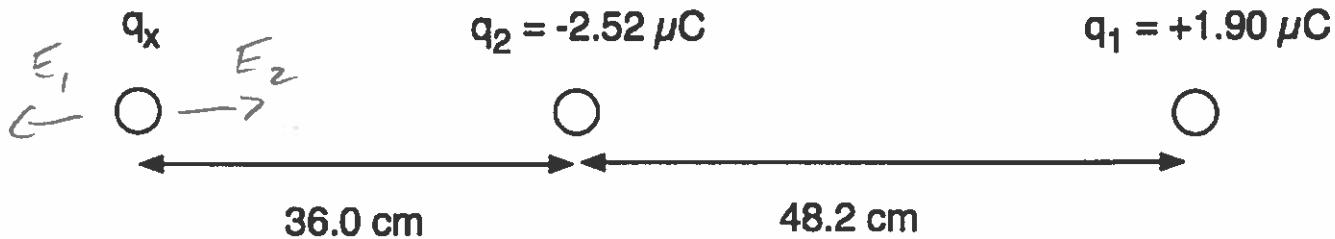


Sp 20 IA #1

Three charges are fixed in place along the x-axis as shown below.

- If the electric force on charge q_x is 0.255 N in the $-x$ direction, what is the charge q_x ?
- Assume the charge q_2 is at the origin. At what value of x will charge q_x feel no net electric force, besides infinity?



At location of q_x , $\vec{E} = +|\vec{E}_2| - |\vec{E}_1|$

$$|\vec{E}_1| = \frac{(9 \times 10^9)(1.90 \times 10^{-6})}{0.842^2} = 24120 \text{ N/C}$$

$$|\vec{E}_2| = \frac{(9 \times 10^9)(2.52 \times 10^{-6})}{36.0^2} = 175,000 \text{ N/C}$$

$$E_{\text{tot}} = 175,000 - 24120 = +150,880 \text{ N/C, } +x \text{ dir}$$

Since F_E points opposite \vec{E} , q_x must be negative

$$|q_x| = \frac{|F_E|}{|\vec{E}|} = \frac{0.255}{150,880} = \boxed{-1.69 \mu\text{C}}$$

- b) Must be to right of q_1 , since q_1 smaller.

$$|\vec{E}_2| = |\vec{E}_1|$$

$$\frac{x - .482}{x} = 0.8683$$

$$\frac{|q_2|}{x^2} = \frac{|q_1|}{(x - .482)^2}$$

$$x - .482 = .8683x$$

$$\frac{(x - .482)^2}{x^2} = \frac{q_2}{q_1}$$

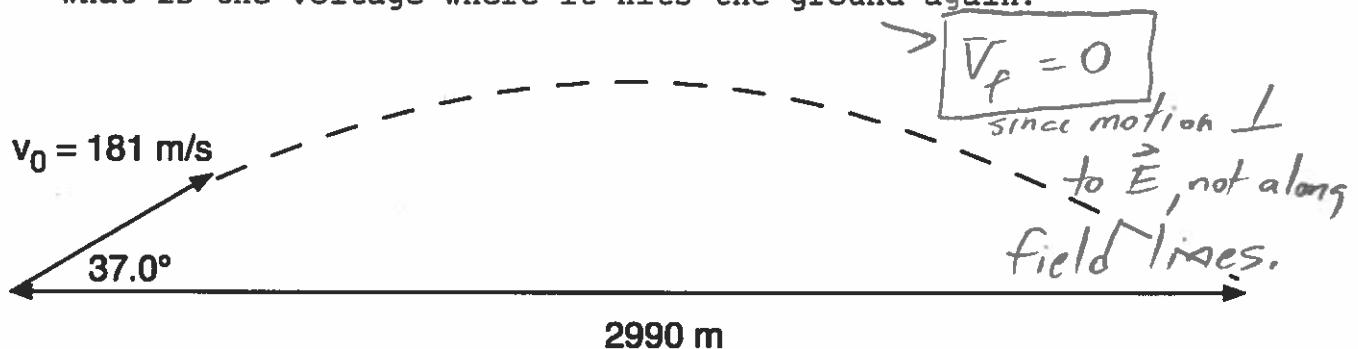
$$.482 = 0.1317x$$

$$\boxed{x = 3.66 \text{ m}}$$

Sp 20 IA #2

A $-25.0 \mu\text{C}$ charge with a mass of 427 grams is launched in a direction 37.0° above the ground as shown with an initial velocity of 181 m/s. It hits the ground again after traveling a horizontal distance of 2990 meters, and all of the motion takes place within a uniform electric field oriented vertically (either up or down). Assume only the electric force and gravity are relevant.

