Problem 4.39 An infinitely long line of charge with uniform density $\rho_l = 9$ (nC/m) lies in the x–y plane parallel to the y-axis at $x = 2$ m. Find the potential V_{AB} at point $A(3\text{ m}, 0, 4\text{ m})$ in Cartesian coordinates with respect to point $B(0,0,0)$ by applying the result of Problem 4.33.

Solution: According to Problem 4.33,

$$V = \frac{\rho_l}{2\pi\varepsilon_0} \ln\left(\frac{r_2}{r_1}\right)$$

where r_1 and r_2 are the distances of A and B. In this case,

$$r_1 = \sqrt{(3-2)^2 + 4^2} = \sqrt{17}\text{ m},$$
$$r_2 = 2\text{ m}.$$

Hence,

$$V_{AB} = \frac{9\times 10^{-9}}{2\pi \times 8.85 \times 10^{-12}} \ln\left(\frac{2}{\sqrt{17}}\right) = -117.09\text{ V}.$$

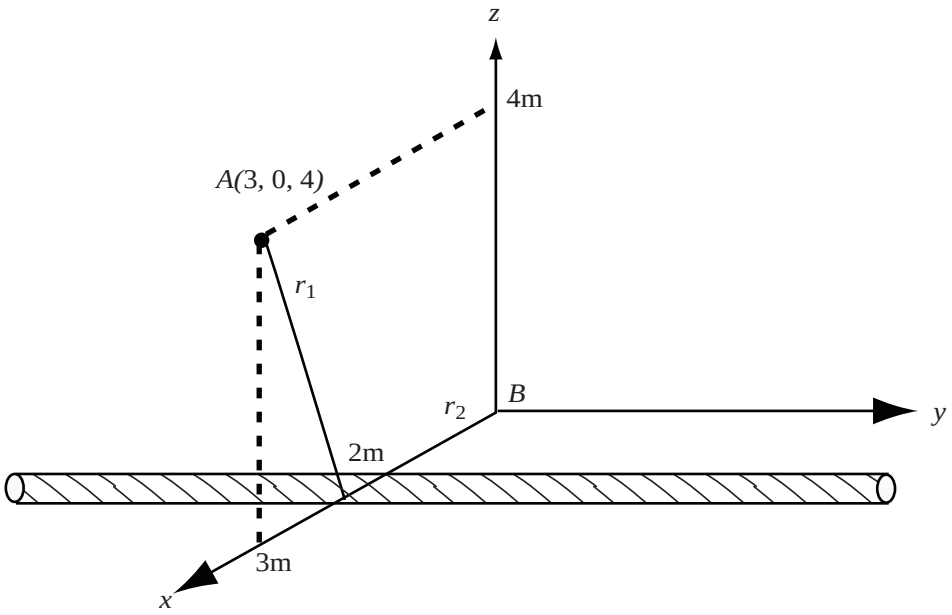

Figure P4.39: Line of charge parallel to y-axis.