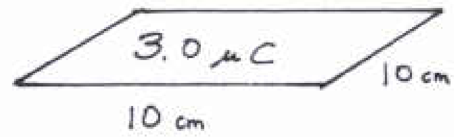
Units? Units?

Name________________

Phys 2120, Section 3
Quiz #2 — Spring 2003

1. A charge of 3.00 μC is spread uniformly over a flat square sheet with side 10.00 cm.



a) What is the charge density of the sheet?

Area of sheet is $A = (0.100\,m)^2 = 1.0\times10^{-2}\,m^2$

Charge density is

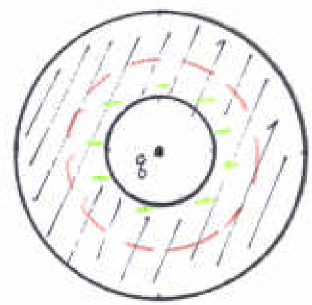
$$\sigma = \frac{q}{A} = \frac{(3.0\times10^{-6}C)}{1.0\times10^{-2}\,m^2} = \boxed{3.0\times10^{-4}\,\frac{C}{m^2}}$$

b) Suppose we are interested in a point which is 2.00 mm away from the center of the sheet so that the sheet can be considered to be infinite in size. What is the magnitude of the electric field at this point?

For E field (near) large plane of charge w/ charge density σ, use:

$$E = \frac{\sigma}{2\epsilon_0} = \frac{3.0\times10^{-4}\,C/m^2}{2(8.85\times10^{-12}\frac{C^2}{Nm^2})} = \boxed{1.69\times10^{7}\,\frac{N}{C}}$$

2. A spherical conductor with no net charge has a (concentric) spherical cavity inside of it, with a 6.0 μC point charge at its center.



$q = 6.0\,\mu C$

a) What is the total charge on the inner surface of the conductor? Give the reasoning that leads you to this answer.

Charge on inner surface must be $\boxed{-6.0\,\mu C}$

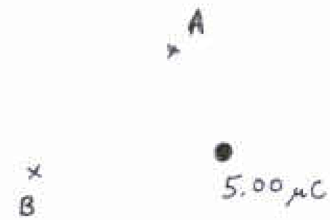
A Gaussian surface drawn within the metal and enclosing the cavity has no flux ($\vec{E} = 0$ within the metal) and hence, by Gauss' Law, zero total charge enclosed. A charge of $-6.0\,\mu C$ on the inner surface summed w/ the $6.0\,\mu C$ pt charge gives zero.

b) What is the total charge on the outer surface on the conductor?

Since there is no net charge on the conductor and the inner surface has charge $-6.0\,\mu C$, the outer surface must carry a charge

$\boxed{+6.0\,\mu C}$

3. Point A is 3.0 cm away from a 5.00 μC point charge. Point B is 5.00 cm away from the same point charge.



a) As we go from A to B, what is ΔV?

Potential at a distance r from pt charge q is given by $V(r) = k\frac{q}{r}$, hence:

$$\Delta V = V(B) - V(A) = k\frac{q}{(0.0500\,m)} - k\frac{q}{(0.0300\,m)}$$

$$= \left(8.99\times10^{9}\,\frac{N\cdot m^2}{C^2}\right)(5.00\times10^{-6}\,C)\left(\frac{1}{(0.050\,m)} - \frac{1}{(0.030\,m)}\right) = \boxed{-6.0\times10^{5}\,V}$$

b) Suppose a 2.0 nC charge moves from A to B. What is its change in potential energy?

$$\Delta U = q\Delta V = (+2.0\times10^{-9}\,C)(-6.0\times10^{5}\,V) = \boxed{-1.2\times10^{-3}\,J}$$

You must show all your work and include the right units with your answers!

$$k = \frac{1}{4\pi\epsilon_0} = 8.99\times10^{9}\,\frac{\text{N-m}^2}{\text{C}^2} \qquad \epsilon_0 = 8.85\times10^{-12}\,\frac{\text{C}^2}{\text{N-m}^2} \qquad F = k\frac{|q_1q_2|}{r^2} = \frac{1}{4\pi\epsilon_0}\frac{|q_1q_2|}{r^2}$$

$$\mathbf{F} = m\mathbf{a} \qquad g = 9.80\frac{\text{m}}{\text{s}^2} \qquad m_{\text{elec}} = 9.1094\times10^{-31}\text{ kg} \qquad e = 1.602\times10^{-19}\text{ C}$$

$$\mathbf{F} = q\mathbf{E} \qquad E_{\text{pt ch}} = k\frac{|q|}{r^2} \qquad E_{\text{plane}} = \frac{\sigma}{2\epsilon_0} \qquad E_{\text{cond}} = \frac{\sigma}{\epsilon_0}$$

"n" = nano = 10^{-9}

$$\Delta U = q\Delta V \qquad V_{\text{pt-ch}} = \frac{1}{4\pi\epsilon_0}\frac{q}{r} \qquad E_x = -\frac{\partial V}{\partial x}$$