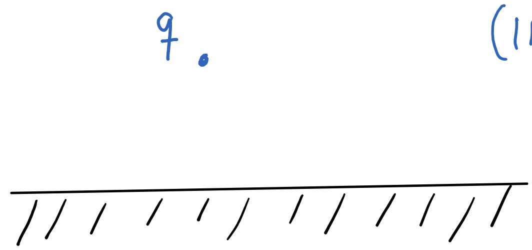
$$\int \nabla\cdot\bar{D}\,dV = \int \rho_v\,dV = \rho_s A$$



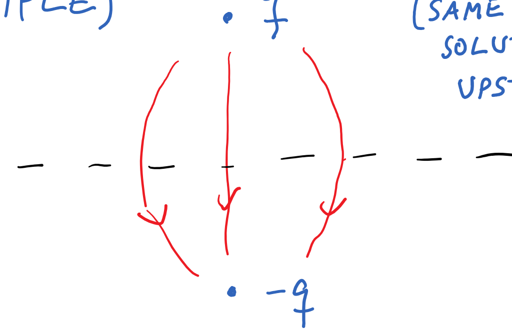
$$= \oint \bar{D}\cdot d\bar{S} = \underbrace{\bar{D}\cdot\bar{a}_n}_{D_n} A$$

ON CONDUCTOR SURFACE

$$D_n = \rho_s$$

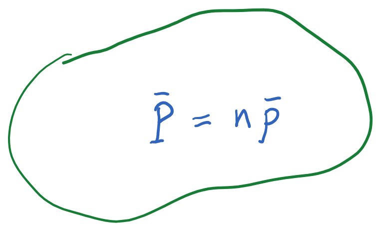


(IMAGE PRINCIPLE)



(SAME SOLUTION UPSTAIRS)

INSULATOR



POLARIZATION

$$[\bar{P}] = m^{-3} Asm = \frac{As}{m^2}$$

$$[\bar{D}] = \frac{As}{Vm}\frac{V}{m} = \frac{As}{m^2}$$

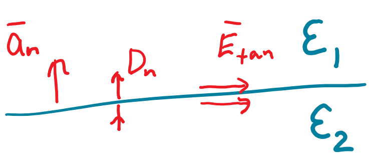
$$\bar{D} = \varepsilon_0 \bar{E} + \underbrace{\bar{P}}_{\chi_e \varepsilon_0 \bar{E}} = \varepsilon_0 (1+\chi_e)\bar{E}$$

$$= \varepsilon \bar{E}$$

MATERIAL PERMITTIVITY

RELATIVE PERMITTIVITY

$$\varepsilon = \varepsilon_r \varepsilon_0$$



BOUNDARY CONDITIONS

$\bar{E}_{tan}$ continuous $\quad \bar{a}_n \times \bar{E}_1 = \bar{a}_n \times \bar{E}_2$

D_n continuous $\quad \bar{a}_n \cdot \bar{D}_1 = \bar{a}_n \cdot \bar{D}_2$