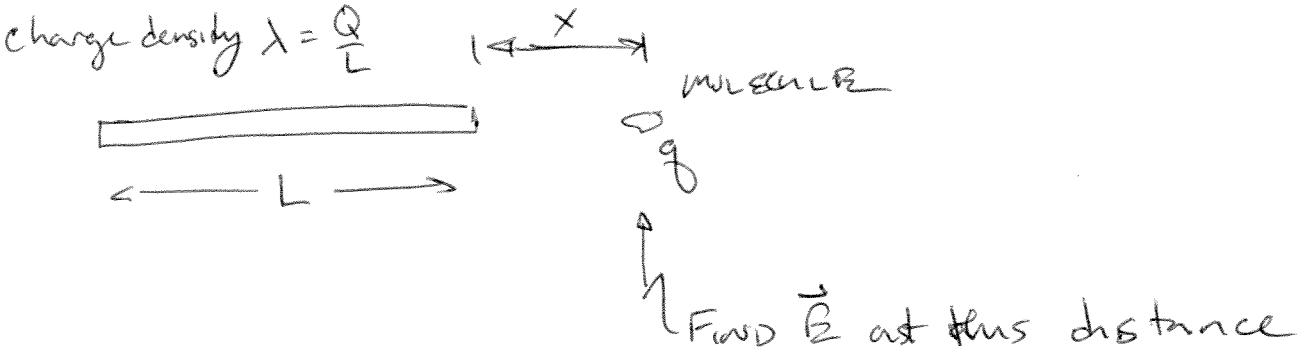
General Problem Solving Guide

Name:	
Lab Time:	KEY
Date:	
Test:	GROUP PROBLEM #1
Problem #:	

List given information, define variables, sketch picture:

charge density $\lambda = \frac{Q}{L}$



Simplify question, list target quantity:

FIND $\vec{E}$ at a distance from end of rod

List all related quantitative relationships:

$$\vec{E}(r_i) = \frac{kq}{r_i^2}\hat{r}_i \qquad \vec{F} = q\vec{E}$$

Break rod into segments and add all segments

Outline approach, sketch diagrams if needed (or sketch next to pictures above):

$$E_{TOT} = \sum_{n=1}^{N} \frac{k\,\Delta q}{r^2} \quad \text{where} \quad r = x + \frac{L}{N}\cdot\frac{n}{2}$$

Rod broken into N parts

or

$$E_{TOT} = \int_{r=x}^{r=x+L} \frac{k\,dq}{r^2} = k\int_{r=x}^{r=x+L} \frac{\lambda\,dr}{r^2}$$

since $dq = \lambda\,dr$

Obtain a general solution:

$$\vec{E}_{TOT} = k\int_{r=x}^{r=x+L} \frac{\lambda\, dr}{r^2} \qquad \lambda = \frac{Q}{L}$$

$$\vec{E}_{TOT} = \frac{kQ}{L}\int_{r=x}^{r=x+L} \frac{dr}{r^2}$$

$$= \frac{kQ}{L}\left(\frac{-1}{r}\Big|_{r=x}^{r=x+L}\right)$$

$$= \frac{kQ}{L}\left(\frac{-1}{x+L} - \frac{-1}{x}\right)$$

$$= \frac{kQ}{L}\left(\frac{-x}{(x+L)x} + \frac{x+L}{x(x+L)}\right)$$

$$= \frac{kQ}{L}\left(\frac{L}{(x+L)x}\right)$$

$$\vec{E}_{TOT} = \frac{kQ}{(x+L)x} = \frac{kQ}{x^2\left(1+\frac{L}{x}\right)}\hat{x}$$

Check Units: _____.

$$\frac{N}{C} = \frac{Nm^2}{C^2}\cdot\frac{C}{m(m)} = \frac{N}{C}$$ ✓

Check Limiting Cases: _____.

$x \to \infty$ $(x >> L)$ $E_{TOT} \propto \frac{1}{x^2}$ ✓

$x \to 0$ $(x << L)$ E_{TOT} = "constant"

$Q\uparrow$ $E\uparrow$ ✓

Obtain a numeric solution: _____.
(i.e. plug in the numbers)

Why is solution reasonable? Explain.

UNITS CHECK

LIMITING CASE WORKS