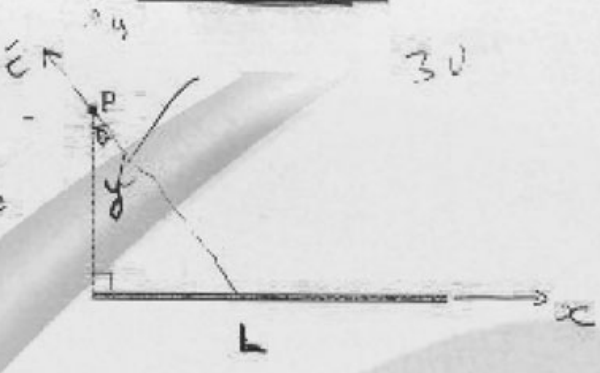
NDU
Faculty of Natural and Applied Sciences
Department of Sciences

PHS212 - Electricity & Magnetism
Quiz 1 - Spring 2003
Duration: 15 min

Name: [redacted]

ID: [redacted]

Find the electric field E at P produced by the rod if its total charge is q and it is uniformly distributed over the length L of the rod. (23 pts if you write the integrals correctly).



30

$dq = \lambda dx$

$\lambda = \frac{q}{L}$

$\vec{E} = \frac{1}{4\pi\varepsilon_0} \frac{dq}{(y^2+x^2)}$

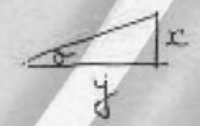
$E_y = E\cos\theta$

$\cos\theta = \frac{y}{(y^2+x^2)^{1/2}}$

$\int dE_y = \int_0^L k \frac{dq}{(y^2+x^2)} \cdot \cos\theta$ // $\sin\theta = \frac{x}{(y^2+x^2)^{1/2}}$

$E_y = k\lambda y \int_0^L \frac{dx}{(y^2+x^2)^{3/2}}$

$x = y\tan\theta$



$\sin\theta = \frac{x}{(y^2+x^2)^{1/2}}$

$dx = y \cdot \frac{1}{\cos^2\theta} d\theta$

$y^2+x^2 = y^2(1+\tan^2\theta) = y^2 \cdot \frac{1}{\cos^2\theta}$

$E_y = k\lambda y \int_{x=0}^{L} \frac{y \frac{1}{\cos^2\theta}}{y^3 \cdot \frac{1}{\cos^3\theta}} d\theta = \frac{k\lambda}{y} \int_{x=0}^{L} \cos\theta \, d\theta$

$E_y = \frac{k\lambda}{y} \sin\theta \Big|_{x=0}^{L}$

$E_y = \frac{k\lambda}{y} \left(\frac{x}{(y^2+x^2)^{1/2}} \right) \Big|_0^L = \frac{k\lambda}{y} \left(\frac{L}{(y^2+L^2)^{1/2}} \right) = \frac{k\lambda}{y(y^2+L^2)^{1/2}}$