11. (II) A uniform electric field $\vec{E} = -4.20\ \mathrm{N/C}\,\hat{i}$ points in the negative x direction as shown in Fig. 23–25. The x and y coordinates of points A, B, and C are given on the diagram (in meters). Determine the differences in potential (*a*) V_{BA}, (*b*) V_{CB}, and (*c*) V_{CA}.

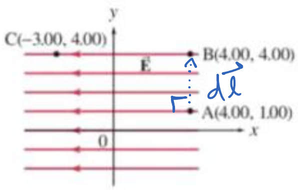


FIGURE 23–25 Problem 11.

Answer: $V_{BA} = 0$, $V_{CB} = -29.4\,\mathrm{V}$, $V_{CA} = -29.4\,\mathrm{V}$

find ΔV

ΔV_{BA}

ΔV_{CB}

ΔV_{CA}

GIVEN: $\vec{E}$, l

$\vec{A}\cdot\vec{B} = |\vec{A}||\vec{B}|$
$= A\,B\,c$
$\hookrightarrow \theta$

$$\Delta V_{BA} = -\int_A^B \vec{E}\cdot d\vec{l}$$
$$= -\int_A^B E\,dl\cos\theta$$
$$= -E\int_A^B dl\ \cancel{\cos 90^\circ} \to 0$$
$$= 0$$

FORMULAS FOR ΔV:

$$\Delta V = V_f - V_i$$

$$\Delta V = q\,\Delta U, \quad \Delta U := \text{CHANGE IN PE}$$

$$\Delta V = -\int_a^b \vec{E}\cdot d\vec{l}$$ ~ "DISTANCE"

11. (II) A uniform electric field $\vec{E} = -4.20\ \mathrm{N/C}\,\hat{i}$ points in the negative x direction as shown in Fig. 23–25. The x and y coordinates of points A, B, and C are given on the diagram (in meters). Determine the differences in potential (*a*) V_{BA}, (*b*) V_{CB}, and (*c*) V_{CA}.

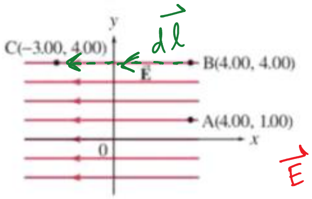
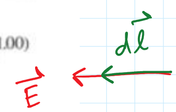


FIGURE 23–25 Problem 11.

Answer: $V_{BA} = 0$, $V_{CB} = -29.4\,\mathrm{V}$, $V_{CA} = -29.4\,\mathrm{V}$



$$\Delta V_{CB} = -\int_B^C \vec{E}\cdot d\vec{l}$$
$$= -\int_B^C E\,dl\cos\cancel{\theta} \to 0^\circ$$
$$= -\int_B^C E\,dl$$
$$= -E\int_B^C dl$$ EVALUATE
$$= -E\,(l_{CB})$$ "TOTAL DISTANCE FROM B → C"
$$= -(4.20)(7)$$
$$= \boxed{-29.4\ \ V}$$

$$\oint \vec{E}\cdot d\vec{A} = \frac{Q_{enc}}{\epsilon_0}$$
$$\oint E\,dA\,\cancel{\cos\theta} \to 1 = \ldots$$
$$E\oint dA = \ldots$$
$$E(A_{TOTAL}) = \ldots$$

11. (II) A uniform electric field $\vec{E} = -4.20\ \mathrm{N/C}\,\hat{i}$ points in the negative x direction as shown in Fig. 23–25. The x and y coordinates of points A, B, and C are given on the diagram (in meters). Determine the differences in potential (*a*) V_{BA}, (*b*) V_{CB}, and (*c*) V_{CA}.

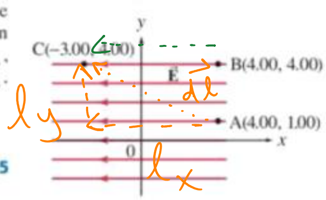


FIGURE 23–25 Problem 11.

