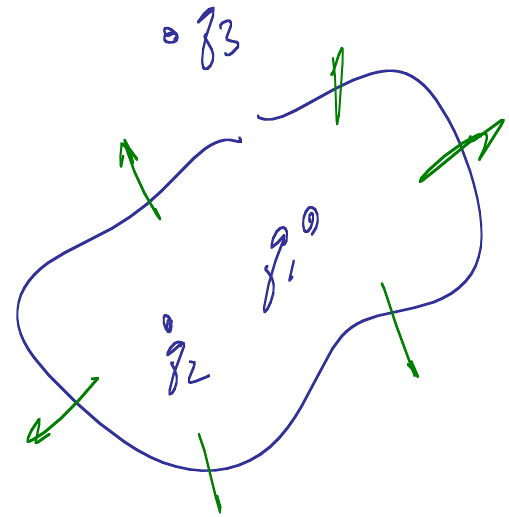
Phys 2120-4 9/10/12

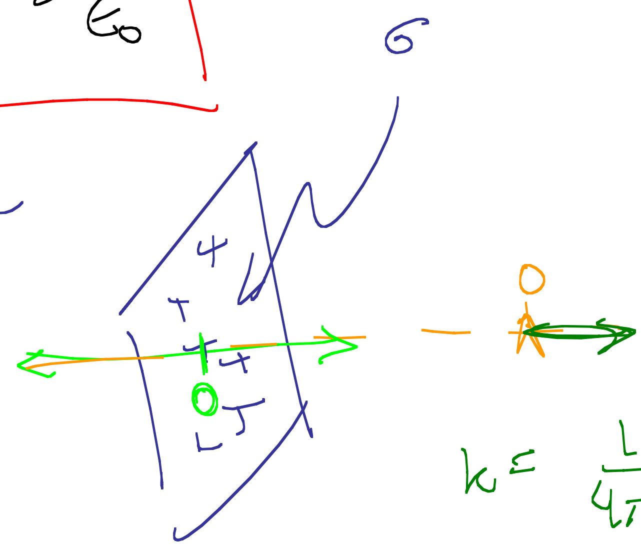
Note Title 9/10/2012

Chap 21: Gauss's's's Law

$$\boxed{\oint_S \vec{E}\cdot d\vec{A} = \frac{q_{encl}}{\epsilon_0}}$$

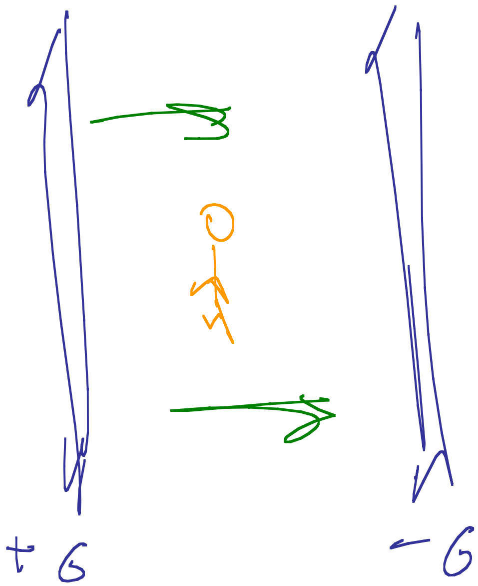


∞ Sheet of charge



$$E_x = \frac{\sigma}{2\epsilon_0}$$

$$k = \frac{1}{4\pi\epsilon_0}$$

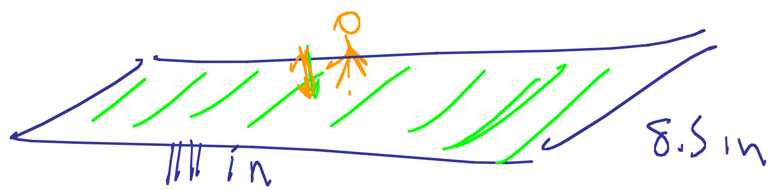


$$E_x = \frac{\sigma}{\epsilon_0} \quad \text{(constant)}$$

21.36 What's the approx. field strength 1 cm above sheet of paper carrying uniform ch. density $\sigma = 45\ \frac{nC}{m^2}$

Guess: ∞ approx for sheet prob.

