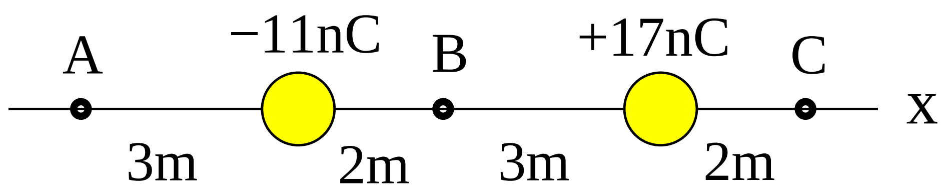
Unit Exam I: Problem #1 (Fall '15)

Consider two point charges positioned on the x-axis as shown.
(1a) Find magnitude and direction of the electric field at point C.
(1b) Find the electric potential at point B.
(2a) Find magnitude and direction of the electric field at point B.
(2b) Find the electric potential at point A.



Consider two point charges positioned on the x-axis as shown.
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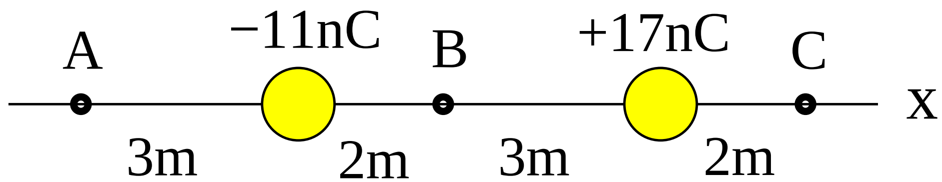
(2a) Find magnitude and direction of the electric field at point B.
(2b) Find the electric potential at point A.



Solution:

(1a) $E_x = -k\frac{|-11\text{nC}|}{(7\text{m})^2} + k\frac{|17\text{nC}|}{(2\text{m})^2} = -2.02\text{N/C} + 38.25\text{N/C} = +36.23\text{N/C}.$

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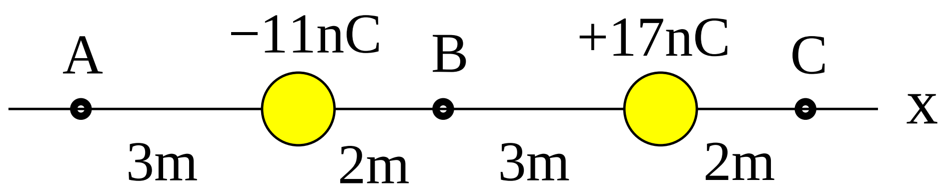


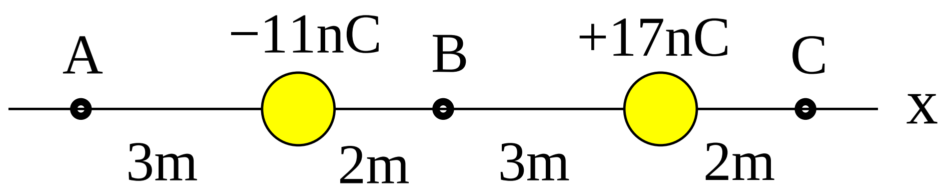
Solution:

(1a) $E_x = -k\frac{|-11\text{nC}|}{(7\text{m})^2} + k\frac{|17\text{nC}|}{(2\text{m})^2} = -2.02\text{N/C} + 38.25\text{N/C} = +36.23\text{N/C}.$

(1b) $V = k\frac{(-11\text{nC})}{2\text{m}} + k\frac{(17\text{nC})}{3\text{m}} = -49.5\text{V} + 51.0\text{V} = 1.5\text{V}.$

Unit Exam I: Problem #1 (Fall ’15)

Consider two point charges positioned on the x-axis as shown.
(1a) Find magnitude and direction of the electric field at point C.
(1b) Find the electric potential at point B.
(2a) Find magnitude and direction of the electric field at point B.
(2b) Find the electric potential at point A.



