Quiz 1, Physics 9C, Winter 2016

General Instructions: This quiz is closed book. Only a calculator is allowed. Please show all your work, and give units for all answers and on all graphs. Credit will only be given for complete solutions. The constant \( k \) in Coulomb’s law is \( k = 9 \cdot 10^9 \).

Three point charges lie along a vertical line as shown in the Figure. Find the magnitude and direction of the electric field this combination of charges produces at the point \( P \) on the \( x \) axis. Pay attention to the signs of the charges! If you prefer, you may give your answer in terms of \( \hat{x} \) and \( \hat{y} \) rather than magnitude + direction.

The directions of the 3 electric fields are shown sketched in the figure. Because \( \vec{Q}_1 = \vec{Q}_3 \) and the distances of \( \vec{Q}_1 \) and \( \vec{Q}_3 \) from \( P \) are equal \( |\vec{E}_1| = |\vec{E}_3| \) and it is clear \( \vec{E}_1 + \vec{E}_3 \) will point in the \(-y\) direction. Meanwhile, \( \vec{E}_2 \) is in the \(+x\) direction.

\[
\vec{E}_1 + \vec{E}_3 = -9 \cdot 10^9 \left(7 \cdot 10^{-9}\right) / \left(0.5^2\right) = \frac{3}{5} \hat{y} \text{ to get } y \text{ component}
\]

\[
\vec{E}_2 = 9 \cdot 10^9 \left(4 \cdot 10^{-9}\right) / \left(0.41^2\right) = 2.25 \cdot 10^7 \hat{x} \text{ to get } x \text{ component}
\]

This answer is sufficient.

\[
|\vec{E}_1 + \vec{E}_2 + \vec{E}_3| = 3.77 \cdot 10^7 \text{ N/C}
\]

Direction is \( 0.93 \) rad = \( 53^\circ \) below \( \hat{x} \) axis

\[
\tan^{-1} \left( \frac{3.02}{2.25} \right)
\]