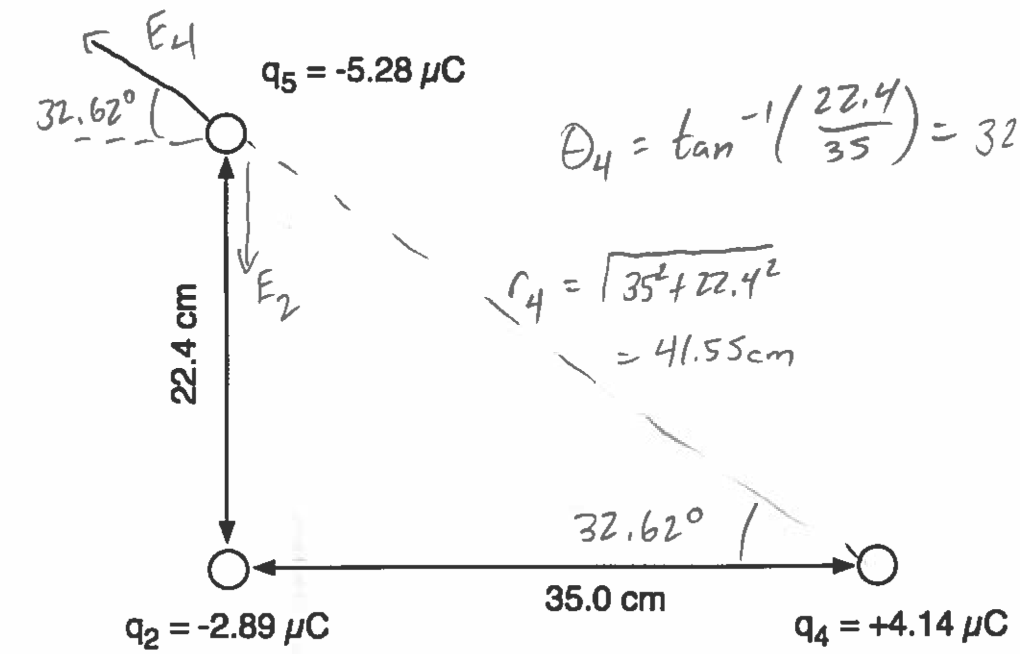
Sp20 IC #1

A 244-gram mass (q_5) is located in the vicinity of two other charges as shown below.

a) What is the magnitude and direction of the electric field at the location of charge q_5 due to the other charges?

b) What is the magnitude and direction of the acceleration of charge q_5 as a result of the electric force it feels?



$$\theta_4 = \tan^{-1}\left(\frac{22.4}{35}\right) = 32.62°$$

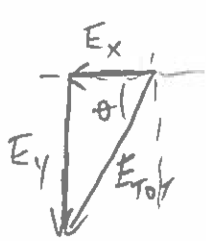
$$r_4 = \sqrt{35^2 + 22.4^2} = 41.55\,\text{cm}$$

$$|E_2| = \frac{k_c q_2}{r_2^2} = \frac{(9\times10^9)(2.89\times10^{-6})}{.224^2} = 5.184\times10^5\ \frac{N}{C},\ -y$$

$$|E_4| = \frac{k_c q_4}{r_4^2} = \frac{(9\times10^9)(4.14\times10^{-6})}{.4155^2} = 2.158\times10^5\ \frac{N}{C},\ 32.62°\text{ above } -x$$

$$E_{TOT,x} = E_{2x} + E_{4x} = 0 - 1.818\times10^5 = -1.818\times10^5$$

$$E_{TOT,y} = E_{2y} + E_{4y} = -5.184\times10^5 + 1.163\times10^5 = -4.021\times10^5$$



$$E_{TOT} = \sqrt{E_x^2 + E_y^2} = \boxed{4.41\times10^5\ \frac{N}{C}}$$

$$\theta = \tan^{-1}\left(\frac{4.021}{1.818}\right) = \boxed{65.7°\text{ below } -x}$$

b) $$|a| = \frac{qE}{m} = \frac{(5.28\times10^{-6})(4.41\times10^5)}{.244} = \boxed{9.54\ m/s,\ 65.7°\text{ above } +x}$$

opp. dir of $\vec{E}$ since q_5 −

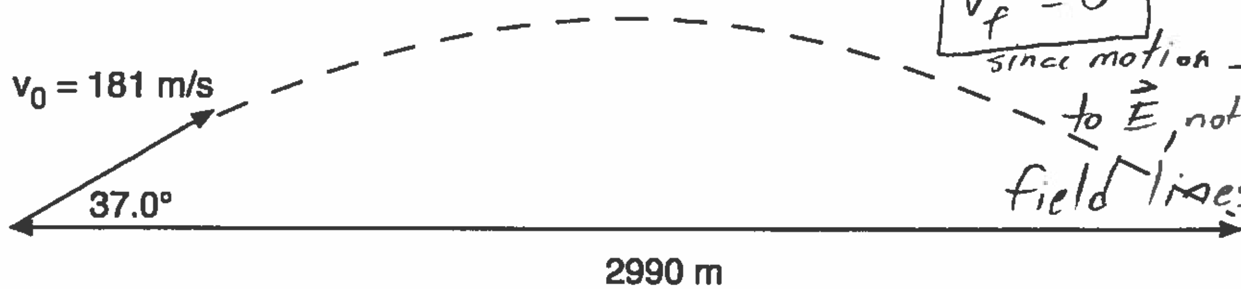
Sp 20 1C #2

A -25.0 μC 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.

