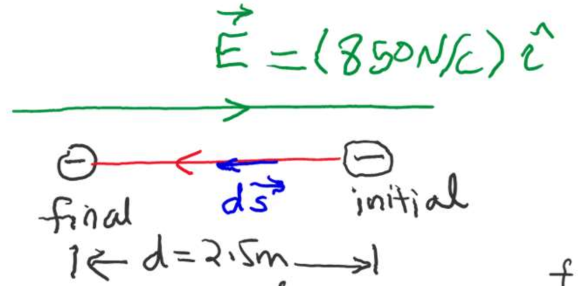
Q1 M2-112-12

An electron is released from rest at the origin in a uniform electric field that points in the positive x direction and has a magnitude of 850 N/C. What is the change in the electric potential energy of the electron-field system when the electron moves a distance of 2.5 m?

A) -3.4×10^{-16} J
B) $+3.4 \times 10^{-16}$ J
C) -1.4×10^{-16} J
D) $+1.4 \times 10^{-16}$ J
E) -5.4×10^{-16} J



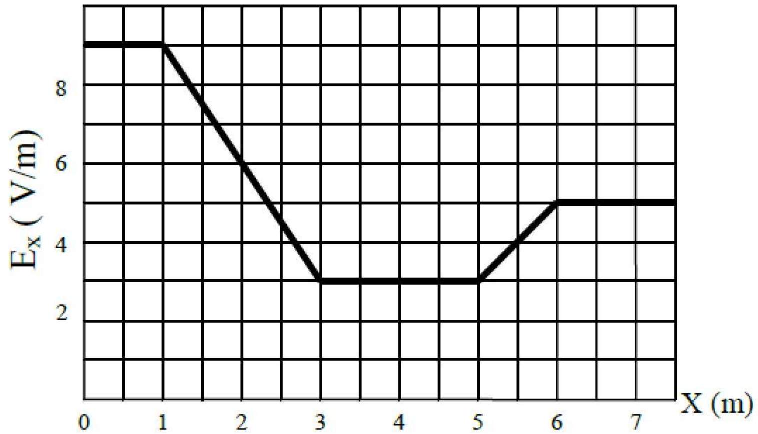
$$\Delta U = -W_{field} = -\int_i^f \vec{F}\cdot d\vec{s} = -\int_i^f q\vec{E}\cdot d\vec{s}$$

$$\Delta U = -\int_i^f (-e)E\,ds\cos 180^\circ = -\int_i^f eE\,ds = -eEd$$

$$\Delta U = -1.6\times10^{-19}(850)(2.5) = -3.4\times10^{-16}\text{ J}$$

Q2 M2-122-11

The figure shows a plot for the electric field E_x as a function of x. Find the magnitude of the potential difference between the points x = 2.00 m and x = 6.00 m.

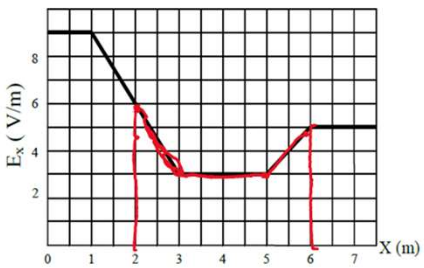


A) 14.5 V
B) 12.5 V
C) 10.0 V
D) 16.5 V
E) 11.0 V

$$\Delta V = -\int_i^f \vec{E} \cdot d\vec{s}$$

$$|\Delta V| = \left| \int_i^f E\,ds \right| = \text{area under the curve}$$

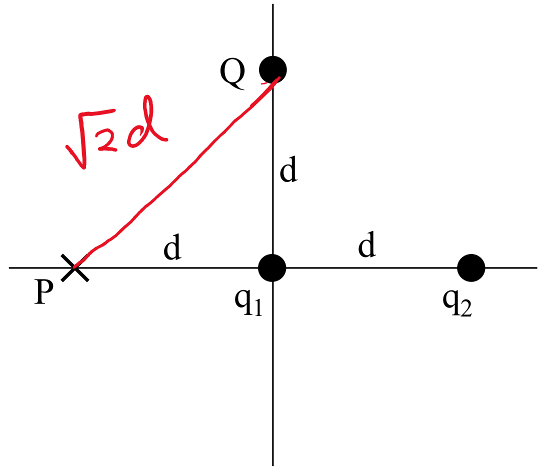
$$= 14.5\ \text{V}$$



Q3 M2-112-14

In the figure, particles with charges q_1 = + 10 µC and q_2 = – 30 µC are fixed in place with a separation of d = 24 cm. What is the value of Q that will make the potential equal zero at point P.

