

Nº 3.5

Дано:

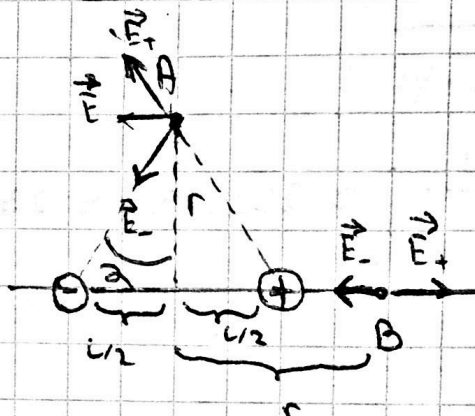
$$\rho = 0,12 \text{ нКл/м}$$

$$Q = \pm 1 \text{ нКл}$$

$$r = 8 \text{ см}$$

Найти: $\varphi_A, \varphi_B,$
 E_A, E_B

Решение:



$$\rho = qL \Leftrightarrow L = \frac{\rho}{q}; \quad L = \frac{0,12 \text{ нКл/м}}{1 \text{ нКл}} = 0,12 \text{ м}$$

$$\varphi_A = \varphi_{A+} + \varphi_{A-} = \frac{Q}{4\pi\epsilon_0 \sqrt{r^2 + \frac{L^2}{4}}} + \frac{-Q}{4\pi\epsilon_0 \sqrt{r^2 + \frac{L^2}{4}}} = 0$$

$$\begin{aligned} \varphi_B &= \varphi_{B+} + \varphi_{B-} = \frac{Q}{4\pi\epsilon_0 (r - \frac{L}{2})} + \frac{-Q}{4\pi\epsilon_0 (r + \frac{L}{2})} \\ &= \frac{Qr + Q\frac{L}{2} - Qr + Q\frac{L}{2}}{4\pi\epsilon_0 (r^2 - \frac{L^2}{4})} = \frac{QL}{4\pi\epsilon_0 (r^2 - \frac{L^2}{4})} = \frac{\rho}{4\pi\epsilon_0 (r^2 - \frac{L^2}{4})} \end{aligned}$$

$$\varphi_B = \frac{0,12 \cdot 10^{-9} \text{ Кл/м}}{4\pi \cdot 8,85 \cdot 10^{-12} \frac{\text{Ф}}{\text{м}} \cdot (0,08^2 - 0,06^2) \text{ м}^2} \approx 385 \text{ В}$$

$$E_{A+} = \frac{Q}{4\pi\epsilon_0 (r^2 + \frac{L^2}{4})} = \frac{10^{-9} \text{ Кл}}{4\pi \cdot 8,85 \cdot 10^{-12} \frac{\text{Ф}}{\text{м}} \cdot (0,08^2 + 0,06^2) \text{ м}^2} \approx 10^3 \text{ В/м}$$

$$E_{A-} = E_{A+}$$

$$E_A = \sqrt{E_{A+}^2 + E_{A-}^2 - 2E_{A+}E_{A-}\cos(\pi - 2\alpha)} = \sqrt{E_{A+}^2 + E_{A-}^2 - 2E_{A+}E_{A-}\cos(2\alpha)}$$

$$\cos(\alpha) = \frac{r}{\sqrt{r^2 + \frac{L^2}{4}}} = \frac{0,08 \text{ м}}{\sqrt{0,0064 \text{ м}^2 + 0,0036 \text{ м}^2}} = 0,8;$$

$$\cos(2\alpha) = \cos(2 \arccos(0,8)) \approx 0,28$$

$$E_A = E_{A+} \sqrt{1 + 1 - 2 \cdot 1 \cdot 1 \cdot \cos(2\alpha)} = \frac{1,2 Q}{4\pi\epsilon_0 (r^2 + \frac{L^2}{4})} = \frac{1,2 \cdot 10^{-9} \text{ Кл}}{4\pi \cdot 8,85 \cdot 10^{-12} \frac{\text{Ф}}{\text{м}} \cdot 0,01 \text{ м}^2} \approx 1079 \frac{\text{В}}{\text{м}} \approx 1,08 \text{ кВ/м}$$

$$E_{B+} = \frac{Q}{4\pi\epsilon_0 (r - \frac{L}{2})^2} ; E_{B-} = \frac{Q}{4\pi\epsilon_0 (r + \frac{L}{2})^2}$$

$$E_B = E_{B+} - E_{B-} = \frac{Q}{4\pi\epsilon_0} \left(\frac{1}{(r - \frac{L}{2})^2} - \frac{1}{(r + \frac{L}{2})^2} \right)$$

$$E_B = \frac{10^{-9} \text{ Кл}}{4\pi \cdot 8,85 \cdot 10^{-12} \frac{\text{Ф}}{\text{м}}} \left(\frac{1}{0,0028} - \frac{1}{0,01} \right) \approx 2312 \text{ В/м} \approx 23,12 \text{ КВ/м}$$

Ответ: $\varphi_A = 0$, $\varphi_B \approx 385 \text{ В}$; $E_A \approx 1,08 \text{ КВ/м}$; $E_B \approx 23,12 \text{ КВ/м}$