HW #4 Ch 23

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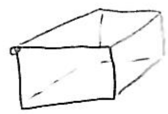

* Three of the faces have no net flux because the field is $\perp$ to the normals.

* $\frac{1}{8}$ of the flux through the sphere must go through the other three faces

$$\Phi = \frac{1}{3} \cdot \frac{1}{8} \frac{q}{\epsilon_0}$$ by Gauss law

the 1/3 is because there are 3 identical faces

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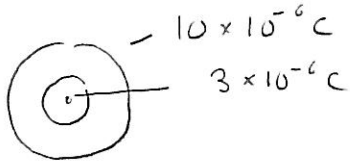

since there is no field in the conductor Gauss law implies that a surface in the conductor bounds no net charge

$\therefore$ inner surface has total charge $-3 \times 10^{-6}$ C

This means that the outer surface must have $13 \times 10^{-6}$ C to get the correct total charge on the sphere

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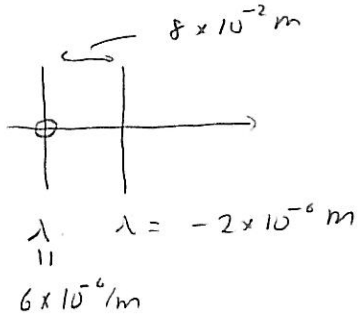


by Gauss law each wire has a field strength

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

where $r$ is the distance to the wire

on the x axis

$$E_x = \frac{\lambda_1}{2\pi\epsilon_0} \frac{1}{x} + \frac{\lambda_2}{2\pi\epsilon_0} \frac{1}{x-L}$$

(here $-x$ accounts for the change in direction of the fields on either side of the wire

$$E_x = 0 = \left( \frac{\lambda_1}{x} + \frac{\lambda_2}{x-L} \right) \frac{1}{2\pi\epsilon_0} = 0$$

$$\left( \frac{(x-L)\lambda_1 + x\lambda_2}{x(x-L)} \right) \frac{1}{2\pi\epsilon_0} = 0 \implies$$

$$(x-L)\lambda_1 + x\lambda_2 = 0$$

$$x(\lambda_1 + \lambda_2) = L\lambda_1$$

$$x = L \frac{\lambda_1}{\lambda_1+\lambda_2} = L \frac{6}{6-2} = \frac{6}{4} L = 1.5 L$$

The field vanishes 4 cm to the right of wire 2

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

The electron has a constant acceleration

$$ma = q_e E$$

$$a = \frac{q_e}{m_e}\frac{\sigma}{2\epsilon_0} = \frac{dv}{dt} = -\frac{3.5\times10^5}{12\times10^{-12}\,s} \quad \text{(slope from graph)}$$

$$\sigma = 2\cdot\left(8.85\times10^{-12}\,\frac{C^2}{Nm^2}\right)\left(9.1\times10^{-31}\,kg\right)\frac{1}{(-1.602\times10^{-19}\,C)}\left(-\frac{3.5\times10^5\,m/s}{12\times10^{-12}\,s}\right)$$

$$= 2.9\times10^{-6}\,C/m$$

51 $$4\pi r^2 E_{shell} = \frac{q_0 + q(r)}{\epsilon_0}$$

$$q(r) = \int_{r_a}^{r} 4\pi r^2 \cdot \frac{A}{r}\,dr = 4\pi A\left(\frac{r^2}{2} - \frac{r_a^2}{2}\right)$$

$$4\pi r^2 E_{shell} = \frac{1}{\epsilon_0}\left(q_0 + 4\pi A\frac{r^2}{2} - 4\pi A\frac{r_a^2}{2}\right)$$

E will be uniform if

$$q_0 = 4\pi A\frac{r_a^2}{2} = 2\pi A r_a^2$$

$$A = \frac{q_0}{2\pi r_a^2} = \frac{45\times10^{-15}\,C}{2\pi\cdot(2\times10^{-2}\,m)^2} = 1.79\times10^{-11}\,m$$

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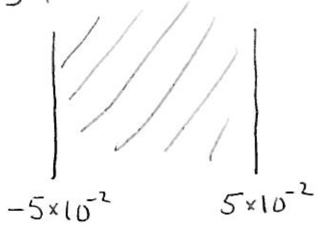


$\rho = 1.2\times10^{-9}\ C/m^3$

a) at 4 cm 9/10 of the charge is to the left, 1/10 is to the right

this is equivalent to being on the right of a slab with 8/10 of the charge

$$\sigma = \int_0^{8\,cm} \rho\, dx = (8\times10^{-2})m \times (1.2\times10^{-9}\ C/m^3)$$

$$E = \frac{\sigma}{2\epsilon_0} = \frac{8\times10^{-2}\ m\ (1.2\times10^{-9}\ C/m^3)}{2\cdot 8.85\ \frac{C^2}{Nm^2}\times10^{-12}} = 5.42\ \frac{N}{C}$$

b) at 6 cm is behaves like an infinite sheet with

$$\sigma = \rho\times10\ cm = (10\times10^{-7}\ m)(1.2\times10^{-7}\ C/m^3)$$

$$E = \frac{\sigma}{2\epsilon_0} = \frac{(10\times10^{-2}\ m)(1.2\times10^{-9}\ C/m^3)}{2\cdot 8.85\times10^{-12}\ C^2/Nm^2} = 6.78\ \frac{N}{C}$$

76 using Gauss law

$$2\pi r h E = \frac{1}{\epsilon_0} \rho h (\pi r^2)$$

$$E = \frac{\rho}{2\epsilon_0} r \qquad r < R$$

$$2\pi r h E = \frac{1}{\epsilon_0} \rho h \pi R^2$$

$$E = \frac{\rho}{2\epsilon_0} \frac{R^2}{r}$$