CONVENTION FOR VECTOR:

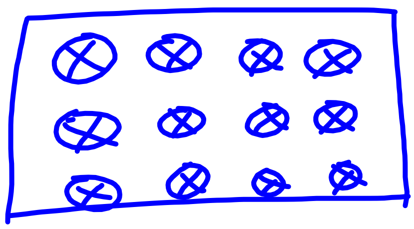
Magnitude unit at angle direction

30 m/s at 15° up-right
north east
into the page

Out of page: $\odot$

Into the page: $\otimes$

Example:



CONTINUATION FROM 1/23:

$$\Delta Q = \left(\frac{\Delta y}{L}\right) Q$$

OR

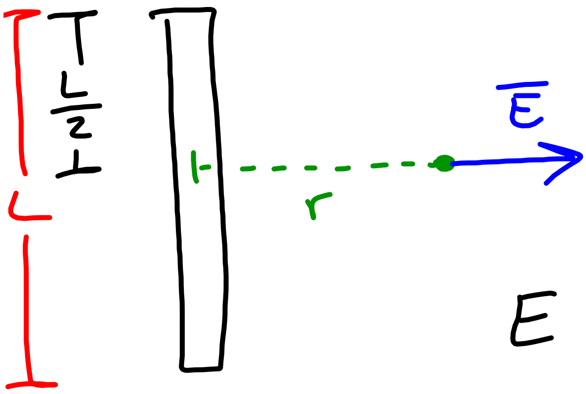
$$\Delta Q = \left(\frac{Q}{L}\right) \Delta y$$

$$\Delta E_x = \frac{1}{4\pi\varepsilon_0} \frac{Q}{L} \frac{x}{(x^2+y^2)^{3/2}} \Delta y$$

$$\Delta E_y = \frac{1}{4\pi\varepsilon_0} \frac{Q}{L} \frac{-y}{(x^2+y^2)^{3/2}} \Delta y$$

$$E_x = \frac{1}{4\pi\varepsilon_0}\,\frac{Qx}{L}\int_{-L/2}^{L/2}\frac{1}{(x^2+y^2)^{3/2}}\,dy$$

$$E_y = \varnothing$$



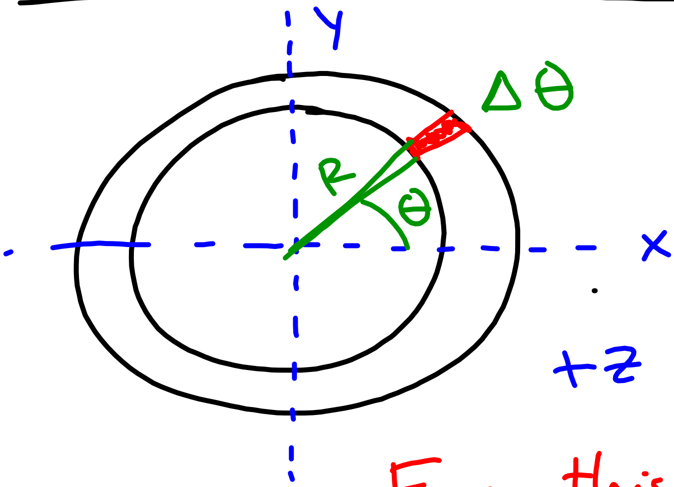
$y \rightarrow \frac{L}{2}$

$x \rightarrow r$

Q is total charge on rod

$$E = \frac{1}{4\pi\varepsilon_0}\left[\frac{Q}{r\sqrt{r^2+(L/2)^2}}\right]$$

UNIFORMLY CHARGED THIN RING



Measurement point is on +z axis at distance z from ring

+z is out of the board

From this $\Delta\theta$, there is a ΔE_x, ΔE_y, and ΔE_z

Integration variable: θ

$\bar{r}$ = <observation location> − <source>

$= \langle \emptyset, \emptyset, z \rangle - \langle R\cos\theta, R\sin\theta, \emptyset \rangle$

$= \langle -R\cos\theta, -R\sin\theta, z \rangle$

$$|\bar{r}| = \sqrt{(-R\cos\theta)^2 + (-R\sin\theta)^2 + z^2}$$

$$= (R^2 + z^2)^{\frac{1}{2}}$$

$\cos^2\theta + \sin^2\theta = 1$

$$\hat{r} = \frac{\langle -R\cos\theta, -R\sin\theta, z \rangle}{(R^2 + z^2)^{1/2}}$$

$$\frac{1}{4\pi\varepsilon_0}\frac{\Delta q}{\underline{r^2}} = \frac{1}{4\pi\varepsilon_0}\frac{\Delta q}{\underline{R^2+z^2}}$$

$$\Delta q = q\left(\frac{\Delta\theta}{2\pi}\right)$$

$$\Delta\vec{E} = (\Delta E)\,\hat{r}$$

$$= \frac{1}{4\pi\varepsilon_0}\frac{q\left(\frac{\Delta\theta}{2\pi}\right)}{(R^2+z^2)}\frac{\langle -R\cos\theta, -R\sin\theta, z\rangle}{(R^2+z^2)^{1/2}}$$

$$\Delta\vec{E} = \frac{1}{4\pi\varepsilon_0}\frac{q}{2\pi}\frac{\Delta\theta}{(R^2+z^2)^{3/2}}\langle -R\cos\theta, -R\sin\theta, z\rangle$$

From symmetry, x- and y-components sum to $\emptyset$. Only concerned with z-component.

$$\Delta E_z = \frac{1}{4\pi\varepsilon_0}\frac{q}{2\pi}\frac{z}{(R^2+z^2)^{3/2}}\Delta\theta$$

$$E_z = \int_{\phi}^{2\pi} dE_z$$

$$= \int_{\phi}^{2\pi} \frac{1}{4\pi\varepsilon_0} \frac{q}{2\pi} \frac{z}{(R^2+z^2)^{3/2}} \, d\theta$$

$$= \frac{1}{4\pi\varepsilon_0} \frac{q}{2\pi} \frac{z}{(R^2+z^2)^{3/2}} \int_{\phi}^{2\pi} d\theta$$

$$E = \frac{1}{4\pi\varepsilon_0} \frac{qz}{(R^2+z^2)^{3/2}}$$

PROBLEMS: P22, P28, P31

chapter 15