Solution:

(1a) $E_x = -k\frac{|-11\mathrm{nC}|}{(7\mathrm{m})^2} + k\frac{|17\mathrm{nC}|}{(2\mathrm{m})^2} = -2.02\mathrm{N/C} + 38.25\mathrm{N/C} = +36.23\mathrm{N/C}.$

(1b) $V = k\frac{(-11\mathrm{nC})}{2\mathrm{m}} + k\frac{(17\mathrm{nC})}{3\mathrm{m}} = -49.5\mathrm{V} + 51.0\mathrm{V} = 1.5\mathrm{V}.$

(2a) $E_x = -k\frac{|-11\mathrm{nC}|}{(2\mathrm{m})^2} - k\frac{|17\mathrm{nC}|}{(3\mathrm{m})^2} = -24.75\mathrm{N/C} - 17.00\mathrm{N/C} = -41.75\mathrm{N/C}.$

Unit Exam I: Problem #1 (Fall '15)

Consider two point charges positioned on the x-axis as shown.
(1a) Find magnitude and direction of the electric field at point C.
(1b) Find the electric potential at point B.
(2a) Find magnitude and direction of the electric field at point B.
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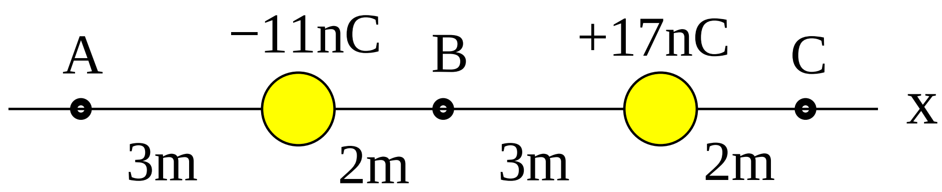


Solution:

(1a) $$E_x = -k\frac{|-11\text{nC}|}{(7\text{m})^2} + k\frac{|17\text{nC}|}{(2\text{m})^2} = -2.02\text{N/C} + 38.25\text{N/C} = +36.23\text{N/C}.$$

(1b) $$V = k\frac{(-11\text{nC})}{2\text{m}} + k\frac{(17\text{nC})}{3\text{m}} = -49.5\text{V} + 51.0\text{V} = 1.5\text{V}.$$

(2a) $$E_x = -k\frac{|-11\text{nC}|}{(2\text{m})^2} - k\frac{|17\text{nC}|}{(3\text{m})^2} = -24.75\text{N/C} - 17.00\text{N/C} = -41.75\text{N/C}.$$

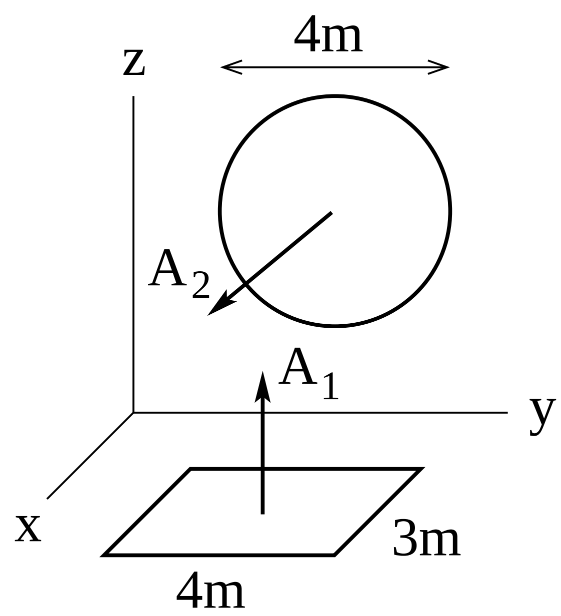
(2b) $$V = k\frac{(-11\text{nC})}{3\text{m}} + k\frac{17\text{nC}}{8\text{m}} = -33.0\text{V} + 19.1\text{V} = -13.9\text{V}.$$

Unit Exam I: Problem #2 (Fall '15)

Consider two plane surfaces (of rectangular and a circular shape) with area vectors $\vec{A}_1$ pointing in positive z-direction) and $\vec{A}_2$ pointing in positive x-direction.
The region is filled with a uniform electric field
(1) $\vec{E} = (4\hat{i} + 5\hat{j} - 7\hat{k})$N/C,
(2) $\vec{E} = (-6\hat{i} + 4\hat{j} + 5\hat{k})$N/C.

