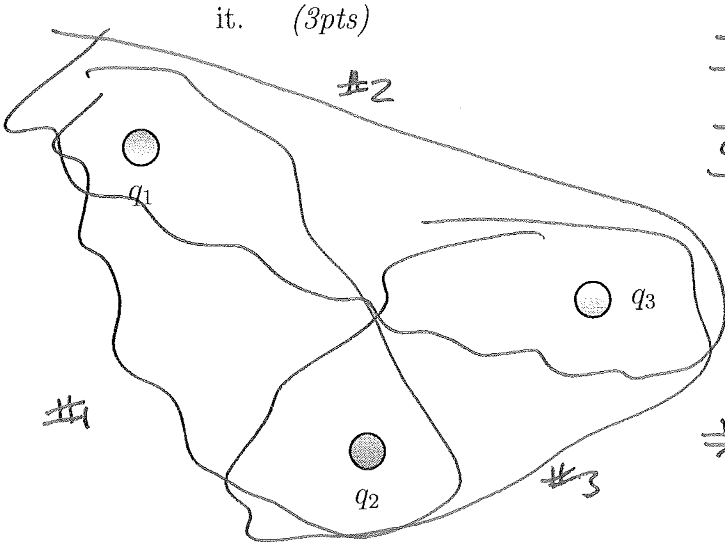
→ If you chose ~~[illegible]~~ A surface will all 3, you did the easiest, $Q_{encl} = 0 \Rightarrow \Phi_{total} = 0$

PHYSICS 161 TEST 2

(a) Three point charges, $q_1 = 50\,\mu C$, $q_2 = -75\,\mu C$, $q_3 = 25\,\mu C$, are arranged as shown. Draw a surface that includes at least two of these charges and find the total flux through it. *(3pts)*



If you choose #1 which has q_1 AND q_2

$\Phi_{total} = \frac{Q_{encl}}{\epsilon_0} \Rightarrow \Phi_1 = \frac{(50\mu C - 75\mu C)}{\epsilon_0} = \frac{-25\times10^{-6} C}{8.85\times10^{-12} C^2/N\cdot m^2}$

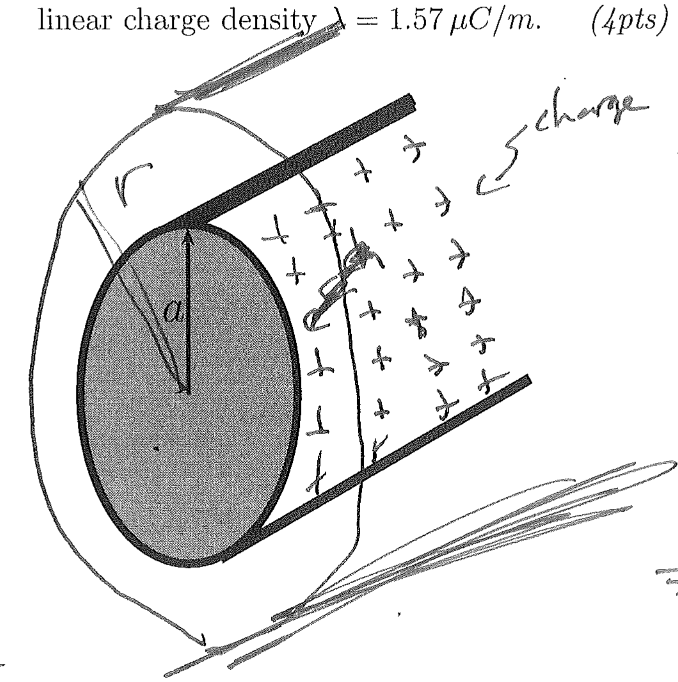
$\Rightarrow \Phi_1 = -2.82\times10^{6}\, N\cdot m^2/C$

If #2 which has $q_1 + q_3$, $Q_{encl} = 75\mu C$

$\Rightarrow \Phi_2 = \frac{75\times10^{-6} C}{8.85\times10^{-12} C^2/N\cdot m^2} = 8.47\times10^{6}\, N\cdot m^2/C$

#3 has q_2 & $q_3 \Rightarrow Q_{encl} = -50\mu C \Rightarrow \Phi_3 = -5.65\times10^{6} N\cdot m^2/C$

(b) An infinitely long cylindrical conductor of radius $a = 0.25\,m$ has surface charge density $\sigma = 1.00\,\mu C/m^2$. Explain how Gauss's law tells us that the electric field created by this cylinder (at points outside the cylinder) is the same as an infinite line of charge with linear charge density $\lambda = 1.57\,\mu C/m$. *(4pts)*



charge

Given shape, A Gaussian Cylinder will work

For $r > a$, $Q_{encl} = \sigma(2\pi a)\ell$

Charge only on outside of ~~[illegible]~~ "real" cylinder at $r = a$

GAUSSIAN CYLINDER OF RADIUS r

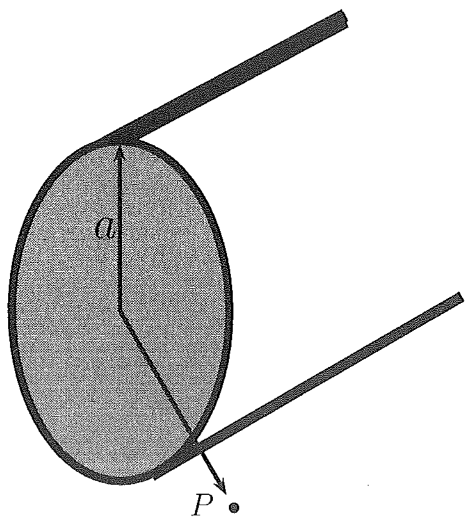
$\Rightarrow Q_{encl} = (1\mu C/m^2)(2\pi)(0.25m)\ell$
$= (1.57\,\mu C/m)\ell$

Gauss's Law $\Rightarrow \Phi_{total} = \frac{Q_{encl}}{\epsilon_0}$. Gaussian cylinder of radius r

$\Rightarrow \Phi_{total} = E(2\pi r\ell)$ $\therefore$ $E(2\pi r \cancel{\ell}) = \frac{(1.57\mu C/m)\cancel{\ell}}{\epsilon_0}$

$\Rightarrow E = \frac{1}{2\pi\epsilon_0}\frac{(1.57\mu C/m)}{r}$ ⟸ SAME AS INFINITE LINE OF CHARGE.

(c) What is the magnitude of the electric field at a point P which is a radial distance $r = 0.45\,m$ from the center of the conductor? *(3pts)*



As just shown, since P at point outside cylinder

$$E = \frac{1}{2\pi\epsilon_0}\frac{\lambda}{r}$$

where $\lambda = 1.57\,\mu C/m = 1.57\times10^{-6}\,C/m$

$r = 0.45\,m$

$$\Rightarrow E = \frac{1}{2\pi(8.85\times10^{-12}\,C^2/(N\cdot m^2))}\ \frac{1.57\times10^{-6}\,C/m}{0.45\,m}$$

$$\left(\text{Units: } \frac{1}{C^2/N\cdot m^2}\cdot\frac{C/m}{m} = \frac{N\cdot m^2}{C^2}\cdot\frac{C}{m}\cdot\frac{1}{m} = N/C\right)$$

$\therefore\ \underline{E = 62\,800\,N/C}$