

4.34 Find the electric potential V at a location a distance b from the origin in the x - y plane due to a line charge with charge density ρ_ℓ and of length l . The line charge is coincident with the z -axis and extends from $z = -l/2$ to $z = l/2$.

Solution: From Eq. (4.48c), we can find the voltage at a distance b away from a line

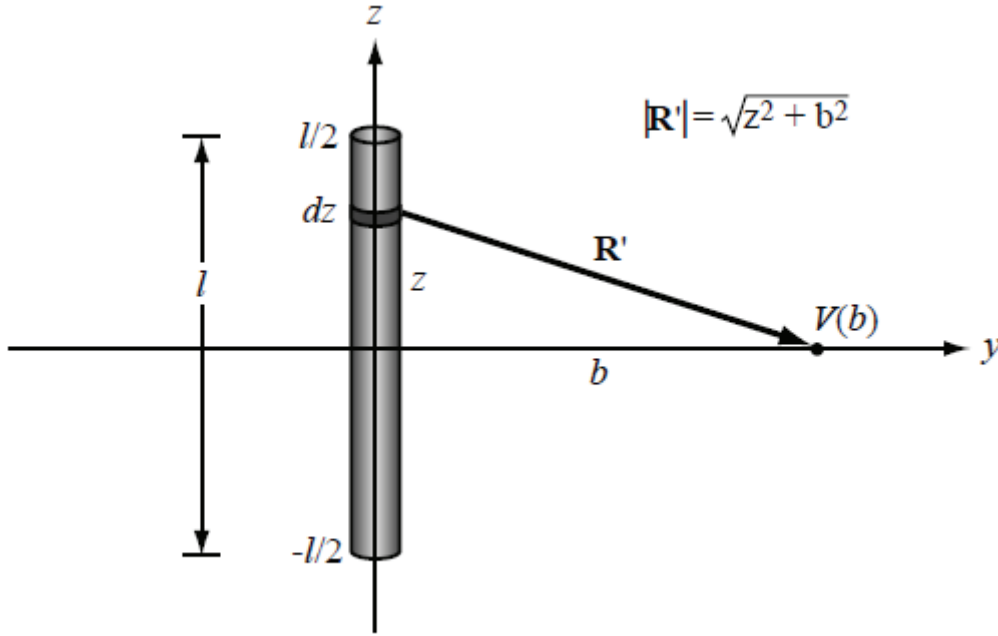


Figure P4.34 Line of charge of length ℓ .

of charge [Fig. P4.34]:

$$V(b) = \frac{1}{4\pi\epsilon} \int_{-l/2}^{l/2} \frac{\rho_\ell}{R'} dz = \frac{\rho_\ell}{4\pi\epsilon} \int_{-l/2}^{l/2} \frac{dz}{\sqrt{z^2 + b^2}} = \frac{\rho_\ell}{4\pi\epsilon} \ln \left(\frac{l + \sqrt{l^2 + 4b^2}}{-l + \sqrt{l^2 + 4b^2}} \right).$$
