Point Charges Two point charges are located on the x-axis. Charge $q1 = q$ is located at the origin and charge $q2 = 2q$ is located at $x = d$, where $q > 0$ and $d > 0$. Consider possible locations of a third positive point charge $q3 > 0$.

1. Draw a good diagram of the situation.
2. Place the third charge at least three different locations and draw the force vectors on the third charge at each location. Include at least one location that is not on the x-axis.
3. Where is it possible for the net force on the third charge to be zero?
4. Is it possible for the net force on the third charge to be zero for locations not on the x-axis? Why or why not?
5. Write an equation for the net force on the third charge at a location where it is possible for the net force on the third charge to be zero using variables clearly defined in the diagram.

Force Diagrams For two of the positions from the Point Charges Problem where the net force is not zero, including one which is not on the x-axis, clearly identify what you have picked for the location of the third charge, and draw the force diagram, including an arrow for the net force. Use a different color for the net force. Calculate the net force (magnitude and direction) on the third charge due to the other two charges. Use the following values.

1. $q1 = 3.00x10^-6C$
2. $q2 = 9.00x10^-6C$
3. $q3 = 1.00x10^-6C$
4. $d = 2.00cm$
5. $k = 9.00x10^9 \frac{Nm^2}{C}$

[0]Select problems may be modified from PH 213 course textbook; Knight Physics for Scientists and Engineers, or past TAs

Name (please print) _____

Homework Problem - Due 10/4/2018

One-hundred and eight electrons are equally spaced around a circle of radius 10.0 cm.

A. What is the electric field at the center of the circle? Explain your reasoning.

B. What would be the electric field be at the same location if one electron was removed? Label the location of electron before it was removed as point P.

Required Solution Format

1. **Understand the problem and devise a plan**

   a. **Read and translate the problem statement. Solution:**

   $$r = 10.0cm$$
   $$N = 108$$
   $$\vec{E} = ?$$

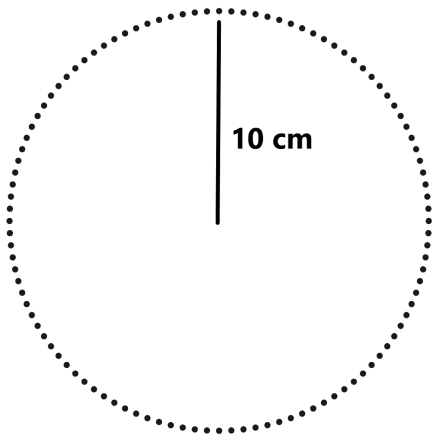
   b. **Determine applicable concepts and/or laws and assumptions and/or simplifications. Solution:**

   Treat all electrons as point particles.

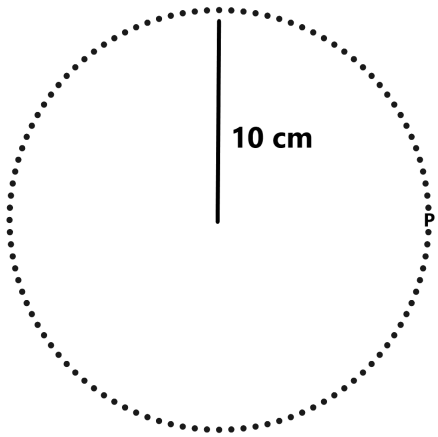
2. **Represent the problem physically and mathematically**

   a. **Represent physically. Solution:**

   A.



B.



b. **Represent the concepts and/or laws mathematically. Solution:**

$$E = \sum_{i=1}^{i=108} \frac{Kq_i}{r_i^2}$$

3. **Solve for the unknown quantity (or quantities)**

   a. **Solve for the unknown quantity (or quantities) using algebra, geometry, trigonometry and/or calculus. (*Be sure to have 3 significant figures.*) Solution:**

      A. Zero. There are an even number of electrons equally spread around the circle. Because of this we can make a symmetry argument that for every electron there is one directly opposite it with an electric field of equal but opposite strength. Thus when summed those two electric fields will cancel out providing no contribution to the overall electric field.

      B. Removing one electron leaves the opposite electron's electric field strength not canceled, while all the other pairs still cancel. So the field at the center will have the magnitude of one point charge, $\vec{E} = \frac{Ke}{r^2} = \frac{(9.0*10^9 \frac{Nm^2}{C^2})(1.60*10^{-19}C)}{(0.1m)^2} = 1.44 * 10^{-7} \frac{N}{C}$ and will point towards the electron opposite to P.

4. **Reflect. Is the answer reasonable? Does it make physical sense?**

   a. **Evaluate the result. Solution:**

      This solution makes sense because the symmetry of the problem balances out the contribution from all (Part A) or most (Part B) of the electrons, so we would expect to have no (Part A) or very little (Part B) electric field.