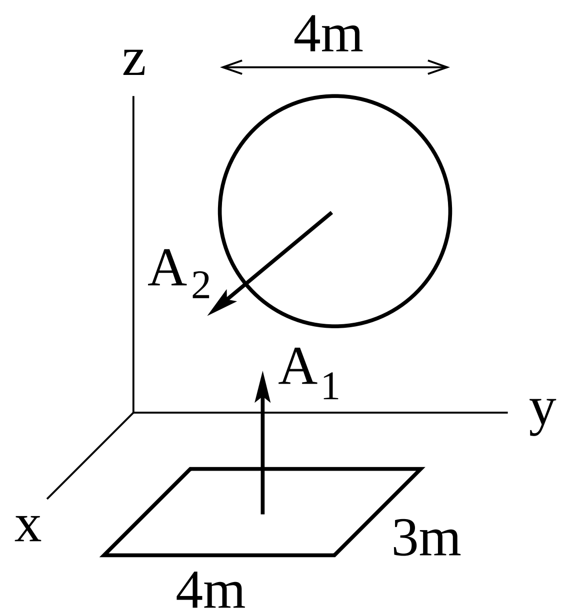
(a) Find the electric flux $\Phi_E^{(1)}$ through area A_1.

(b) Find the electric flux $\Phi_E^{(2)}$ through area A_2.



Unit Exam I: Problem #2 (Fall ’15)

Consider two plane surfaces (of rectangular and a circular shape) with area vectors $\vec{A}_1$ pointing in positive z-direction) and $\vec{A}_2$ pointing in positive x-direction.
The region is filled with a uniform electric field
(1) $\vec{E} = (4\hat{i} + 5\hat{j} - 7\hat{k})$N/C,
(2) $\vec{E} = (-6\hat{i} + 4\hat{j} + 5\hat{k})$N/C.
(a) Find the electric flux $\Phi_E^{(1)}$ through area A_1.
(b) Find the electric flux $\Phi_E^{(2)}$ through area A_2.



Solution:

(1a) $\Phi_E^{(1)} = \vec{E} \cdot \vec{A}_1 = (-7\mathrm{N/C})(12.0\mathrm{m}^2) = -84.0\mathrm{Nm}^2/\mathrm{C}.$

Unit Exam I: Problem #2 (Fall ’15)

Consider two plane surfaces (of rectangular and a circular shape) with area vectors $\vec{A}_1$ pointing in positive z-direction) and $\vec{A}_2$ pointing in positive x-direction.
The region is filled with a uniform electric field
(1) $\vec{E} = (4\hat{i} + 5\hat{j} - 7\hat{k})$N/C,
(2) $\vec{E} = (-6\hat{i} + 4\hat{j} + 5\hat{k})$N/C.
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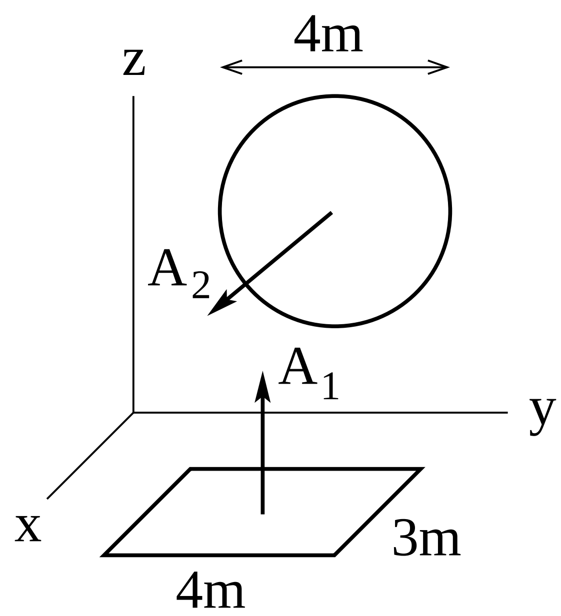

Solution:

(1a) $\Phi_E^{(1)} = \vec{E} \cdot \vec{A}_1 = (-7\text{N/C})(12.0\text{m}^2) = -84.0\text{Nm}^2/\text{C}.$

(1b) $\Phi_E^{(2)} = \vec{E} \cdot \vec{A}_2 = (4\text{N/C})(12.6\text{m}^2) = 50.4\text{Nm}^2/\text{C}.$

Unit Exam I: Problem #2 (Fall ’15)

Consider two plane surfaces (of rectangular and a circular shape) with area vectors $\vec{A}_1$ pointing in positive z-direction) and $\vec{A}_2$ pointing in positive x-direction.
The region is filled with a uniform electric field

(1) $\vec{E} = (4\hat{i} + 5\hat{j} - 7\hat{k})$N/C,

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(a) Find the electric flux $\Phi_E^{(1)}$ through area A_1.

