Week 6 Quiz

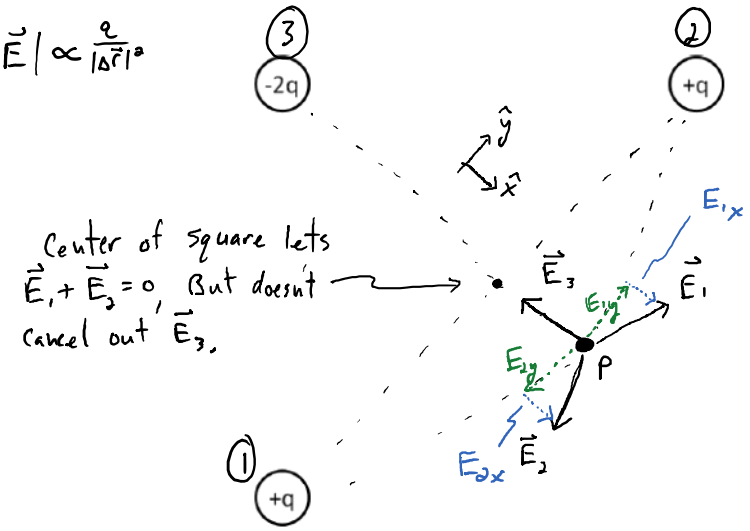
Tuesday, May 4, 2021 11:33 AM

Three charges are fixed on three of the corners of a square. A charge of –2q is placed in the upper left, charges of +q are placed on the upper right and lower left corners. **There are questions on both pages of this quiz**, all pertaining to this arrangement of charges. You are encouraged to use algebraic logic to solve these problems, however you are not expected to calculate exact answers.

(a) (4 pts) At how many locations near the charges would you find an electric field strength of zero N/C? On the diagram below indicate the approximate location(s) of the point(s). Explain how you determined the location(s) using written words, diagrams, algebraic equations, etc.

$\Sigma \vec{E} = \vec{E}_1 + \vec{E}_2 + \vec{E}_3 \stackrel{?}{=} 0$ ← for net $\vec{E}$ to be zero, the 3 electric field vectors must cancel each other out.

$|\vec{E}| \propto \frac{q}{|\Delta \vec{r}|^2}$



Center of square lets $\vec{E}_1 + \vec{E}_2 = 0$, but doesn't cancel out $\vec{E}_3$.

Point P allows $E_{1y} + E_{2y} = 0$ but $E_{1x} + E_{2x} \neq 0$. That remaining x-component from 1 & 2 can cancel out $\vec{E}_3$ which is all in the $-\hat{x}$ direction.

1 location

Rubric

~~ Part (a) ~~
1 pt - Correct location
1.5 pts - Vector analysis
1.5 pts - Explain vector cancelation applied to this problem

~~ Part (b) ~~
1.5 pts - Ranking
1.5 pts - Net E directions
3 pts - Explanation using vector addition and component partial/complete cancelation

(b) (6 points) At each of the locations A, B, and C, sketch the electric field vector. Then rank the magnitude of the electric field at the following locations A, B, and C. Explain your ranking using written words, diagrams, algebraic reasoning, etc. Most of the points will be dedicated to your explanation! Point C is in the middle of the square. Point B is half way between the top two charges. Point A is equidistant, directly opposite point C on a diagonal line through the upper left charge.

Ranking $|\vec{E}_B| > |\vec{E}_C| > |\vec{E}_A|$

Reasoning: B has the largest electric field because both E_2 and E_3 point in the same direction and are relatively large. While E1 does contribute some cancelation in the horizontal direction, it is relatively smaller in magnitude. The electric field at point C is larger than A because the magnitude of E_3 is the same for both points, due to being the same distance from the charge, but in the case of point C, E_1 and E_2 completely cancel, leaving the resultant to be just the contribution from E_3. At point A, E_1 and E_2 have components opposite E_3, so the resultant of the summation has partial cancelation along the line E_3 lies on, resulting in a field smaller than that just from E_3.