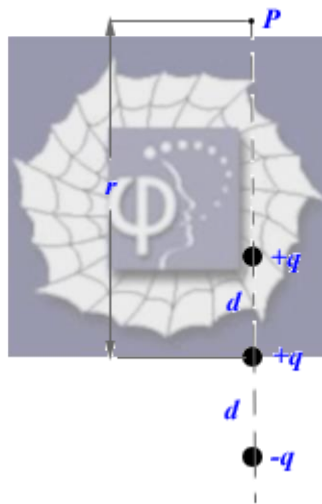


352.

Problem 30.35 (RHK)

For the charge configuration shown in the figure, we have to show that $V(r)$ of points on the vertical axis, assuming $r \gg d$, is given by

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r} \left(1 + \frac{2d}{r} \right).$$



Solution:

For the charge configuration shown in the figure we will calculate the electric potential at point P on the vertical axis at a distance r from the charge in the middle.

$$V(r) = \frac{1}{4\pi\epsilon_0} \left(\frac{q}{r-d} + \frac{q}{r} + \frac{q}{r+d} \right)$$
$$= \frac{1}{4\pi\epsilon_0} q \left(\frac{1}{r} + \frac{2d}{r^2 - d^2} \right).$$

For $r \gg d$,

$$\frac{2d}{r^2 - d^2} \approx \frac{2d}{r^2}.$$

Therefore,

$$V = \frac{1}{4\pi\epsilon_0} \frac{q}{r} \left(1 + \frac{2d}{r} \right).$$

