

4.40 An infinitely long line of charge with uniform density $\rho_l = 18$ (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 4.32.

Solution: According to Problem 4.32,

$$V = \frac{\rho_l}{2\pi\epsilon_0} \ln\left(\frac{r_2}{r_1}\right)$$

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,

$$V_{AB} = \frac{18 \times 10^{-9}}{2\pi \times 8.85 \times 10^{-12}} \ln\left(\frac{2}{\sqrt{17}}\right) = -234.18 \text{ V}.$$