OK.



$$E_x = \frac{\sigma}{2\epsilon_0} = \frac{(45\times10^{-9}\ C/m^2)}{2(8.85\times10^{-12}\ \frac{C^2}{Nm^2})} = 2.54\times10^{3}\ \frac{N}{C}$$

21.37 The dish ... has area 0.14 m^2 uniformly charged to 5.0 μC. Find the approx. field strength

a) 1 mm from dish not near edge

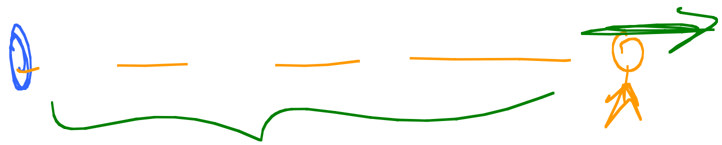
b) 2.5 m from dish

$A = \pi R^2$

$R = 21$ cm

a) $E = \frac{\sigma}{2\epsilon_0} = 2.02 \times 10^6 \frac{N}{C}$ $\qquad \sigma = \frac{Q}{A}$

b) Treat it as point charge



2.5m

$$E = k\frac{q}{r^2}$$

$$= (9.0\times 10^9)\frac{(5\times 10^{-6}\,C)}{(2.5\,m)^2}$$

$$= 7.20 \times 10^3 \frac{N}{C}$$

$\frac{V}{m}$

More on Gauss's Law:

In conductors, charges are free to move.

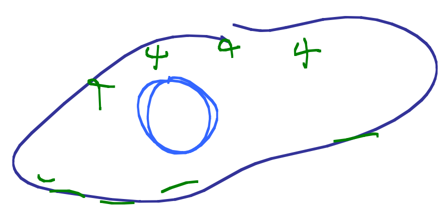
Charge distrib. in a conductor:

"Electrostatic equilibrium" Charges not moving

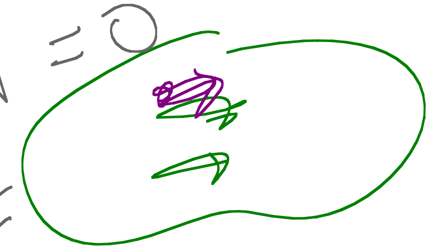
Inside conductor $\vec{E}$ field is zero

