Name_____

Physics 111 Quiz #1, September 16, 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. Two point-charges $q_1 = 3nC$ and $q_2 = unknown$ are placed along the x-axis. Point charge $q_1$is placed at a point $(x, y) = (-4,0)$ while point charge q_2 is placed at $(x, y) = (7,0)$, where the distances are measured in centimeters. With the two point-charges in this configuration, the net electric field at the origin $(x, y) = (0,0)$ is known to be zero. What are the magnitude and sign of the point charge q_2 that makes this possible?

   In order for the field to vanish somewhere between the two charges, $q_2$has to be *positive*.

   $$E_{net,P} = 0 = E_{1P} - E_{2P} = \frac{kq_1}{r_{1P}^2} - \frac{kq_2}{r_{2P}^2} \rightarrow q_2 = \left(\frac{r_{2P}}{r_{1P}}\right)^2 q_1$$

   $$q_2 = \left(\frac{7cm}{4cm}\right)^2 \times 3nC = 9.2nC$$

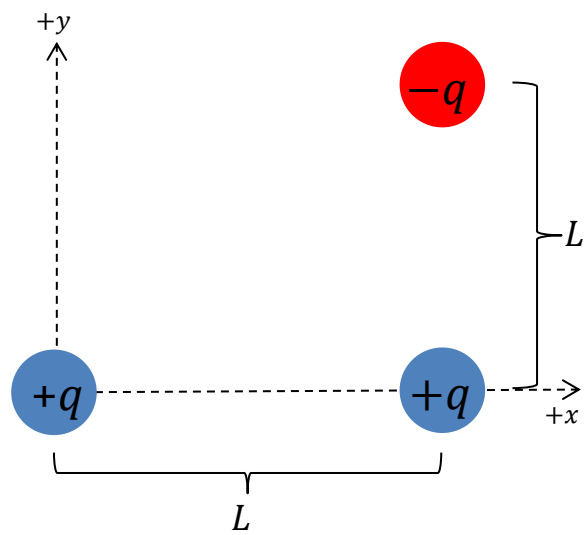
2. Suppose that point-charge q_2 is moved to a point $(x, y) = (2,0)$ along the x-axis, where the distances are still measured in centimeters. What, is the electric field at the origin in this case?

   $$E_P = E_{P1} - E_{P2} = \frac{kq_1}{r_{1P}^2} - \frac{kq_2}{r_{2P}^2} = 9 \times 10^9 \frac{Nm^2}{C^2}\left[\frac{3 \times 10^{-9}C}{(0.04m)^2} - \frac{9.2 \times 10^{-9}C}{(0.02m)^2}\right] = -1.9 \times 10^5 \frac{N}{C}$$

3. A $q_3 = -2nC$ point-charge is placed at the origin with the point charges configured as in part 2. What is the magnitude and direction of the electric force felt by q_3?

$F = qE = -2 \times 10^{-9}C \times -1.9 \times 10^{5}\frac{N}{C} = 3.8 \times 10^{-4}N$ in the positive direction.

4. Suppose that you have the situation shown below. Each point-charge has the same magnitude of charge, q, and the sign of each point-charge is shown in the figure. What is the net electric force on the point charge located at the origin?



$$F_{net,x} = -F_{q,q} + F_{-q,q,x} = -F_{q,q} + F_{-q,q}\cos\theta = -\frac{kq^2}{L^2} + \frac{kq^2}{2L^2}\cos 45 = -0.65\frac{kq^2}{L^2}$$

$$F_{net,y} = -F_{-q,q,y} = -F_{-q,q}\sin\theta = \frac{kq^2}{2L^2}\sin 45 = 0.35\frac{kq^2}{L^2}$$

$$F_{net} = \sqrt{F_{net,x}^2 + F_{net,y}^2} = \sqrt{(-0.65)^2 + (0.35)^2}\frac{kq^2}{L^2} = 0.74\frac{kq^2}{L^2}$$

$\tan\phi = \frac{F_{net,y}}{F_{net,x}} \rightarrow \phi = \tan^{-1}\left(\frac{F_{net,y}}{F_{net,x}}\right) = \tan^{-1}\left(\frac{-0.35\frac{kq^2}{L^2}}{0.65\frac{kq^2}{L^2}}\right) = 28.3^0$ above the negative x-axis.