- What is the magnitude and direction of the uniform electric field in which this charge is immersed?
- If the voltage at the beginning of its motion is 0 Volts, what is the voltage where it hits the ground again?



W_E does no work in this problem since \vec{ds}, \vec{F}_E are perpendicular, so we must use 2-d motion equations.

$$\frac{x}{\Delta x} = 2990$$

$$v_{ox} = 144.55 \text{ m/s}$$

$$v_x = 144.55 \text{ m/s}$$

$$a_x = 0$$

$$t = ?$$

$$\frac{y}{\Delta y} = 0$$

$$v_{oy} = 108.92$$

$$v_y = ?$$

$$a_y = ?$$

$$t = ?$$

1) Use x to find t:

$$\Delta x = v_{ox} t + \frac{1}{2} a_x t^2$$

$$t = \frac{2990}{144.55} = 20.68 \text{ s}$$

2) Use t to find a_y :

F_E points down since

$$|a_y| > 9.8 \text{ m/s}^2$$

$$\Delta y = v_{oy} t + \frac{1}{2} a_y t^2$$

$$0 = (108.92)(20.68) + \frac{1}{2} a_y (20.68)^2$$

$$a_y = -\frac{(108.92)(20.68)}{\frac{1}{2}(20.68)^2} = -10.53 \text{ m/s}^2$$

$$-F_E - |mg| = ma \Rightarrow F_E = -ma - mg$$

$$\vec{E} = \frac{|\vec{F}_E|}{|q|} = \frac{.313}{25 \times 10^{-6}}$$

$$= 12500 \frac{\text{N}}{\text{C}}, \uparrow$$

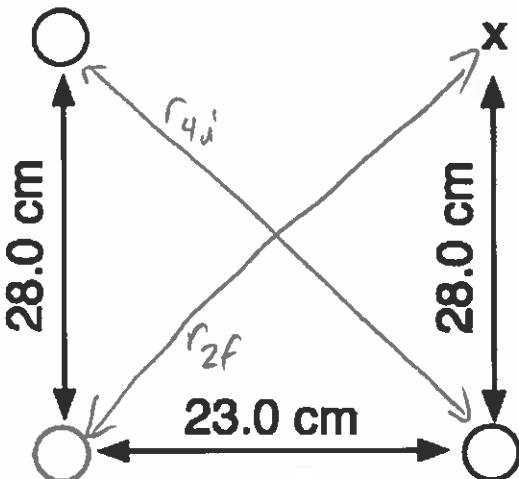
points up since $F_E \downarrow + q \downarrow$

$$F_E = (.427)(10.53 - 9.8) = 0.313 \text{ N}$$

Sp 20 1A #3

For the arrangement shown below, calculate the work done by the electric force as charges q_2 and q_4 remain fixed in place while charge q_5 moves from its initial location shown to point x , which is directly above its initial location.

$$q_4 = +4.14 \mu\text{C}$$



$$\begin{aligned}r_{4i} &= r_{2i} = \sqrt{23^2 + 28^2} \\&= 0.3624\end{aligned}$$

$$q_2 = -2.89 \mu\text{C}$$

$$q_5 = -5.28 \mu\text{C}$$

$$\begin{aligned}V_i &= \frac{k_c q_2}{r_{2i}} + \frac{k_c q_4}{r_{4i}} = \frac{(9 \times 10^9)(-2.89 \times 10^{-6})}{.23} + \frac{(9 \times 10^9)(4.14 \times 10^{-6})}{.3624} \\&= -113087 + 102815 = -10272 \text{ Volts}\end{aligned}$$

$$\begin{aligned}V_f &= \frac{(9 \times 10^9)(-2.89 \times 10^{-6})}{.3624} + \frac{(9 \times 10^9)(4.14 \times 10^{-6})}{.23} \\&= -71772 + 162000 = +90228 \text{ Volts}\end{aligned}$$

$$W_E = -q_5 \Delta V = -(-5.28 \times 10^{-6})(90228 - (-10272))$$

$$= \boxed{10.531 \text{ J}}$$