Consider Gaussian surface

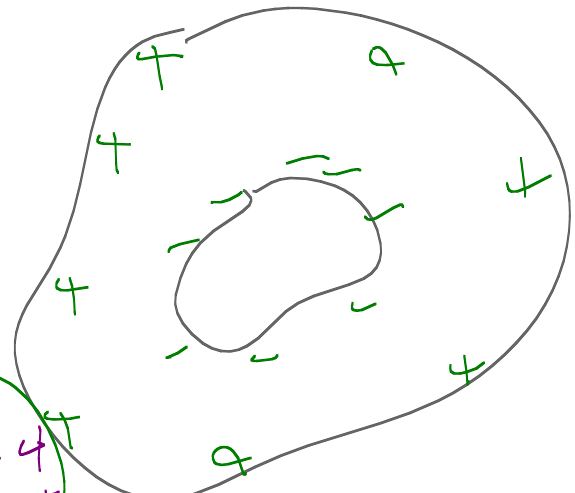
No charge density inside



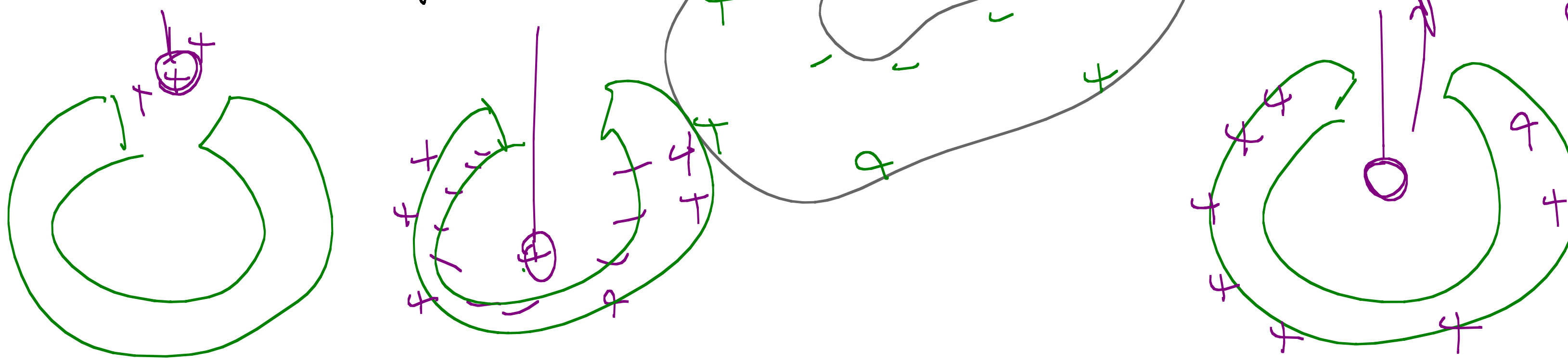
$$\oint \vec{E} \cdot d\vec{A} = 0 = \frac{q_{end}}{\epsilon_0}$$



Can consider a conductor with a cavity

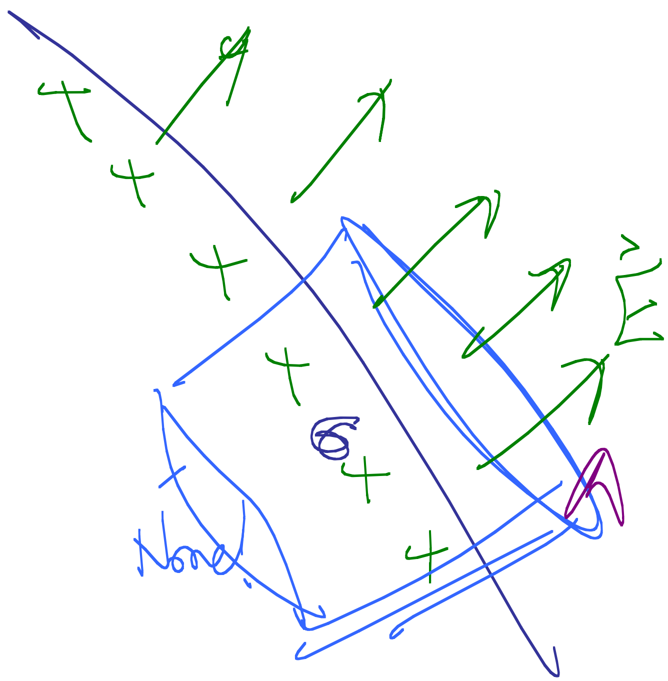


Book has example



Can confirm Gauss's & coulomb's laws $1/r^2$

Surface of conductor



Electric Field at surface

Gaussian surface.

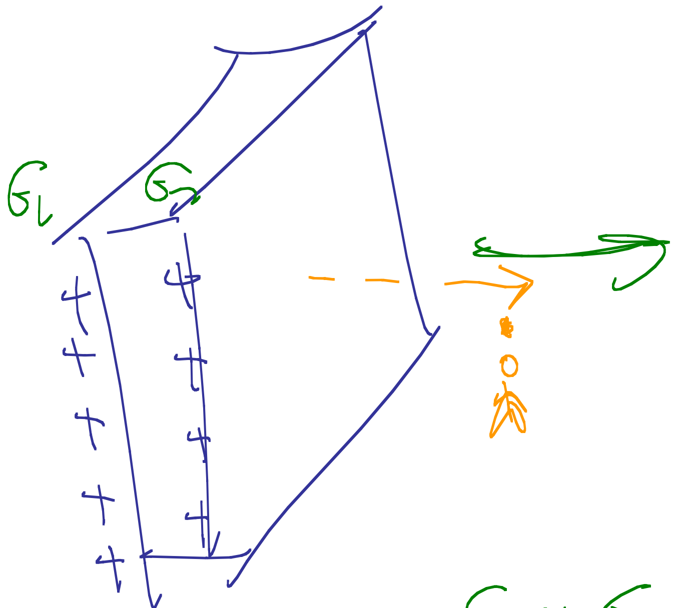
$$\int \vec{E} \cdot d\vec{A} = E A$$

$$= \sigma A / \epsilon_0$$

$$E = \sigma / \epsilon_0$$

Huh?

