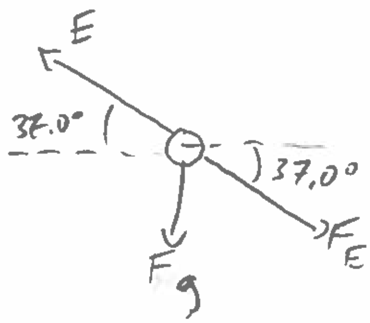
Sp20 1B #1

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 $+x$

$|F_{App}| = ?$

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

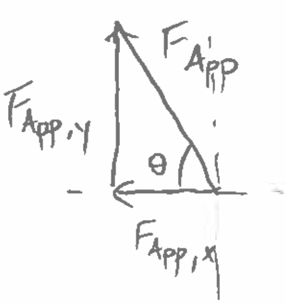
$F_{E,x} = 37.1\cos 36° = 30.01$ $\quad$ $F_{E,y} = -37.1\sin 36° = -21.81\ N$

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

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

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

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



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

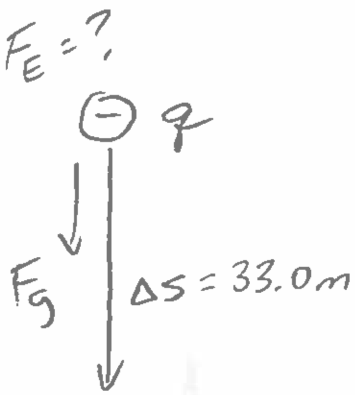
$\theta = \tan^{-1}\left(\frac{52.86}{30.01}\right) =$ **60.3° above −x**

Sp 20 1B #2

A ball with a charge of $-27.0\ \mu C$ and mass 375 grams is dropped from rest at a height 33.0 meters above the ground. The ball has a final speed of 40.4 m/s the instant before it hits the ground. Assume gravity and the electric force are the only relevant forces.

a) What is the magnitude and direction of the uniform electric field through which the ball moves?

b) If the voltage at ground level is exactly zero Volts, what is the voltage at the ball's initial position?



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

$$+|mg\Delta y| + W_E = \tfrac{1}{2}mv^2 - 0$$

$$+121.3 + W_E = 306.0$$

$$W_E = +184.7$$

Since W_E +, F_E points down

Since q −, $\vec{E}$ points opposite F_E, so $\vec{E}\ \uparrow$

$$W_E = |qE|\cdot|\Delta s|$$

$$184.7 = (27\times10^{-6})E(33.0) \Rightarrow \boxed{\vec{E} = 207{,}000\ \tfrac{N}{C},\ \uparrow}$$

b)

Since $\vec{E}$ points $\uparrow$, $V_f > V_i$

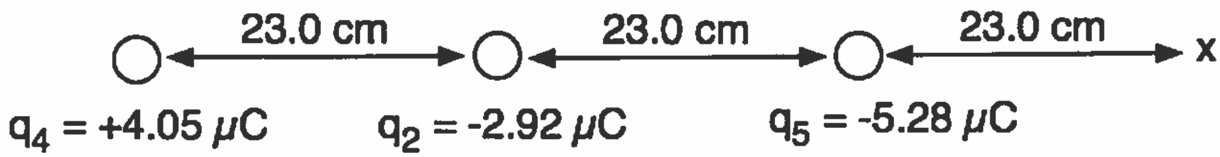
$$\Delta V = V_f - V_i = +(207{,}295)(33)$$

$$0 - V_i = +6.84\times10^6$$

$$\boxed{V_i = -6.84\times10^6\ \text{Volts}}$$

Sp 20 1B #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?



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

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

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

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

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

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

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

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

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

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