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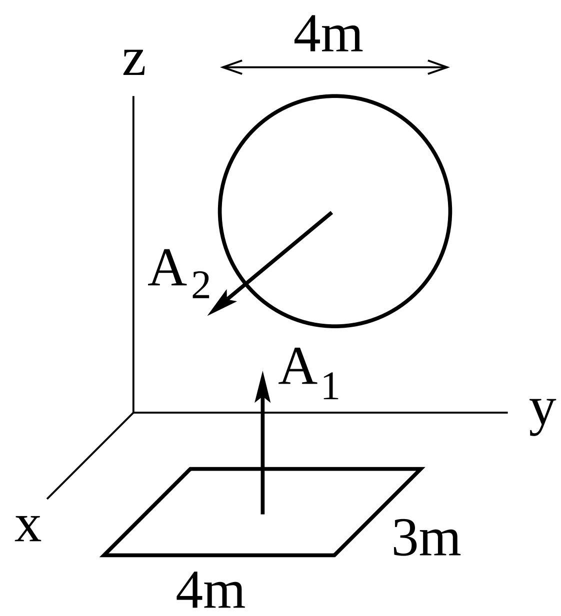

Solution:

(1a) $\Phi_E^{(1)} = \vec{E} \cdot \vec{A}_1 = (-7\mathrm{N/C})(12.0\mathrm{m}^2) = -84.0\mathrm{Nm}^2/\mathrm{C}.$

(1b) $\Phi_E^{(2)} = \vec{E} \cdot \vec{A}_2 = (4\mathrm{N/C})(12.6\mathrm{m}^2) = 50.4\mathrm{Nm}^2/\mathrm{C}.$

(2a) $\Phi_E^{(1)} = \vec{E} \cdot \vec{A}_1 = (5\mathrm{N/C})(12.0\mathrm{m}^2) = 60.0\mathrm{Nm}^2/\mathrm{C}.$

Consider two plane surfaces (of rectangular and a circular shape) with area vectors $\vec{A}_1$ pointing in positive z-direction) and $\vec{A}_2$ pointing in positive x-direction.
The region is filled with a uniform electric field
(1) $\vec{E} = (4\hat{i} + 5\hat{j} - 7\hat{k})$N/C,
(2) $\vec{E} = (-6\hat{i} + 4\hat{j} + 5\hat{k})$N/C.
(a) Find the electric flux $\Phi_E^{(1)}$ through area A_1.
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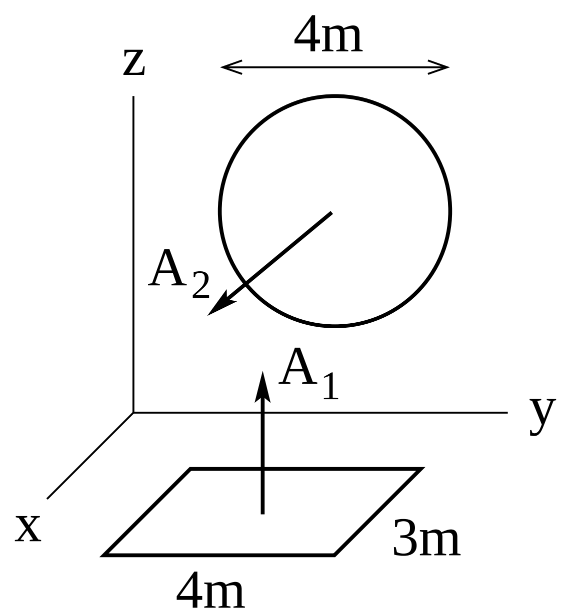

Solution:

