Name_____

Physics 121 Quiz #2, September 23, 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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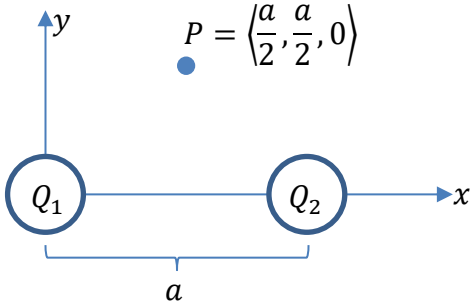
Consider to very long plastic rods each of length $L = 10m$ placed parallel to each other a distance $a = 10cm$ apart. The rods are oriented along the z-axis (which points into and out of the plane of the page) with the midpoint of the rods located at $z = 0$. Each rod has a charge $Q_1 = Q_2 = 3.2\mu C$.



1. What is the electric field (magnitude and direction) at a point $P = \langle \frac{a}{2}, \frac{a}{2}, 0 \rangle$ due to the rod with charge Q_1?

$$\vec{E}_1 = \langle \frac{kQ_1}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \cos\theta \, , \frac{kQ_1}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \sin\theta \, , 0 \rangle$$

$$r = \sqrt{\left(\frac{a}{2}\right)^2 + \left(\frac{a}{2}\right)^2} = \frac{a}{\sqrt{2}} = \frac{0.1m}{\sqrt{2}} = 0.071m$$

$$\tan\theta = \frac{a/2}{a/2} = 1 \rightarrow \theta = \tan^{-1} 1 = 45^0$$

$$\vec{E}_1 = \langle \frac{kQ_1}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \cos\theta \, , \frac{kQ_1}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \sin\theta \, , 0 \rangle$$

$$\vec{E}_1 = \frac{9 \times 10^9 \frac{Nm^2}{C^2} \times 3.2 \times 10^{-6} C}{0.071m\sqrt{(0.071m)^2 + \left(\frac{10m}{2}\right)^2}} \langle \cos 45 \, , \sin 45 \, , 0 \rangle$$

$$\vec{E}_1 = \langle 5.7, 5.7, 0 \rangle \times 10^4 \frac{N}{C}$$

2. What is the electric field (magnitude and direction) at a point $P = \langle \frac{a}{2}, \frac{a}{2}, 0 \rangle$ due to the rod with charge Q_2?

$$\vec{E}_2 = \langle -\frac{kQ_2}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \cos\theta \, , \frac{kQ_2}{r\sqrt{r^2 + \left(\frac{L}{2}\right)^2}} \sin\theta \, , 0 \rangle$$

$$\vec{E}_2 = \frac{9 \times 10^9 \frac{Nm^2}{C^2} \times 3.2 \times 10^{-6} C}{0.071m\sqrt{(0.071m)^2 + \left(\frac{10m}{2}\right)^2}} \langle -\cos 45 \, , \sin 45 \, , 0 \rangle$$

$$\vec{E}_2 = \langle -5.7, 5.7, 0 \rangle \times 10^4 \frac{N}{C}$$

3. What is the net electric field at point $P = \langle \frac{a}{2}, \frac{a}{2}, 0 \rangle$ from rods with charges Q_1 and Q_2?

$$\vec{E}_{net} = \vec{E}_1 + \vec{E}_2 = \langle 5.7, 5.7, 0 \rangle \times 10^4 \frac{N}{C} + \langle -5.7, 5.7, 0 \rangle \times 10^4 \frac{N}{C} = \langle 0, 1.15, 0 \rangle \times 10^5 \frac{N}{C}$$

4. Suppose that a point charge $q_3 = -4\mu C$ were placed at point $P = \langle \frac{a}{2}, \frac{a}{2}, 0 \rangle$. What force would q_3 experience?

$$\vec{F}_{q_3} = q_3 \vec{E}_{net} = -4 \times 10^{-6} C \times \langle 0, 1.15, 0 \rangle \times 10^5 \frac{N}{C} = \langle 0, -0.456, 0 \rangle N$$