Phys 202 - A4 ⇒ 7-9

7. Assembling Charges.

Method

① Take a charge from ∞ to some position

② Calculate work required.

③ Repeat for each charge.

Step 1




Step 2




$$W = \int_{\infty}^{s} \vec{F} \cdot d\vec{r} = \int_{\infty}^{s} -\frac{k_e Q Q}{r^2}\, dr$$

$$= \frac{k_e Q Q}{r}\Big|_{\infty}^{s}$$

$$= \frac{k_e Q Q}{s} - \frac{k_e Q Q}{\infty}^{0}$$

$$W = \frac{k_e Q^2}{s}$$

Step 3




$$W = \frac{k_e Q^2}{s} + \frac{k_e Q^2}{\sqrt{2}\, s}$$

Step 4




$$W = \frac{k_e Q^2}{s} + \frac{k_e Q^2}{s} + \frac{k_e Q^2}{\sqrt{2}\, s}$$

$$W_{Total} = \frac{k_e Q^2}{s} + \frac{k_e Q^2}{s} + \frac{k_e Q^2}{\sqrt{2}s} + \frac{k_e Q^2}{s} + \frac{k_e Q^2}{s} + \frac{k_e Q^2}{\sqrt{2}s}$$

$$= \frac{k_e Q^2}{s}\left[1 + 1 + \frac{1}{\sqrt{2}} + 1 + 1 + \frac{1}{\sqrt{2}}\right]$$

$$= \frac{k_e Q^2}{s}(5.414z)$$

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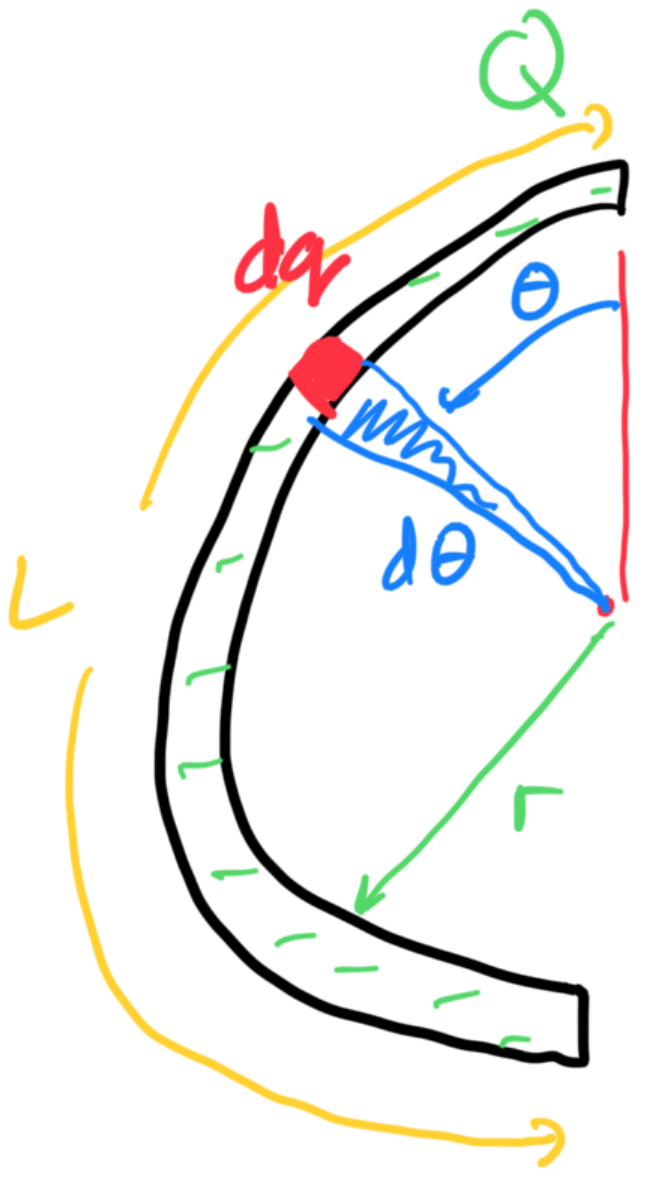
8.