Both sides have same σ

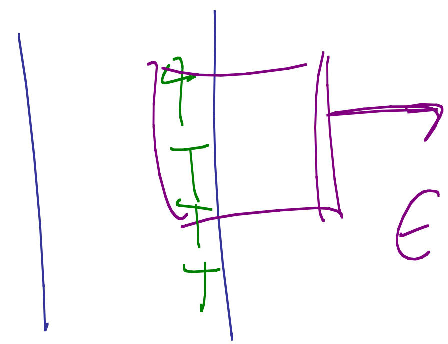


$$E = \frac{\sigma_{Total}}{2\epsilon_0} = \frac{\sigma_1 + \sigma_2}{2\epsilon_0}$$

$$= \sigma_1 / \epsilon_0$$

$$\sigma_1 + \sigma_2 = \sigma_{total}$$

∞ conducting sheet

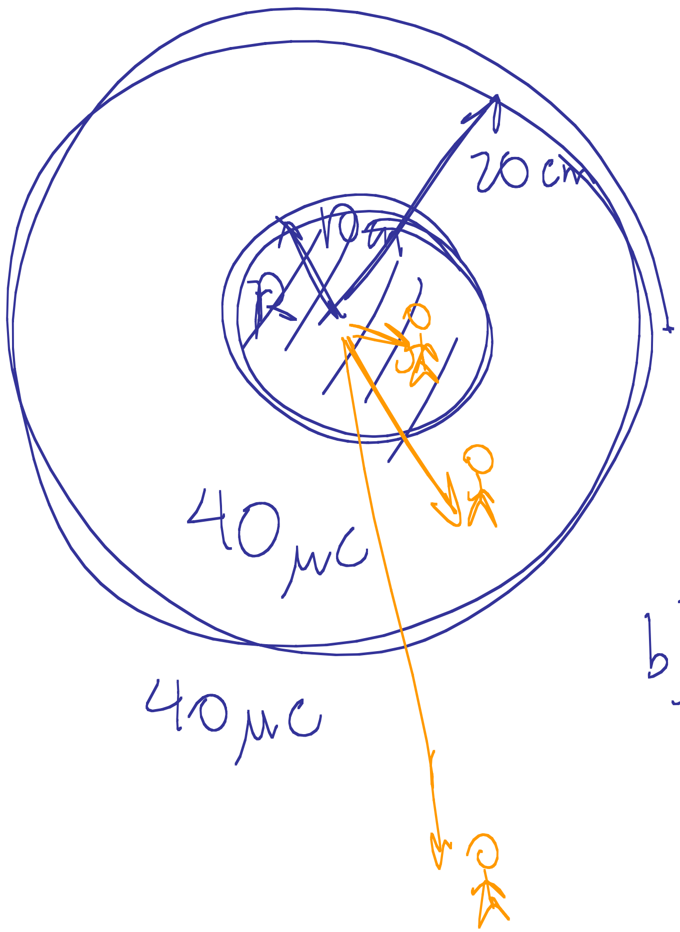


$$E = \sigma_1 / \epsilon_0$$

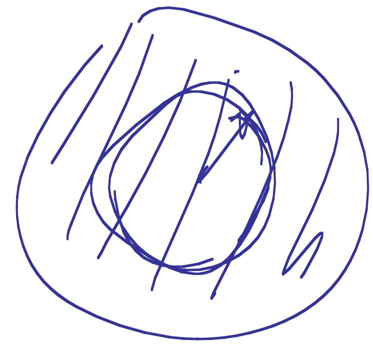
21.58 A solid sphere 10 cm in radius carries a 40 μC charge dist'd uniformly thru volume Surrounded by concentric shell 20 cm in radius also unif'ly charged with 40 μC.

