

Phy250 Unquiz 01

Note: $k=8.99 \times 10^9 \frac{\text{Nm}^2}{\text{C}^2}$

Consider the following charges: 1:($+2\mu\text{C}; 2,3$), 2:($-3\mu\text{C}; 1,5$)

(a) Find \vec{E} and $|\vec{E}|$ at (7,2) with correct SI units.

(b) If a charge $Q=-3\mu\text{C}$ is located at (7,2), find \vec{F} and $|\vec{F}|$ with correct SI units.

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Write down what you want to calculate: $\vec{E} = \sum_{i=1}^{i=2} k \frac{q_i}{r_{ip}^2} \hat{r}_{ip}$

Identify the following vectors: $\vec{r}_p; \vec{r}_1; \vec{r}_2$

$$\vec{r}_p = 7\hat{x} + 2\hat{y}; \vec{r}_1 = 2\hat{x} + 3\hat{y}; \vec{r}_2 = 1\hat{x} + 5\hat{y}$$

Calculate the following vectors: $\vec{r}_{1p}; \vec{r}_{2p}$

$$\vec{r}_{1p} = \vec{r}_p - \vec{r}_1 = (7-2)\hat{x} + (2-3)\hat{y} = 5\hat{x} - 1\hat{y}$$

$$\vec{r}_{2p} = \vec{r}_p - \vec{r}_2 = (7-1)\hat{x} + (2-5)\hat{y} = 6\hat{x} - 3\hat{y}$$

Calculate the following: $r_{1p}^2; r_{2p}^2; \hat{r}_{1p}; \hat{r}_{2p}$

$$r_{1p}^2 = 5^2 + 1^2 = 26; r_{2p}^2 = 6^2 + 3^2 = 45$$

$$\hat{r}_{1p} = \frac{\vec{r}_{1p}}{|\vec{r}_{1p}|} = \frac{5\hat{x} - 1\hat{y}}{\sqrt{26}}; \hat{r}_{2p} = \frac{\vec{r}_{2p}}{|\vec{r}_{2p}|} = \frac{6\hat{x} - 3\hat{y}}{\sqrt{45}}$$

Put every thing together:

$$\vec{E} = 8990 \left[2 \frac{(5\hat{x} - 1\hat{y})}{26\sqrt{26}} - 3 \frac{(6\hat{x} - 3\hat{y})}{45\sqrt{45}} \right] \frac{\text{N}}{\text{C}}$$

Find \vec{F} from $\vec{F} = q_p \vec{E}$

$$\vec{F} = -3 \times 10^{-6} \times 8990 \left[2 \frac{(5\hat{x} - 1\hat{y})}{26\sqrt{26}} - 3 \frac{(6\hat{x} - 3\hat{y})}{45\sqrt{45}} \right] \text{N}$$

numerical answers:

$$\vec{E} = (1 \times 10^{-6} \times 8.990 \times 10^9) [(0.0754\hat{x} - 0.0151\hat{y}) + (-0.0596\hat{x} + 0.0298\hat{y})]$$

$$\Rightarrow \vec{E} = 8990 [0.0158\hat{x} + 0.0147\hat{y}] = 142.9\hat{x} + 132.2\hat{y}$$

$$\vec{F} = (-3 \times 10^{-6}) [142.9\hat{x} + 132.2\hat{y}]$$

Final answer:

$$\vec{E} = [142.9\hat{x} + 132.2\hat{y}] \frac{\text{N}}{\text{C}}; \vec{F} = [-4.29 \times 10^{-4}\hat{x} - 3.97 \times 10^{-4}\hat{y}] \text{N}$$