a) What is the magnitude and direction of the uniform electric field in which this charge is immersed?

b) If the voltage at the beginning of its motion is 0 Volts, what is the voltage where it hits the ground again?

$\boxed{V_f = 0}$ since motion $\perp$ to $\vec{E}$, not along field lines.



W_E does no work in this problem since $\vec{\Delta s}$, $\vec{F_E}$ are perpendicular, so we must use 2-d motion equations.

x	y
$\Delta x = 2990$	$\Delta y = 0$
$V_{0x} = 144.55\ m/s$	$V_{0y} = 108.92$
$V_x = 144.55\ m/s$	$V_y = ?$
$a_x = 0$	$a_y = ?$
$t = ?$	$t = ?$

1) Use x to find t:

$$\Delta x = v_{0x} t + \cancel{\tfrac{1}{2} a_x t^2}^{\,0}$$

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

2) Use t to find a_y:

$$\Delta y = V_{0y} t + \tfrac{1}{2} a_y t^2$$

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

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

F_E points down since $|a_y| > 9.8\ m/s^2$

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

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

$$\vec{E} = \frac{|F_E|}{|q|} = \frac{.313}{25\times10^{-6}} = \boxed{12500\ \frac{N}{C}, \uparrow}$$

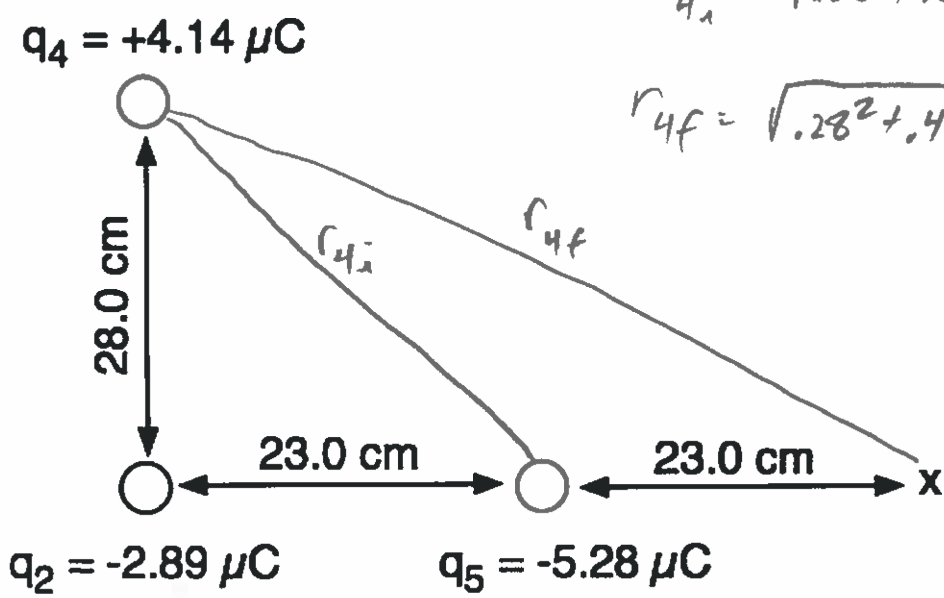
points up since $F_E \downarrow$ + q −

Sp20 1c #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 to the right of its initial location.

$$r_{4i} = \sqrt{.28^2 + .23^2} = 0.3624 \text{ m}$$

$$r_{4f} = \sqrt{.28^2 + .46^2} = 0.5385 \text{ m}$$



$$V_i = \frac{k_c q_2}{r_{2i}} + \frac{k_c q_4}{r_{4i}} = \frac{(9\times10^9)(-2.89\times10^{-6})}{.23} + \frac{(9\times10^9)(4.14\times10^{-6})}{.3624}$$

$$= -113087 + 102815 = -10272 \text{ Volts}$$

$$V_f = \frac{(9\times10^9)(-2.89\times10^{-6})}{.46} + \frac{(9\times10^9)(4.14\times10^{-6})}{.5385}$$

$$= -56543 + 69192 = 12649 \text{ Volts}$$

$$W_E = -q_5(V_f - V_i)$$

$$= -(-5.28\times10^{-6})(12649 - (-10272))$$

$$= \boxed{0.121 \text{ J}}$$