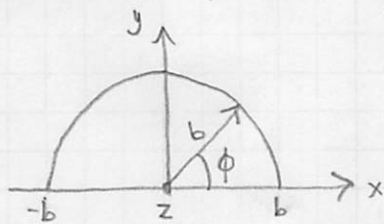


4.10 A line of uniform charge density ρ_L occupies a semicircle of radius b as shown below. Determine the electric field at the origin.



$$\vec{E} = \frac{1}{4\pi\epsilon} \int \hat{R}' \frac{\rho_L}{R'^2} dl \quad \text{Eq 4.21c}$$

$$\vec{R}' = -\hat{r} b$$

$$\vec{E} = \frac{1}{4\pi\epsilon} \int (-\hat{r}) \frac{\rho_L}{b^2} dl$$

$$\hat{R}' = \frac{\vec{R}'}{R'} = -\frac{\hat{r} b}{b} = -\hat{r} = \frac{\rho_L}{4\pi\epsilon} \int_0^\pi -\hat{r} \frac{1}{b^2} b d\phi$$

$$= -\hat{r} \frac{\rho_L}{4\pi\epsilon b} \int_0^\pi d\phi$$

$$= -\hat{r} \frac{\rho_L}{4\epsilon b} \quad \text{V/m}$$