Name________________________

Sept. 19, 2012

Quiz #1 — Fall 2012

Phys 2120 – Sec 4

1. Give the units in which one must express the following quantities in the MKS (i.e. physics) system:

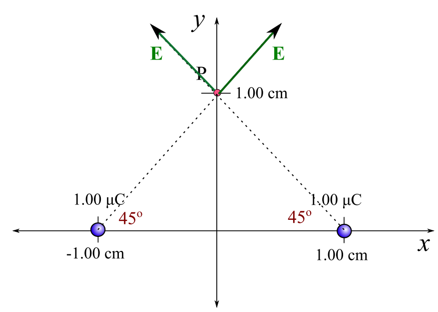
a) Electric charge, Q $\boxed{\text{C, Coulombs}}$

b) Electric field, $\mathbf{E}$. $\boxed{\frac{\text{N}}{\text{C}}}$

c) Electric flux, Φ $\boxed{\frac{\text{N}\cdot\text{m}^2}{\text{C}}}$

d) Electric potential, V. $\boxed{\text{V, Volts}}$

2. In the $x-y$ coordinate system shown, there is a $1.00\,\mu$C charge on the x at $x = 1.00$ cm and another one at $x = -1.00$ cm.



a) The point P is at $x = 0.0$ cm, $y = 1.00$ cm. Find the electric field at P. *The electric field is a vector... give a complete answer!*

The fact that the two charges give fields of equal magnitude at P makes things simple. The distance of each charge from P is

$$r = \sqrt{(1.00 \text{ cm})^2 + (1.00 \text{ cm})^2} = 1.41 \times 10^{-2} \text{ m}$$

Each charge contributes a field of magnitude

$$E = k\frac{q}{r^2} = (8.99 \times 10^9 \tfrac{\text{N}\cdot\text{m}^2}{\text{C}^2})\frac{(1 \times 10^{-6} \text{ C})}{(2.00 \times 10^{-4} \text{ m}^2)} = 4.50 \times 10^7 \tfrac{\text{N}}{\text{C}}$$

Now by symmetry the x components of the fields from the charges will cancel and we get only the y components - each of which is just $\sin 45°$ times the magnitude E. The total E_y is then

$$E_y = 2(\sin 45°)(4.50 \times 10^7 \tfrac{\text{N}}{\text{C}}) = 6.36 \times 10^7 \tfrac{\text{N}}{\text{C}} \qquad \Longrightarrow \qquad \mathbf{E} = \boxed{(6.36 \times 10^7 \tfrac{\text{N}}{\text{C}})\,\hat{\mathbf{j}}}$$

b) If a $-2.00\,\mu$C charge is placed at P what is the force on this charge?

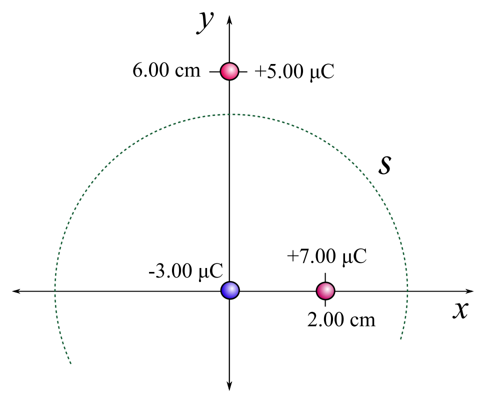
Our basic formula $\mathbf{F} = q\mathbf{E}$ gives us

$$\mathbf{F} = (-2.00 \times 10^{-6} \text{ C})(6.36 \times 10^7 \tfrac{\text{N}}{\text{C}})\,\hat{\mathbf{j}} = \boxed{-(127 \text{ N})\,\hat{\mathbf{j}}}$$

3. A charge of $-3.00\,\mu\text{C}$ sits at the origin and a charge of $+7.00\,\mu\text{C}$ sits on the x axis at $x = 2.00$ cm and a $+5.00\,\mu\text{C}$ charge sits on the y axis at $y = 6.00$ cm.

If we consider a spherical surface $\mathcal{S}$ of radius 5.00 cm centered on the origin, what is the total flux $\oint \mathbf{E}\cdot d\mathbf{A}$ through this surface?

Give a complete explanation with your answer!



From Gauss's law the total electric flux through $\mathcal{S}$ is $q_{\rm encl}/\epsilon_0$. The total charge inside the $5.00\ \text{cm}$ sphere does not include the $+5.00\,\mu\text{C}$ charge, and it is

$$q_{\rm encl} = -3.00\,\mu\text{C} + 7.00\,\mu\text{C} = +4.00\,\mu\text{C}$$

so the flux thru $\mathcal{S}$ is

$$\oint_{\mathcal{S}} \mathbf{E}\cdot d\mathbf{A} = \frac{q_{\rm enc}}{\epsilon_0} = \frac{(4.00\times 10^{-6}\ \text{C})}{(8.854\times 10^{-12}\ \frac{\text{C}^2}{\text{N}\cdot\text{m}^2})} = \boxed{4.52\times 10^{5}\ \frac{\text{N}\cdot\text{m}^2}{\text{C}}}$$

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

$$c = 2.998\times 10^8\,\tfrac{\text{m}}{\text{s}} \qquad k = \frac{1}{4\pi\epsilon_0} = 8.99\times 10^9\ \tfrac{\text{N}\cdot\text{m}^2}{\text{C}^2} \qquad \epsilon_0 = 8.85\times 10^{-12}\ \tfrac{\text{C}^2}{\text{N}\cdot\text{m}^2}$$

$$F = k\frac{|q_1q_2|}{r^2} \qquad E_{\rm pt-ch} = k\frac{q}{r^2} \qquad E_{\rm line-ch} = \frac{2k\lambda}{r} \qquad E_{\rm sheet} = \frac{\sigma}{2\epsilon_0} \qquad E_{\rm cond,\,surf} = \frac{\sigma}{\epsilon_0}$$

$$\oint \mathbf{E}\cdot d\mathbf{A} = \frac{q_{\rm encl}}{\epsilon_0} \qquad \Delta U = q\Delta V \qquad \Delta V_{AB} = -\int_A^B \mathbf{E}\cdot d\mathbf{r}$$