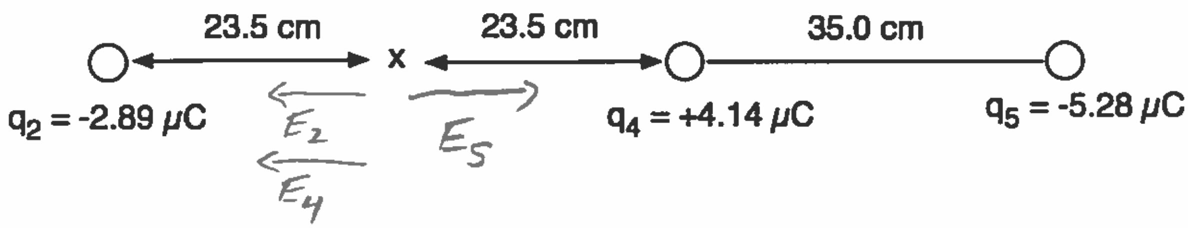
Sp 2010 #1

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

a) Find the magnitude and direction of the electric field at the location marked x.

b) If a 1.25-kg mass with a charge of -6.10 μC were located at x, what would be the magnitude and direction of its acceleration?



a) $|\vec{E}_2| = \frac{(9\times10^9)(2.89\times10^{-6})}{.235^2} = 4.710\times10^5\ \frac{N}{C}$

$|\vec{E}_4| = \frac{(9\times10^9)(4.14\times10^{-6})}{.235^2} = 6.747\times10^5\ \frac{N}{C}$

$|\vec{E}_5| = \frac{(9\times10^9)(5.28\times10^{-6})}{.585^2} = 1.389\times10^5\ \frac{N}{C}$

$E_{TOT} = -|\vec{E}_2| - |\vec{E}_4| + |\vec{E}_5| = -1.01\times10^6\ \frac{N}{C}$

or $1.01\times10^6\ \frac{N}{C}$, $-x$ dir

b) $|a| = \left|\frac{q_x E}{m}\right| = \frac{(6.10\times10^{-6})(1.01\times10^6)}{1.25} = 4.91$

dir of $\vec{a}$ is opposite $\vec{E}$ since q_x negative

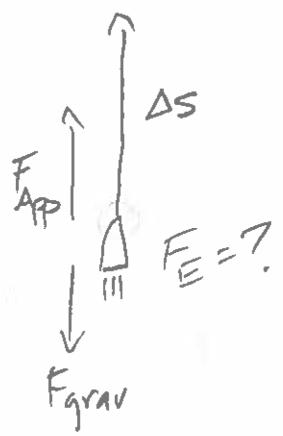
$a = 4.91\ m/s^2$, $+x$ dir

Sp 20 1D #2

A 3.50-kg model rocket's engines provide a constant upward (+y) applied force of 122 N. The rocket is also moving through a uniform electric field of 7850 N/C pointing in the -y direction. Assume only gravity, the applied force and the electric force are relevant in this problem. Starting from rest, the rocket moves upwards a total distance of 338 meters in 4.68 seconds, and the rocket has some charge q.

a) Find the value of q for the rocket, and be sure to indicate clearly whether it is positive or negative.

b) How much work is done by the electric force during this motion?



$$\Sigma W_F = W_{App} + W_{grav} + W_E = \Delta K$$

$$(122)(338) - (3.50)(9.8)(338) + W_E = \tfrac{1}{2}(3.5)v^2$$

$\Delta y = 338$

$v_{0y} = 0$

$t = 4.68\,s$

$$\Delta y = \tfrac{1}{2}(v + v_0)t, \quad v_0 = 0$$

$$338 = \tfrac{1}{2}v(4.68)$$

$$v = 144.4\ m/s$$

$$41236 - 11593 + W_E = 36510$$

$$\Rightarrow W_E = 6867\ J$$

Since W_E +, F_E points ↑

Since $\vec{E}$ points down, opposite F_E, q must be negative

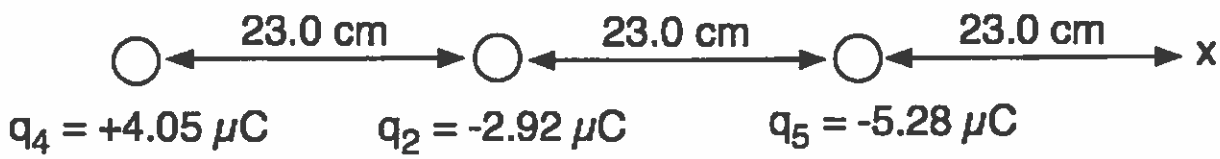
$$6867 = +|qE\Delta s| = q(7850)(338)$$

$$|q| = 2.59 \times 10^{-3}\ C \rightarrow \boxed{q = -2.59 \times 10^{-3}\ C}$$

b) See above, $\boxed{W_E = 6870\ J}$

Sp 20 ID #3

Three charges are arranged in a line as shown below. Assume only the electric force does any work in this problem. Charges q_2 and q_4 remain fixed in place throughout this problem. Charge q_5 has a mass of 35.0 grams and is initially at rest, but it accelerates in response to the electric force acting upon it, moving 23.0 cm in the +x direction to a final location marked by x in the diagram below. What is the speed of charge q_5 when it reaches that final location?



$$V_i = \frac{k_c q_4}{r_{4i}} + \frac{k_c q_2}{r_{2i}} = \frac{(9\times10^9)(4.05\times10^{-6})}{.46\,m} + \frac{(9\times10^9)(-2.92\times10^{-6})}{.23}$$

$$= 79239 - 114261 = -35022 \text{ Volts}$$

$$V_f = \frac{(9\times10^9)(4.05\times10^{-6})}{0.69} + \frac{(9\times10^9)(-2.92\times10^{-6})}{.46}$$

$$= 52826 - 57130 = -4304 \text{ Volts}$$

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

$$= -(-5.28\times10^{-6})(-4304-(-35022))$$

$$= (5.28\times10^{-6})(30718) = 0.1622 \text{ J}$$

$$\Sigma W_F = W_E = \Delta K$$

$$0.1622 = \tfrac{1}{2}(.035)v^2 - 0$$

$$\Rightarrow \boxed{v = 3.04 \text{ m/s}}$$