Answer: $V_{BA} = 0$, $V_{CB} = -29.4\,\mathrm{V}$, $V_{CA} = -29.4\,\mathrm{V}$

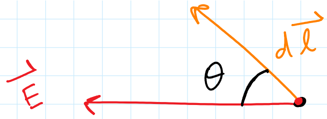
$$\Delta V_{CA} = -\int_A^C \vec{E}\cdot d\vec{l}$$
$$= -\int_A^C E\,dl\cos\theta$$
$$= -E\cos\theta\int_A^C dl$$
$$= -E\cos\theta\ l$$

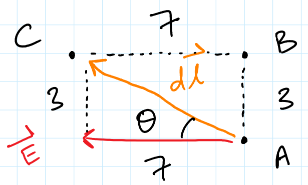
$\cos\theta$

$\cos\theta$

$=$ ANGLE B/W $\vec{A}$ & $\vec{B}$

Answer: $V_{BA} = 0$, $V_{CB} = -29.4\,\mathrm{V}$, $V_{CA} = -29.4\,\mathrm{V}$





$$\theta = \tan^{-1}\left[\frac{3}{7}\right] \approx 23.2^\circ$$

$$\ell_{CA} = \sqrt{3^2 + 7^2} = \sqrt{58}$$

$$= -E\cos\theta \int_A d\ell$$

$$= -E\cos\theta\, \ell_{CA}$$

$$= -(4.20)\cos 23.2^\circ\,(\sqrt{58})$$

$$= \boxed{-29.4\ \mathrm{V}}$$

77. Three charges are at the corners of an equilateral triangle (side ℓ) as shown in Fig. 23–38. Determine the potential at the midpoint of each of the sides. Let $V = 0$ at $r = \infty$.

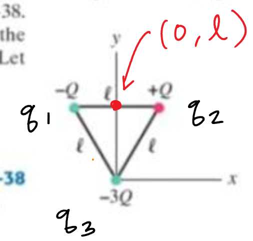


FIGURE 23–38
Problem 77.

* NOTE: For today's session, let's just find the potential at the point $(0, \ell)$ *

Answer: at $(0, \ell)$, the net electric potential is $V = -\dfrac{\sqrt{3}Q}{2\pi\epsilon_0 \ell}$

FINDING V_{NET} AT $(0, \ell)$

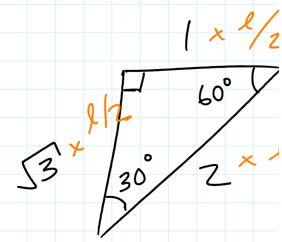
$$V_{NET} = V_1 + V_2 + V_3$$

$$= K\frac{q_1}{r_1} + K\frac{q_2}{r_2} + K\frac{q_3}{r_3}$$

$$\begin{cases} q_1 = -Q \\ q_2 = +Q \\ q_3 = -3Q \end{cases}$$

$$r_1 = r_2 = \ell/2$$

$$r_3 = \sqrt{3}\,\ell/2$$



$$\rightarrow V_{NET} = \cancel{K\frac{-Q}{\ell/2} + K\frac{+Q}{\ell/2}} + K\frac{-3Q}{\sqrt{3}\,\ell/2}$$

$$= \boxed{-K\frac{6Q}{\sqrt{3}\,\ell}}$$

~ "TECHNICALLY CORRECT" ; MATHEMATICALLY EQUIVALENT

WE "RATIONALIZE" THE FRACTION TO MATCH THE SOLUTION

$$V_{NET} = -K\frac{6Q}{\sqrt{3}\,\ell} \times \frac{\sqrt{3}}{\sqrt{3}} = -K\frac{\overset{2}{\cancel{6}}\sqrt{3}\,Q}{\cancel{3}\,\ell} = -K\frac{2\sqrt{3}\,Q}{\ell}$$

$$= -\left(\frac{1}{\underset{2}{\cancel{4}}\pi\epsilon_0}\right)\frac{\cancel{2}\sqrt{3}\,Q}{\ell} = \boxed{-\frac{\sqrt{3}\,Q}{2\pi\epsilon_0 \ell}}$$

BADA BING
BADA BOOM

α

α

$s\alpha$

$\ell/2$