Answer on Question #65627-Physics-Electromagnetism

A thin rod extends along the z-axis from z = -d to z = d. The rod carries a charge uniformly distributed along its length with linear charge density lamda. By integrating over this charge distribution, calculate the potential at a point P1 on the z-axis with coordinates (0,0,2d).

Solution

$$dV = k\frac{dq}{d+x} = k\frac{\lambda dx}{d+x}$$

The potential at a point P1 on the z-axis with coordinates (0,0,2d) is

$$V = \int_0^{2d} dV = \int_0^{2d} k\frac{\lambda dx}{d+x} = k\lambda \int_0^{2d} \frac{dx}{d+x} = k\lambda\ \ln(d+x)_0^{2d} = k\lambda[\ln(3d) - \ln(d)] = k\lambda\left[\ln\left(\frac{3d}{d}\right)\right]$$
$$= k\lambda \ln 3.$$

Answer: $\boldsymbol{k\lambda \ln 3}$.