First Midterm

Problem 2 Solution

Electric fields generated by every charge are.

3' $E_1 = \frac{kQ_1}{r_1^2}\hat{r}_1 = \frac{k\cdot 5.70nC}{r_1^2}\hat{r}_1 = \frac{k\cdot 5.70nC}{r_1^2}\left(\frac{\sqrt{2}}{2}\vec{i} - \frac{\sqrt{2}}{2}\vec{j}\right)$

3' $E_2 = \frac{kQ_2}{r_2^2}\hat{r}_2 = \frac{k\,2.75nC}{r_2^2}\hat{r}_2 = \frac{k\cdot 2.75nC}{r_2^2}\left(-\frac{\sqrt{2}}{2}\vec{i} - \frac{\sqrt{2}}{2}\vec{j}\right)$

3' $E_3 = \frac{kQ_3}{r_3^2}\hat{r}_3 = k\cdot\frac{-7.5nC}{r_3^2}\hat{r}_3 = \frac{k\cdot(-7.5nC)}{r_3^2}\left(\frac{\sqrt{2}}{2}\vec{i} + \frac{\sqrt{2}}{2}\vec{j}\right)$

3' $E_4 = \frac{kQ_4}{r_4^2}\hat{r}_4 = \frac{k\ 13.2nC}{r_4^2}\hat{r}_4 = \frac{k\ 13.2nC}{r_4^2}\left(-\frac{\sqrt{2}}{2}\vec{i} + \frac{\sqrt{2}}{2}\vec{j}\right)$

add them together, we get.

8' $E_1 + E_2 + E_3 + E_4 = \frac{k}{r^2}\left[-17.25\times\frac{\sqrt{2}}{2}\vec{i} - 2.75\cdot\frac{\sqrt{2}}{2}\vec{j}\right]$

$= (-12.81\,\vec{i} - 1.984\,\vec{j})\times 10^8\ V/m$

so the magnitude is $\sqrt{(12.81)^2 + (1.984)^2} = 13.0\times 10^8\ V/m = 1.30\times 10^9\ V/m$

the direction is.

5' $\theta = \arctan\left(\frac{-1.98k}{-12.81}\right) + \pi = 188.9^\circ \doteq 189^\circ$

or $\theta = \arctan\left(\frac{-1.98k}{12.81}\right) - \pi = -171^\circ$