Find electric field a) 5.0 cm b) 15 cm.

c) 30 cm from center.



a)



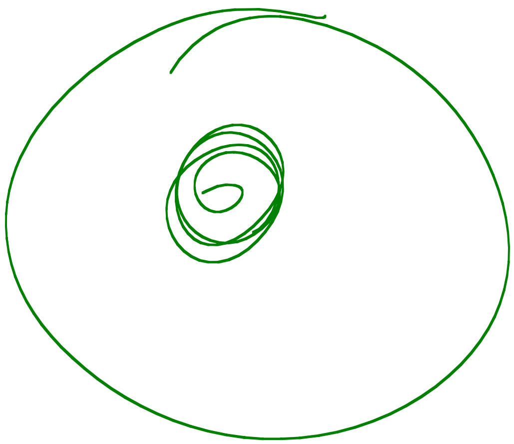
Same as before inside ball of charge

$$E = \frac{Qr}{4\pi\epsilon_0 R^3}$$

$$= 18\times10^{6}\ \mathrm{N/C}$$

b) Same a for pt. charge at origin

$$E = k\frac{Q}{r^2} = 1.60\times10^{7}\ \frac{N}{C}$$



c) $E = k \dfrac{Q_{Total}}{r^2}$

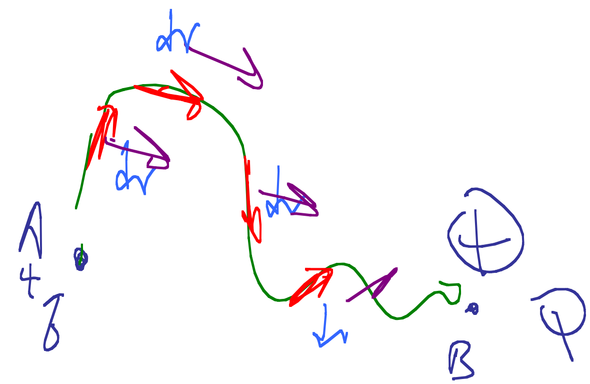
$= k \dfrac{(80\,\mu C)}{(0.30\,m)^2} = 8.0 \times 10^6 \dfrac{N}{C}$

Chap 22

$$\vec{F} = q\vec{E}$$

Electrical Potential

Bring q close to $+Q$ requires work.

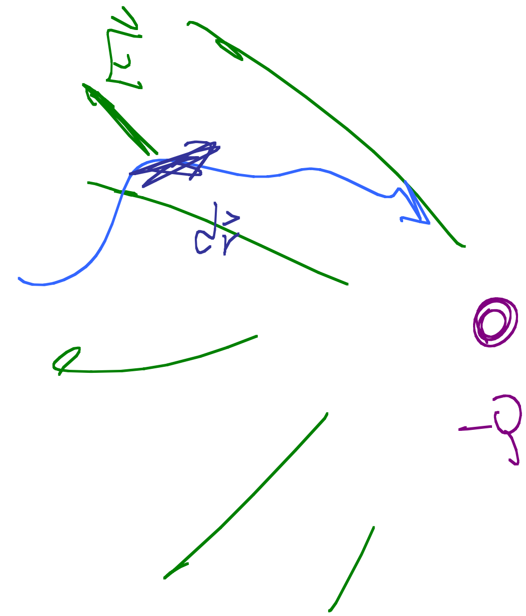


$$W = \int_A^B \vec{F}_{elec} \cdot d\vec{r} = -\Delta U_{AB}$$

Elec. pot'l energy.

$$\vec{F} = q\vec{E}$$ substitute

$$W = q\int \vec{E}\cdot d\vec{r} = -\Delta U_{AB}$$



$$\Delta U_{AB} = q\left(-\int_A^B \vec{E}\cdot d\vec{r}\right)$$

Pot'l energy /char is proportional to change

$$\Delta U_{AB}/q = -\int_A^B \vec{E}\cdot d\vec{r} \equiv \Delta V$$

V electrical potential

$$\frac{\Delta U_{AB}}{q} = \Delta V_{AB}$$

What is V

Scalar

$$[V] = \frac{[U]}{[q]} = \frac{\text{Joules}}{\text{coulomb}} = \text{Volt}$$

$$[E] = N/C = \frac{N \cdot m}{C\,m} = \frac{J}{C\,m} = V/m$$