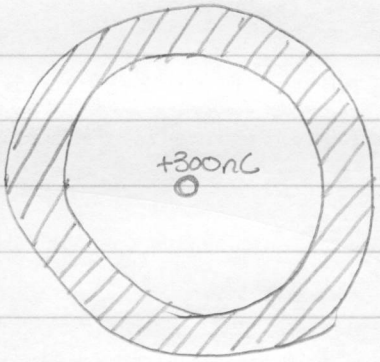
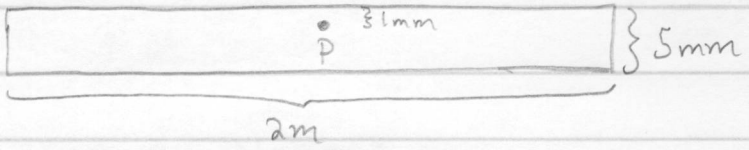
Physics 2b Quiz 2 Solutions #1



A hollow conducting sphere carries a charge of -500nC
A point charge of +300nC is present at the center.
What is the charge on the outer surface?

The +300nC point charge inside the conductor brings a -300nC charge to the inner surface because $\vec{E}$ in the bulk of the conductor must be zero. The net charge on the conductor is given as -500nC, leaving **-200nC** for the outside surface.

Physics 2b Quiz 2 Solutions #2



Insulating slab, 5mm x 2m x 2m, uniform 8×10^{-11} C charge
What is $\vec{E}$ 1mm below the surface near the center?

Here "near the center" and the large length and width (2m) versus the small thickness (5mm) tells you that approximating this as an infinite slab will be appropriate. Look at the solution to problem #36 in Chapter 24. Here we have:

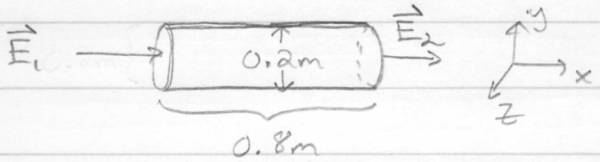
$E = \frac{\rho x}{\varepsilon_0}$, where x is measure from the center of the slab

$$E = \frac{\rho x}{\varepsilon_0} = \frac{Q x}{V \varepsilon_0} = \frac{(8\times10^{-11}\,C)(1.5\times10^{-3}\,m)}{(2m\times2m\times5\times10^{-3}\,m)\,\varepsilon_0} = 0.677\ V/m$$

$\boxed{0.68\ \frac{V}{m}}$ is the closest

Note: $1\ V/m = 1\ N/C$

Physics 2b Quiz 2 Solutions #3



$E_1 = 6000\ N/C$, $E_2 = 4000\ N/C$, What is the charge enclosed?

Here we have an electric field specified everywhere on a closed surface, so we can use Gauss's law to find the charge enclosed.

$$\oint_{\text{cylinder}} \vec{E}\cdot d\vec{A} = q_{enc}/\varepsilon_0$$

$$\int_{\text{left circle}} \vec{E}\cdot d\vec{A} + \int_{\text{sides}} \vec{E}\cdot d\vec{A} + \int_{\text{right circle}} \vec{E}\cdot d\vec{A} = q_{enc}/\varepsilon_0$$

$$-\pi(.1m)^2(6000\ N/C) + 0 + \pi(.1m)^2(4000\ N/C) = q_{enc}/\varepsilon_0$$

negative b/c flux is into the surface ↑

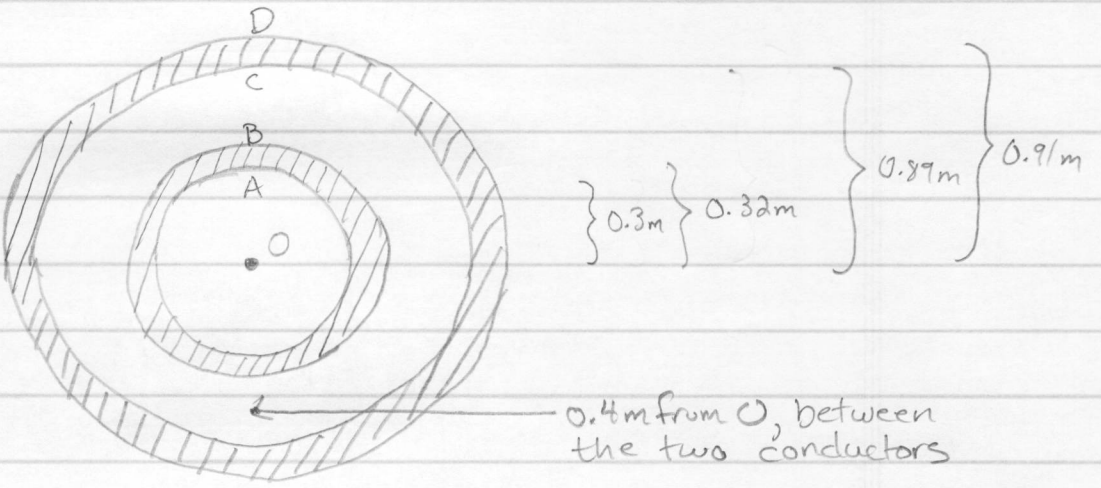
$$(-62.83\ Nm^2/C)\cdot\varepsilon_0 = q_{enc}$$

$$-5.56\times10^{-10}\ C = q_{enc}$$

$\boxed{-0.6\ nC}$ is the closest.

Note: $\vec{E}$ is given as uniform in y and z so the surface integrals reduce to "EA" and the integral over the sides of the cylinder gives zero because the normal to the surface there has no x-component, whereas the electric field only has an x-component.

Physics 2b Quiz 2 Solutions #4



two hollow conducting spheres centered on O
inner sphere has $-100nC$, outer sphere has $+60nC$
What is $\vec{E}$ at 0.4m from O?

This is a spherically symmetric charge distribution so $\vec{E}$ will only have a radial component and we can use Gauss's law to find $\vec{E}$. This was done numerous times in lecture, discussion, examples and homework. However, we also know that outside a spherically symmetric charge distribution, $\vec{E}$ is the same as that for a point charge with the same total charge located at the center of the distribution.

$$E = \frac{kQ}{r^2} = 9\times10^9 \frac{Nm^2}{C^2} \frac{(-100\times10^{-9}C)}{(0.4m)^2} = -5625\ N/C$$

$\boxed{-6000\ N/C}$ is the closest

Note: Gauss's law tells us that the charge on the outer conductor does not change E inside its inner surface