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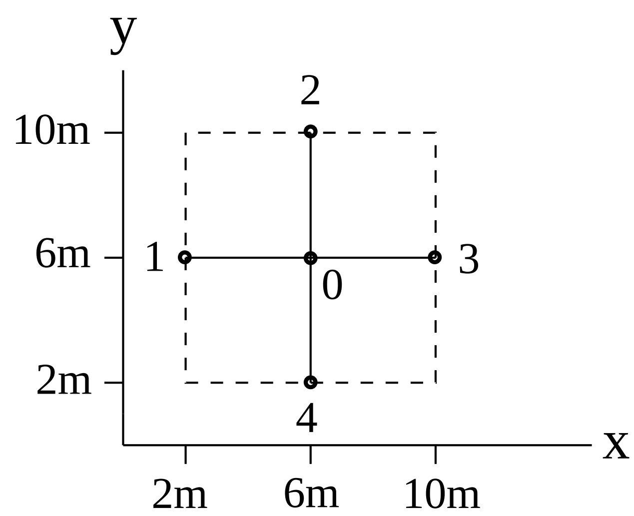
(1b) $\Phi_E^{(2)} = \vec{E} \cdot \vec{A}_2 = (4\mathrm{N/C})(12.6\mathrm{m}^2) = 50.4\mathrm{Nm}^2/\mathrm{C}.$

(2a) $\Phi_E^{(1)} = \vec{E} \cdot \vec{A}_1 = (5\mathrm{N/C})(12.0\mathrm{m}^2) = 60.0\mathrm{Nm}^2/\mathrm{C}.$

(2b) $\Phi_E^{(2)} = \vec{E} \cdot \vec{A}_2 = (-6\mathrm{N/C})(12.6\mathrm{m}^2) = -75.6\mathrm{Nm}^2/\mathrm{C}.$

Unit Exam I: Problem #3 (Fall '15)

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\mathrm{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\mathrm{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
(a) If the electric potential vanishes at point 0, what are the electric potentials at points 1, 2, 3, 4?
(b) If a proton ($m = 1.67 \times 10^{-27}$kg, $q = 1.60 \times 10^{-19}$C) is released from rest at point 0, toward which point will it start moving?
(c) What will be the kinetic energy of the proton when it gets there?



Unit Exam I: Problem #3 (Fall '15)

Consider a region of space with a uniform electric field
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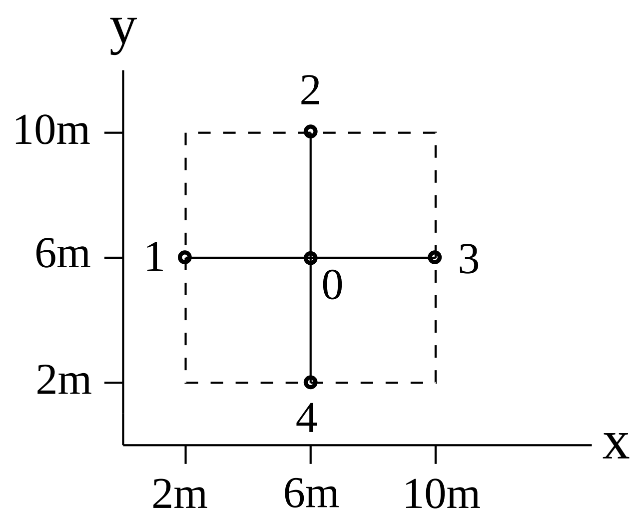

Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\mathrm{V},\ V_3 = 0,\ V_4 = +4.8\mathrm{V}.$

Unit Exam I: Problem #3 (Fall '15)

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\mathrm{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\mathrm{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
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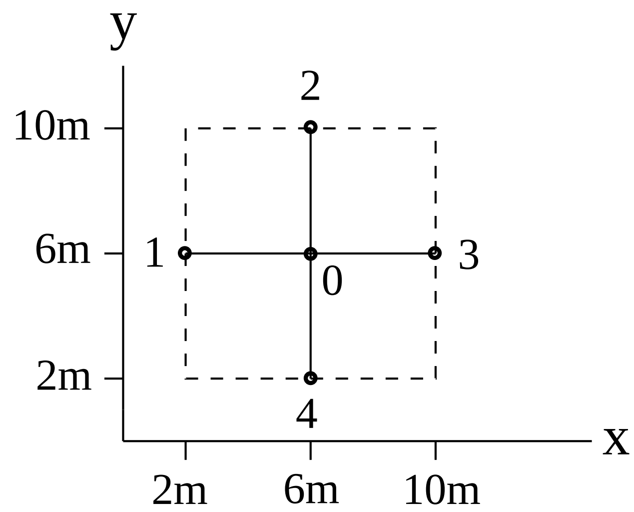
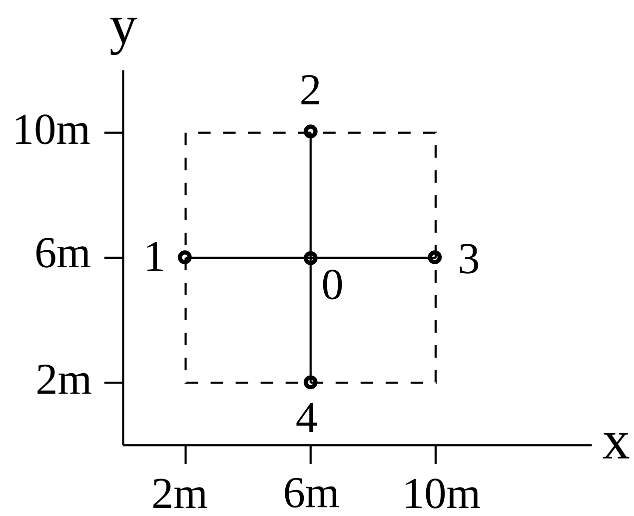


Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\mathrm{V},\ V_3 = 0,\ V_4 = +4.8\mathrm{V}.$

(1b) $\mathbf{F} = q\mathbf{E}$ (toward point 2).

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\mathrm{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\mathrm{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
(a) If the electric potential vanishes at point 0, what are the electric potentials at points 1, 2, 3, 4?
(b) If a proton ($m = 1.67 \times 10^{-27}$kg, $q = 1.60 \times 10^{-19}$C) is released from rest at point 0, toward which point will it start moving?
(c) What will be the kinetic energy of the proton when it gets there?



Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\mathrm{V},\ V_3 = 0,\ V_4 = +4.8\mathrm{V}.$

(1b) $\mathbf{F} = q\mathbf{E}$ (toward point 2).

(1c) $\Delta V = (V_2 - V_0) = -4.8\mathrm{V},$
$\Delta U = q\Delta V = -7.68 \times 10^{-19}\mathrm{J},$
$K = -\Delta U = +7.68 \times 10^{-19}\mathrm{J}.$

Unit Exam I: Problem #3 (Fall ’15)

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\text{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\text{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
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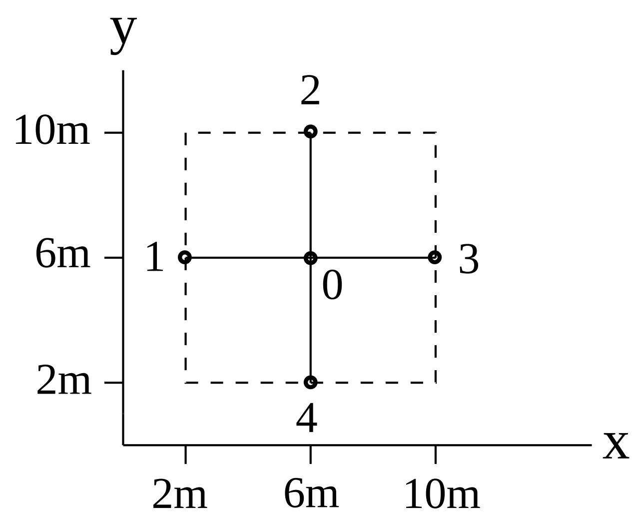


Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\text{V},\ V_3 = 0,\ V_4 = +4.8\text{V}.$

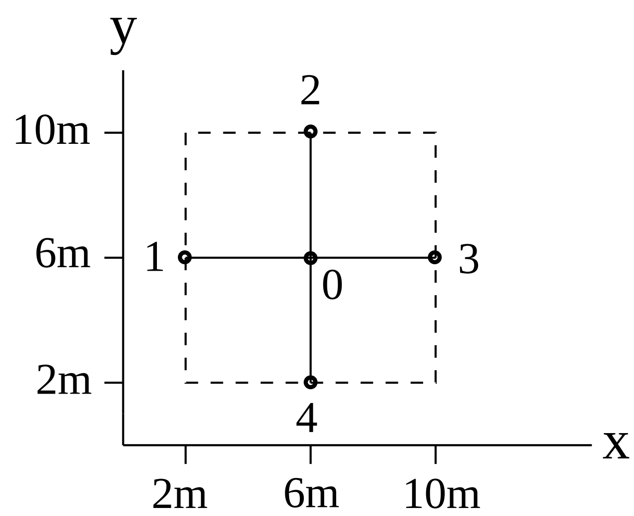
(1b) $\mathbf{F} = q\mathbf{E}$ (toward point 2).

