

Answer on Question #66219-Physics - Field Theory

A -12 nC charge is located at $(x, y) = (1 \text{ CM}, 0 \text{ CM})$ what are the electric fields at the positions $(x, y) = (5,0) \text{ CM}$ $(-5,0)\text{cm}$ and $(0,5)\text{cm}$ write each electric field vector in component form.

Solution

The charge position $\mathbf{r} = (1,0)$.

The electric field at the point \mathbf{r}' is

$$\mathbf{E} = k \frac{q}{|\mathbf{r} - \mathbf{r}'|^2} \frac{\mathbf{r} - \mathbf{r}'}{|\mathbf{r} - \mathbf{r}'|}$$

So

a) $\mathbf{r} - \mathbf{r}' = (5 - 1; 0 - 0) = (4; 0), \quad |\mathbf{r} - \mathbf{r}'| = \sqrt{4^2 + 0^2} = 4 \text{ cm} = 0.04 \text{ m}.$

$$\mathbf{E} = 9 \times 10^9 \frac{-12 \times 10^{-9} (0.04; 0)}{0.04^2 \cdot 0.04} = (-67500; 0) \frac{\text{V}}{\text{m}} = (-67.5; 0) \frac{\text{kV}}{\text{m}}.$$

b) $\mathbf{r} - \mathbf{r}' = (-5 - 1; 0 - 0) = (-6; 0), \quad |\mathbf{r} - \mathbf{r}'| = \sqrt{(-6)^2 + 0^2} = 6 \text{ cm} = 0.06 \text{ m}.$

$$\mathbf{E} = 9 \times 10^9 \frac{-12 \times 10^{-9} (0.06; 0)}{0.06^2 \cdot 0.06} = (-30000; 0) \frac{\text{V}}{\text{m}} = (-30; 0) \frac{\text{kV}}{\text{m}}.$$

c) $\mathbf{r} - \mathbf{r}' = (0 - 1; 5 - 0) = (-1; 5), \quad |\mathbf{r} - \mathbf{r}'| = \sqrt{(-1)^2 + 5^2} = \sqrt{26} \text{ cm} = 0.05 \text{ m}.$

$$\mathbf{E} = 9 \times 10^9 \frac{-12 \times 10^{-9} (-0.01; 0.05)}{0.05^2 \cdot 0.05} = (8640; -43200) \frac{\text{V}}{\text{m}} = (8.64; -43.2) \frac{\text{kV}}{\text{m}}.$$

Answers: $(-67.5; 0) \frac{\text{kV}}{\text{m}}, (-30; 0) \frac{\text{kV}}{\text{m}}, (8.64; -43.2) \frac{\text{kV}}{\text{m}}.$

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