A) 7.1 µC
B) 5.1 µC
C) 10 µC
D) 3.5 µC
E) 4.5 µC



$$V = \frac{kq_1}{r_1} + \frac{kq_2}{r_2} + \frac{kQ}{r_3} = 0$$

$$\frac{kq_1}{d} + \frac{kq_2}{2d} + \frac{kQ}{\sqrt{2}d} = 0$$

$$Q = \sqrt{2}\left(-q_1 - \frac{q_2}{2}\right) = \sqrt{2}\left(-10\mu C - \left(-\frac{30\mu C}{2}\right)\right)$$

$$= \sqrt{2}(5\mu C) = 7.1\mu C$$

Q4 M2-112-15

In a certain region of space, the electric potential is given by: $V = -2.0\,xyz^2$, where V is in volts, and x, y, and z are in meters.

What is the magnitude of the electric field at the point with position vector $(2.0\hat{\imath} - 2.0\hat{\jmath} + 4.0\,\hat{k})$?

A) 111 V/m
B) 90.8 V/m
C) 16.1 V/m
D) 743 V/m
E) 571 V/m

$$E_x = -\frac{\partial V}{\partial x} = 2yz^2 = 2(-2)(4)^2 = -64 \text{ N/C}$$

$$E_y = -\frac{\partial V}{\partial y} = 2xz^2 = +64 \text{ N/C}$$

$$E_z = -\frac{\partial V}{\partial z} = 4xyz = 4(2)(-2)(4) = -64 \text{ N/C}$$

$$E = \sqrt{E_x^2 + E_y^2 + E_z^2} = 111 \text{ V}$$

Four identical charged particles, each of charge q = 30 μC, are fixed at the corner of a square of length 10.0 cm. How much work is required, by an external agent, to move one of them to infinity?

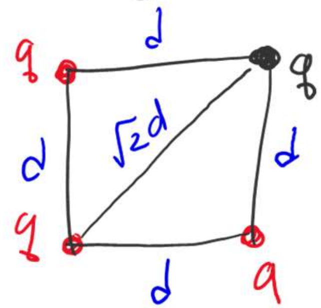
A) −219 J
B) +219 J
C) −510 J
D) +105 J
E) −105 J

$$\Delta K \,(\to 0) = -\Delta U + W_{app}$$

$$W_{app} = \Delta U = q\,\Delta V = q(V_f\,(\to 0) - V_i) = -q\left(\frac{kq}{d} + \frac{kq}{d} + \frac{kq}{\sqrt{2}d}\right)$$

$$W_{app} = -\frac{kq^2}{d}\left(2 + \frac{1}{\sqrt{2}}\right) = \frac{(9\times10^9)(30\times10^{-6})^2}{0.1}\left(2 + \frac{1}{\sqrt{2}}\right)$$

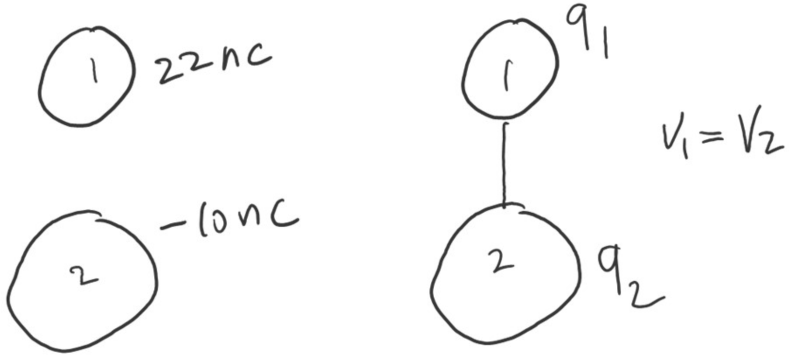
$$W_{app} = -219\,J$$



Q6 M2-132-13

Two metal spheres 1 and 2 with radii r_1= 1.0 cm and r_2 =2.0 cm carry charges q_1= +22 nC, and q_2= −10 nC, respectively. Initially both spheres are far apart. Then the spheres are connected by a thin wire, how much charge is lost by sphere 1 when the electrostatic equilibrium is reached?

A) +18 nC
B) −18 nC
C) +12 nC
D) −12 nC
E) +14 nC



$V_1 = V_2$

$\frac{kq_1}{R_1} = \frac{kq_2}{R_2}$

$q_1 + q_2 = 22nC - 10nC = 12nC$

$\frac{q_1}{0.01} = \frac{q_2}{0.02} \Rightarrow 2q_1 = q_2 \Longrightarrow 3q_1 = 12nC \Rightarrow q_1 = 4nC$

$q_2 = 8nC$

charge lost by sphere 1 is $22nC - 4nC = 18nC$