Name_____

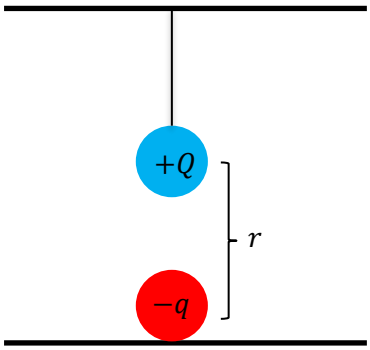
Physics 111 Quiz #1, January 10, 2025

Please show all work, thoughts and/or reasoning to receive partial credit. The quiz is worth 10 points total, and all parts may not be of equal weight.

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

_____

1. A point-charge $-q$ is placed at rest on a horizontal surface. A second point-charge $+Q$ is suspended from the ceiling by a light string directly above the first point-charge with a center-to-center separation of r between the point-charges. A sketch of the situation is shown below. What is the expression for the sum of the forces on point-charge $-q$? That is, write the symbolic equation for the forces that act on point-charge $-q$.



$$F_{net_{-q}} = F_N - F_W + F_e = m_{-q}a_y = 0$$

2. Due to the electrostatic attraction between point-charges $-q$ and Q, it is observed that point-charge $-q$ is just barely touching the horizontal surface for a certain value of $+Q$. What magnitude of the electric force on point-charge $-q$ would be required to just barely lift $-q$ from the horizontal surface? Assume the masses of point-charges $-q$ and $+Q$ are $m_{-q} = m_{+Q} = 25g$.

   Just barely touching means $F_N = 0$, so we have:

$$F_E - F_W = m_{-q}a_y = 0 \rightarrow F_e = F_W = m_{-q}g = \left(25g \times \frac{1kg}{1000g}\right) \times 9.8\frac{m}{s^2} = 0.245N$$

3. If the magnitude of point-charge $-q$ is $3nC$, what is the is the value of the point-charge $+Q$ that just lifts $-q$ from the table? Assume that the center-to-center separation between the two charges is $r = 10cm$.

   From Coulomb's law:

   $$F_e = k\frac{Q_1 Q_2}{r^2} = k\frac{qQ}{r^2} \rightarrow Q = \frac{r^2 F_e}{kq} = \frac{(0.1m)^2 \times 0.245N}{9 \times 10^9 \frac{Nm^2}{C^2} \times 3 \times 10^{-9} C}$$

   $$Q = 9.1 \times 10^{-5} C = 9.1 \times 10^4 nC$$

4. What is the magnitude of the tension force in the string connection point-charge $+Q$ to the ceiling?

   $$F_T - F_W - F_e = m_Q a_y = 0 \rightarrow F_T = F_e + F_W = 0.245N + \left(25g \times \frac{1kg}{1000g}\right) \times 9.8\frac{m}{s^2}$$

   $$F_T = 0.49N$$

5. Suppose that the string holding point-charge to the ceiling is cut. What is the magnitude of the initial acceleration of $+Q$?

   Cutting the string means $F_T = 0$.

   $$-F_W - F_e = m_Q a_y \rightarrow a_y = -\frac{(F_e + F_w)}{m_Q} = \frac{0.49N}{25g \times \frac{1kg}{1000g}} = -19.6\frac{m}{s^2}$$

   The magnitude of the initial acceleration of $+Q$ is $19.6\frac{m}{s^2}$.