Physics 302
Winter Quarter 1992
March 17, 1994
George Williams

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FINAL EXAM

Name (print)_____ Name (signed)_____

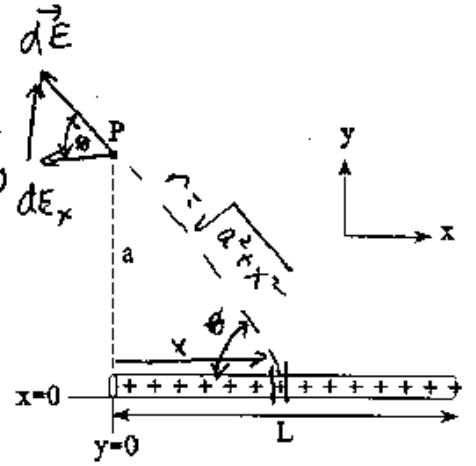
Discussion Instructor (circle): Basko Chakhbazian DiCarlo Gundlach Romer Wei

Discussion Section # _____

SHOW ALL WORK!!!!!
REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Given a rod of nonconductor of length L with a charge density expressed as $\lambda = \lambda_0 x^2$ C/m.

(a) Calculate the x-component of the electric field due to the rod at point P, a distance a from the end of the rod.
(b) Calculate the electric potential at point P due to the rod.



(a) $|d\vec{E}| = \frac{K\,dq}{r^2} = \frac{K\lambda\,dx}{x^2+a^2}$

$|d\vec{E}|_x = |d\vec{E}|\cos\theta = \frac{K\lambda\,dx}{x^2+a^2}\frac{x}{\sqrt{x^2+a^2}} \Rightarrow |d\vec{E}|_x = \frac{K\lambda_0 x^3\,dx}{(x^2+a^2)^{3/2}}$

$|\vec{E}_x| = \int |d\vec{E}|_x = \int_0^L \frac{K\lambda_0 x^3\,dx}{(x^2+a^2)^{3/2}} = K\lambda_0\left[\left(\sqrt{x^2+a^2} + \frac{a^2}{\sqrt{x^2+a^2}}\right)\Big|_0^L\right]$

↑ DATA Sheet ↑

$E_x = K\lambda_0\left[\left(\sqrt{L^2+a^2} + \frac{a^2}{\sqrt{L^2+a^2}}\right) - (a+a)\right]$

$$\vec{E}_x = K\lambda_0\left[\sqrt{L^2+a^2} + \frac{a^2}{\sqrt{L^2+a^2}} - 2a\right](-\hat{i})$$

(b) $dV = \frac{K\,dq}{r} = \frac{K\lambda_0 x^2\,dx}{\sqrt{x^2+a^2}}$ $\quad V = \int_0^L \frac{K\lambda_0 x^2}{(x^2+a^2)^{1/2}}$) over

$$V = K\lambda_0 \left[\left(\frac{x}{2}\sqrt{x^2+a^2} - \frac{a^2}{2}\ln\left(x+\sqrt{x^2+a^2}\right)\right)\Big|_0^L \right]$$

↑ DATA SHEET ↑

$$= K\lambda_0 \left[\frac{L}{2}\sqrt{L^2+a^2} - \frac{a^2}{2}\ln\left(L+\sqrt{L^2+a^2}\right) - \left(-\frac{a^2}{2}\ln a\right) \right]$$

$$\Rightarrow \boxed{V = K\lambda_0 \left[\frac{L}{2}\sqrt{L^2+a^2} - \frac{a^2}{2}\ln\left(L+\sqrt{L^2+a^2}\right) + \frac{a^2}{2}\ln a \right]}$$

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All She Wrote!!

AMEN!!