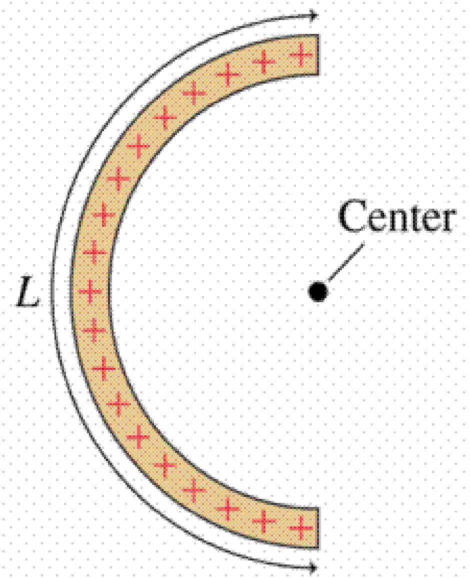
Note Title 9/6/2005

Review for Quiz 2, Problem 48, Chapter 26



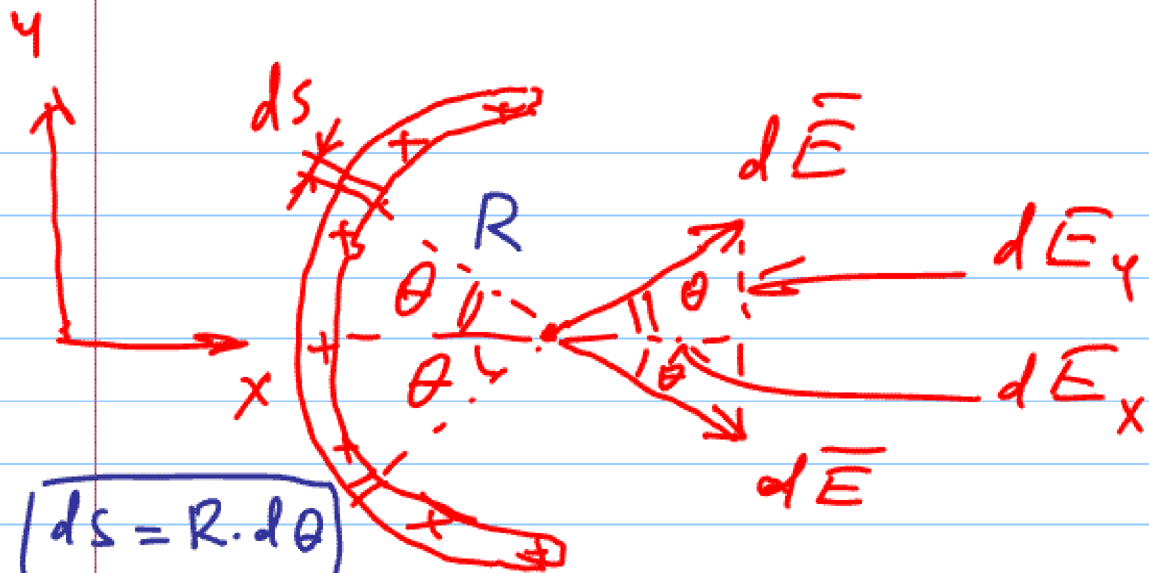
Charge Q is uniformly distributed along a thin, flexible rod of length L. The rod is then bent into the semicircle, see Figure.

a) Find an expression for the electric field $\boldsymbol{E}_{net}$ as a vector at the center of the semicircle.

b) Evaluate the field strength if L = 10 cm and Q = 30 nC.

Grading Criteria:

1. Sketch for a field $d\boldsymbol{E}$ created by differentially small charge dQ.
2. Direction of $\boldsymbol{E}_{net}$.
3. Integrals for components of $\boldsymbol{E}_{net}$.
4. Integration limits.
5. Numbers.

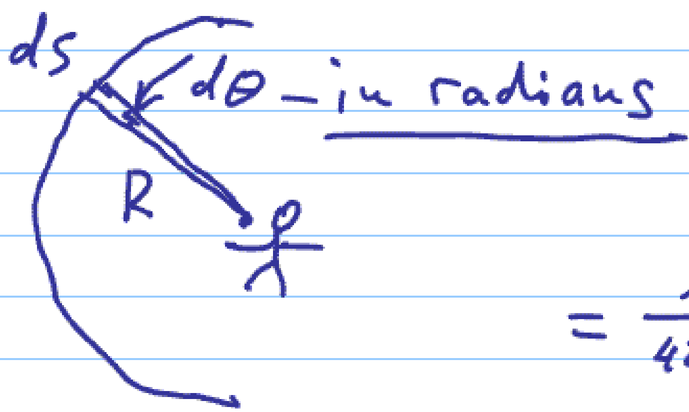


$$E_{net,y} = 0!$$

$$dE_x = \frac{1}{4\pi\varepsilon_0}\frac{\lambda\cdot ds}{R^2}\cos\theta$$

$$\boxed{ds = R\cdot d\theta}$$

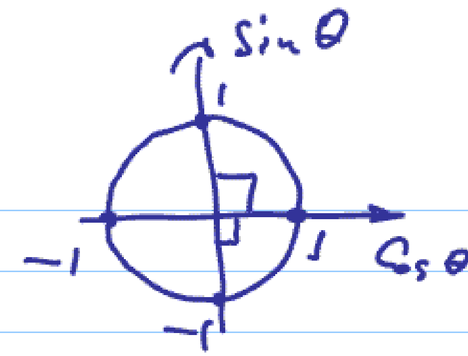
$$= \frac{1}{4\pi\varepsilon_0}\frac{\lambda\cdot \cancel{R}\cdot d\theta}{R^{\cancel{2}}}\cdot\cos\theta = \frac{\lambda}{4\pi\varepsilon_0\cdot R}\cos\theta\cdot d\theta$$



$$E_{net,x} = \int dE_x =$$

$$= \frac{\lambda}{4\pi\varepsilon_0\cdot R}\int_{-\frac{\pi}{2}}^{\frac{\pi}{2}}\cos\theta\cdot d\theta =$$

$$= \frac{\lambda}{4\pi\varepsilon_0 \cdot R} \sin\theta \Big|_{-\frac{\pi}{2}}^{\frac{\pi}{2}} =$$



$$= \frac{\lambda}{4\pi\varepsilon_0 \cdot R}\left(1-(-1)\right) = \frac{2\lambda}{4\pi\varepsilon_0 \cdot R} = \qquad \boxed{\lambda = \frac{Q}{L}}$$

$$= \frac{Q}{2\pi\varepsilon_0 \cdot R \cdot L}$$

Since it is a semi-circle: $L = \frac{2\pi R}{2} = \pi R$

$R = \frac{L}{\pi}$

$$E_{net,x} = \frac{Q}{2\cancel{\pi}\varepsilon_0 \frac{L}{\cancel{\pi}} \cdot L} = \frac{Q}{2\varepsilon_0 \cdot L^2}$$

You can substitute numbers, make sure everything is in SI system of units.