(1c) $\Delta V = (V_2 - V_0) = -4.8\text{V},$
$\Delta U = q\Delta V = -7.68 \times 10^{-19}\text{J},$
$K = -\Delta U = +7.68 \times 10^{-19}\text{J}.$

(2a) $V_1 = 2.4\text{V},\ V_2 = 0,\ V_3 = -2.4\text{V},\ V_4 = 0.$

Unit Exam I: Problem #3 (Fall ’15)

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\mathrm{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\mathrm{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
(a) If the electric potential vanishes at point 0, what are the electric potentials at points 1, 2, 3, 4?
(b) If a proton ($m = 1.67 \times 10^{-27}$kg, $q = 1.60 \times 10^{-19}$C) is released from rest at point 0, toward which point will it start moving?
(c) What will be the kinetic energy of the proton when it gets there?



Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\mathrm{V},\ V_3 = 0,\ V_4 = +4.8\mathrm{V}.$

(1b) $\mathbf{F} = q\mathbf{E}$ (toward point 2).

(1c) $\Delta V = (V_2 - V_0) = -4.8\mathrm{V},$
$\Delta U = q\Delta V = -7.68 \times 10^{-19}\mathrm{J},$
$K = -\Delta U = +7.68 \times 10^{-19}\mathrm{J}.$

(2a) $V_1 = 2.4\mathrm{V},\ V_2 = 0,\ V_3 = -2.4\mathrm{V},\ V_4 = 0.$

(2b) $\mathbf{F} = q\mathbf{E}$ (toward point 3).

Unit Exam I: Problem #3 (Fall '15)

Consider a region of space with a uniform electric field
(1) $\mathbf{E} = 1.2\text{V/m}\,\hat{\mathbf{j}}$, (2) $\mathbf{E} = 0.6\text{V/m}\,\hat{\mathbf{i}}$. Ignore gravity.
(a) If the electric potential vanishes at point 0, what are the electric potentials at points 1, 2, 3, 4?
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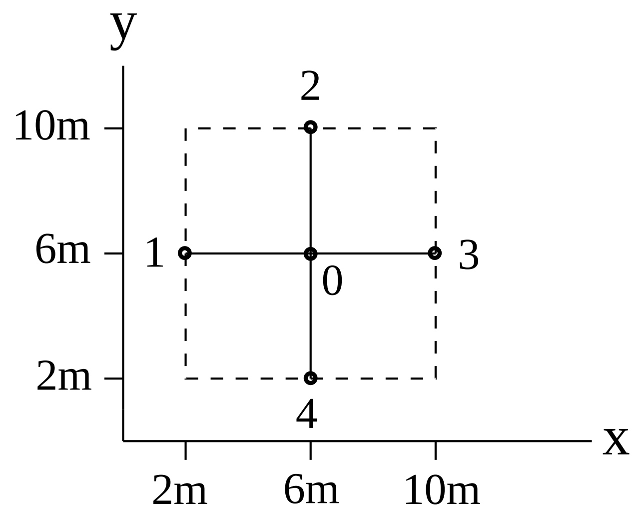
(c) What will be the kinetic energy of the proton when it gets there?



Solution:

(1a) $V_1 = 0,\ V_2 = -4.8\text{V},\ V_3 = 0,\ V_4 = +4.8\text{V}.$

(1b) $\mathbf{F} = q\mathbf{E}$ (toward point 2).

(1c) $\Delta V = (V_2 - V_0) = -4.8\text{V},$
$\Delta U = q\Delta V = -7.68 \times 10^{-19}\text{J},$
$K = -\Delta U = +7.68 \times 10^{-19}\text{J}.$

(2a) $V_1 = 2.4\text{V},\ V_2 = 0,\ V_3 = -2.4\text{V},\ V_4 = 0.$

(2b) $\mathbf{F} = q\mathbf{E}$ (toward point 3).

(2c) $\Delta V = (V_3 - V_0) = -2.4\text{V},$
$\Delta U = q\Delta V = -3.84 \times 10^{-19}\text{J},$
$K = -\Delta U = +3.84 \times 10^{-19}\text{J}.$