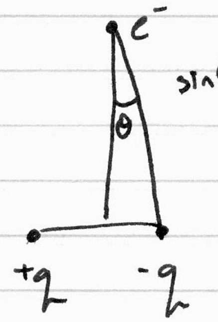
Former Exam #1 Physics 152

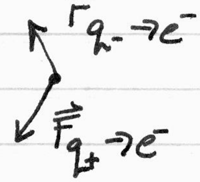
1)



$\sin\theta = \frac{\frac{d}{2}}{\sqrt{y^2+\left(\frac{d}{2}\right)^2}}$

$\longrightarrow +x$

FBD



b) The strength of $F_{q_+ \to e}$ is

$$\|\vec{F}\| = \frac{kqe}{\left(\sqrt{y^2+\left(\frac{d}{2}\right)^2}\right)^2} = \frac{kqe}{y^2+\left(\frac{d}{2}\right)^2}$$

and is the same size for both source charges.

c) The net force is in the $-\hat{i}$ direction

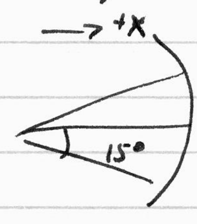
$$\vec{F}_e = \sum \vec{F}_{i \to e} \Rightarrow F_{e_x} = \sum F_{i \to e_x}$$

$$= \frac{-kqe}{\left(y^2+\left(\frac{d}{2}\right)^2\right)} \frac{\frac{d}{2}}{\sqrt{y^2+\left(\frac{d}{2}\right)^2}} \times 2$$

$$= \frac{kqed}{\left(y^2+\left(\frac{d}{2}\right)^2\right)^{3/2}}$$

2) $\vec{E} = \int \frac{k\,dq}{r^2}\hat{r}$

$\vec{E}$ will point exactly in $-x$ direction by symmetry.



$$\lambda = \frac{10\mu C}{30^\circ} = \frac{1800}{30\pi} \mu C/\text{Rad} = \frac{60}{\pi} \mu C/\text{Rad}$$

$$E_x = \int_{-\frac{\pi}{12}}^{\pi/12} \frac{-k\lambda\,d\theta\cos\theta}{r^2}$$

$$= \frac{-k\lambda}{r^2} \sin\theta \Big|_{-\pi/12}^{\pi/12} = \frac{-9\times10^9\, 60\times10^{-6}\, 2\sin\pi/12}{(.2)^2\,\pi}$$

$$= 2.2\times10^6 \frac{N}{C}$$

b) an electron placed at that point would accelerate to the right

$$\vec{a} = \frac{q\vec{E}}{m} = \frac{e}{m}\, 2.2\times10^{6}\,\frac{N}{C}\,\hat{i}$$

$$= 3.9\times10^{17}\ m/s^2\ \hat{i}$$

3) a) the flux through the surface is $\frac{q_{enc}}{\epsilon_0} = \frac{+q + -q}{\epsilon_0} = 0.$

b) the surface doesn't respect the symmetry ~~of~~ of the problem,

$\vec{E} \nparallel d\vec{A}$ so the integral will be hard to carry out

i.e. $\oint \vec{E}\cdot d\vec{A}$

4) a) $\vec{E} = -\vec{\nabla} V$

or just

$$E_x = -\frac{\partial V}{\partial x}$$

$$E_y = -\frac{\partial V}{\partial y}$$

$$E_z = -\frac{\partial V}{\partial z}$$

b) $$\frac{-\partial - \frac{\sigma z}{2\epsilon_0}}{\partial z} = \frac{\sigma}{2\epsilon_0}$$

c) $$W = -\Delta PE = +e\,\Delta V$$

$$= -\frac{e\sigma z_f}{2\epsilon_0} + \frac{e\sigma z_i}{2\epsilon_0}$$

$$= \frac{-e\sigma}{2\epsilon_0}(2m - 5m) = \frac{1.6\times10^{-19}C\ \ 3m\ \ 20\,C/m^2\ \ Nm^2}{2\ \ 8.85\times10^{-12}\ C^2}$$

~~$= 5.4\times10^{-12}$~~

$= 5.4\times10^{-7} J$