① $\lambda = \frac{Q}{L}$ ② $L = \pi r \therefore r = \frac{L}{\pi}$

③ $dq = \lambda\, dx = \lambda\, r\, d\theta$

$= \frac{Q}{L} \cdot \frac{L}{\pi} \cdot d\theta = \frac{Q}{\pi}\, d\theta$

④ $dU = \frac{k_e\, dq}{r} = \frac{k_e \left(\frac{Q}{\pi} d\theta\right)}{L/\pi}$

$dU = \frac{k_e\, Q}{L}\, d\theta$

⑤ $V = \int_0^{\pi} \frac{k_e\, Q}{L}\, d\theta = \frac{\pi k_e\, Q}{L}$

Simple Solution : All of the charge is the same distance from the centre !!

$\therefore V = \frac{k_e\, Q}{r}$

$= \frac{k_e\, Q}{(L/\pi)} = \frac{\pi k_e\, Q}{L}$

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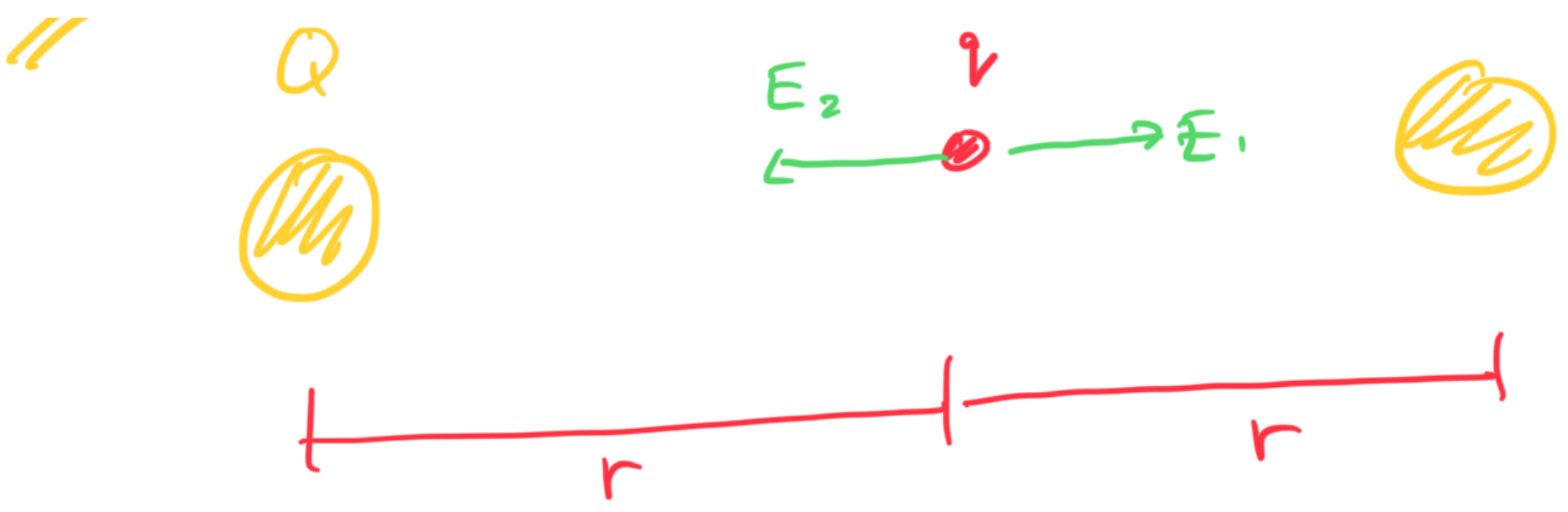
$Q = 1.8\,\mu C, \quad r = 0.800\ m$

9. Q




$$|\vec{E}_1| = \frac{k_e Q}{r} = |\vec{E}_2|$$

$$\therefore \vec{E}_{TOTAL} = 0 \qquad (b)$$

(since $\vec{F}_E = q\vec{E}_{TOTAL}$)

$$\vec{F}_E = 0 \qquad (a)$$

c) $$V_{origin} = \frac{kQ}{r} + \frac{kQ}{r}$$

$$= \frac{2kQ}{r} = 40.5\,kV$$