Name_____

Physics 111 Quiz #1, January 14, 2022

Please show all work, thoughts and/or reasoning in order to receive partial credit. The quiz is worth 10 points total.

I affirm that I have carried out my academic endeavors with full academic honesty.

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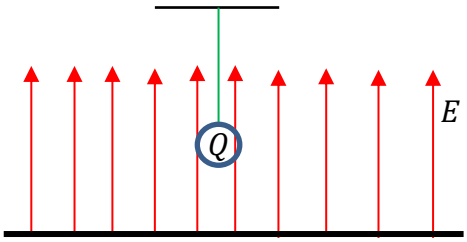
1. Suppose a square plate of charge is placed on the floor. The plate produces a constant upward electric field with magnitude $E = 100{,}000\frac{N}{C}$. Above the plate is an insulated sphere with mass $150g$ suspended from a $L = 0.5m$ cord. The sphere has a charge $Q = +3\mu C$ placed on it and it hangs motionless. What is the magnitude of the tension force in the cord?



$$F_{net,y} = F_T - F_W + F_e = ma_y = 0$$

$$F_T = F_W - F_e = mg - QE$$

$$F_T = \left(150g \times \frac{1kg}{1000g}\right) \times 9.8\frac{m}{s^2} - 3 \times 10^{-6}C \times 1 \times 10^5\frac{N}{C}$$

$$F_T = 1.17N$$

2. Suppose that we could vary the charge that we place on the sphere. Explain what the sign of the charge Q would have to be in order for the tension force in the cord to be three times the weight of the sphere? Be sure to explain/justify your answer fully.

To create a larger upward force of tension, we need to add to the downward force of the weight with the electric force. To get the electric force to point downward on the charge, the charge needs to be *negative* to feel a force opposite to the direction of the electric field.

3. What would the magnitude of the charge Q have to be in order for the tension in the cord to be three times the weight of the sphere?

$F_{net,y} = F_T - F_W - F_e = 3F_W - F_W - F_e = ma_y = 0$

$F_e = 2F_W \rightarrow QE = 2mg \rightarrow Q = \frac{2mg}{E} = \frac{2\times 0.15kg\times 9.8\frac{m}{s^2}}{1\times 10^5\frac{N}{C}} = 2.94\times 10^{-5}C = 29.4\mu C$

4. To create the charge in part 3, how many elementary charges would have had to be transferred to the sphere?

$Q = ne \rightarrow n = \frac{Q}{e} = \frac{-29.4\times 10^{-6}C}{-1.6\times 10^{-19}C} = 1.8\times 10^{14}$

5. Suppose two point-charges $+q$ and $-q$ are separated by a distance s. If point charge $+q$ is located at $(x, y) = (-\frac{s}{2}, 0)$ and point charge $-q$ is located at $(x, y) = (+\frac{s}{2}, 0)$, what is the electric field at the origin, $(x, y) = (0,0)$?

$E_{net} = E_+ + E_- = \frac{kq}{(s/2)^2} + \frac{kq}{(s/2)^2} = \frac{8kq^2}{s^2}$