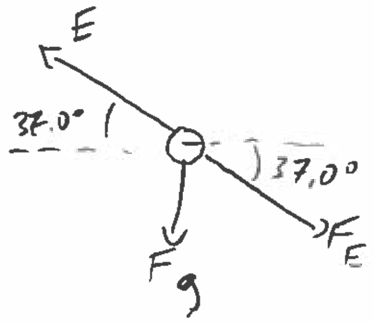
Sp 20 1[redacted] #1
E

An experimenter is attempting to hold a 3.15 kg ball in place. The ball has a -424 μC charge on it, and the ball is immersed in an electric field of magnitude 87500 N/C, pointing in a direction 36.0° above the -x direction. What is the magnitude and direction of the applied force needed to hold the ball in place? Assume gravity, electric and applied forces are all relevant.



$|F_g| = mg = 30.87\,N$, $-y$ dir

$|F_E| = qE = 37.1\,N$, $36°$ below $+x$

$|F_{App}| = ?$

$F_{g,x} = 0$ $\quad F_{g,y} = -30.87\,N$

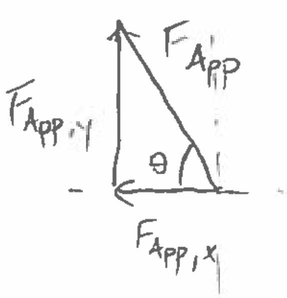
$F_{E,x} = 37.1\cos 36° = 30.01$ $\quad F_{E,y} = -37.1\sin 36° = -21.81\,N$

$F_{g,x} + F_{E,x} + F_{App,x} = 0$

$0 + 30.01 + F_{App,x} = 0 \Rightarrow F_{App,x} = -30.01$

$F_{g,y} + F_{E,y} + F_{App,y} = 0$

$-30.87 - 21.81 + F_{App,y} = 0 \Rightarrow F_{App,y} = +52.68$



$|F_{App}| = \sqrt{30.01^2 + 52.68^2} =$ **60.6 N**

$\theta = \tan^{-1}\left(\frac{52.86}{30.01}\right) =$ **60.3° above −x**

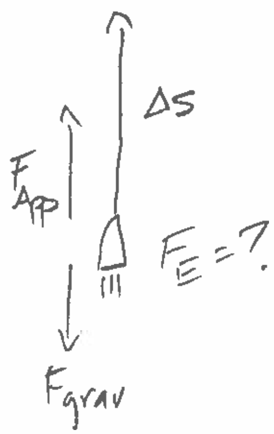
Sp20 1E #2

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 $\vec{F}_E$, q must be negative

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

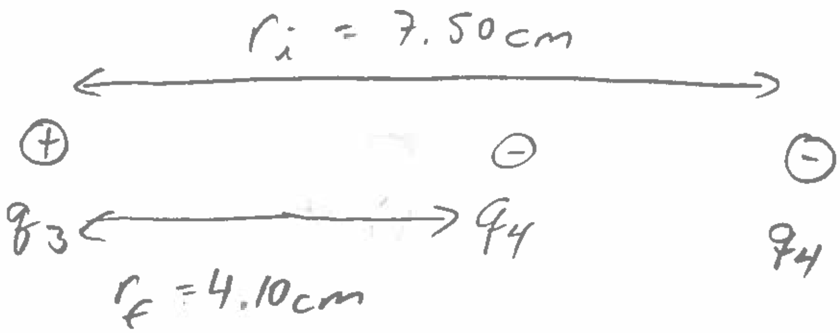
$$|q| = 2.59\times10^{-3}\ C \Rightarrow \boxed{q = -2.59\times10^{-3}\ C}$$

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

Sp 20 IE #3

Charge q_3 (3.00 μC) is fixed in place at the origin. Nearby, at a coordinate x = 7.50 cm, a charge q_4 (-4.80 μC) with a mass of 382 grams is initially at rest. An unknown applied force also acts in this problem in addition to the electric force while charge q_4 moves from its initial location at x = 7.50 cm to its final location at x = 4.10 cm. When it arrives at its final location, q_4 has a speed of 133 m/s in the -x direction.

How much work is done by the applied force during this motion?



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

$$V_i \text{ due to } q_3 = \frac{k_c q_3}{r_i} = \frac{(9\times10^9)(3\times10^{-6})}{.075} = 360{,}000 \text{ Volts}$$

$$V_f \text{ due to } q_3 = \frac{(9\times10^9)(3\times10^{-6})}{.041} = 658{,}537 \text{ Volts}$$

$$W_E = -q_4 \Delta V_3 = -(-4.80\times10^{-6})(658{,}537 - 360{,}000)$$

$$= +1.433 \text{ J}$$

$$\Delta K = \tfrac{1}{2}mv^2 - 0 = \tfrac{1}{2}(.382)(1.33)^2 = 0.338 \text{ J}$$

$$1.433 + W_{App} = 0.338$$

$$\boxed{W_{App} = -1.10 \text{ J}}$$