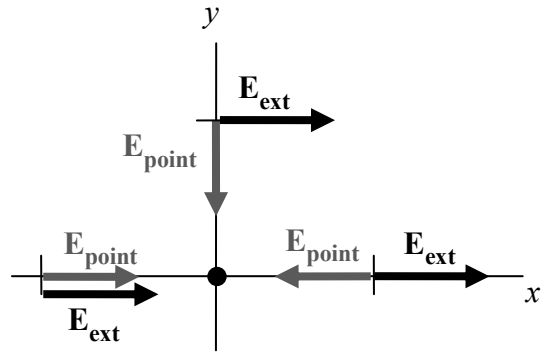


38. **REASONING** At every position in space, the net electric field \mathbf{E} is the vector sum of the external electric field \mathbf{E}_{ext} and the electric field $\mathbf{E}_{\text{point}}$ created by the point charge at the origin: $\mathbf{E} = \mathbf{E}_{\text{ext}} + \mathbf{E}_{\text{point}}$. The external electric field is uniform, which means that it has the same magnitude $E_{\text{ext}} = 4500 \text{ N/C}$ at all locations and that it always points in the positive x direction (see the drawing). The magnitude E_{point} of the electric field due to the point charge at the origin



is given by $E_{\text{point}} = \frac{k|q|}{r^2}$ (Equation 18.3), where r is the distance between the origin and the location where the electric field is to be evaluated, q is the charge at the origin, and $k = 8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$. All three locations given in the problem are a distance $r = 0.15 \text{ m}$ from the origin, so we have that

$$E_{\text{point}} = \frac{k|q|}{r^2} = \frac{(8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2) |-8.0 \times 10^{-9} \text{ C}|}{(0.15 \text{ m})^2} = 3200 \text{ N/C}$$

The direction of the electric field $\mathbf{E}_{\text{point}}$ varies from location to location, but because the charge q is negative, $\mathbf{E}_{\text{point}}$ is always directed towards the origin (see the drawing).

SOLUTION

a. At $x = -0.15 \text{ m}$, the electric field of the point charge and the external electric field both point in the positive x direction (see the drawing), so the magnitude E of the net electric field is the sum of the magnitudes of the individual electric fields:

$$E = E_{\text{ext}} + E_{\text{point}} = 4500 \text{ N/C} + 3200 \text{ N/C} = \boxed{7700 \text{ N/C}}$$

b. At $x = +0.15 \text{ m}$, the electric field of the point charge is opposite the external electric field (see the drawing). Therefore, the magnitude E of the net electric field is the difference between the magnitudes of the individual electric fields:

$$E = E_{\text{ext}} - E_{\text{point}} = 4500 \text{ N/C} - 3200 \text{ N/C} = \boxed{1300 \text{ N/C}}$$

c. At $y = +0.15 \text{ m}$, the electric fields $\mathbf{E}_{\text{point}}$ and \mathbf{E}_{ext} are perpendicular (see the drawing). This makes them, in effect, the x -component (\mathbf{E}_{ext}) and y -component ($\mathbf{E}_{\text{point}}$) of the net electric field \mathbf{E} . The magnitude E of the net electric field, then, is given by the Pythagorean theorem (Equation 1.7):

$$E = \sqrt{E_{\text{ext}}^2 + E_{\text{point}}^2} = \sqrt{(4500 \text{ N/C})^2 + (3200 \text{ N/C})^2} = \boxed{5500 \text{ N/C}}$$