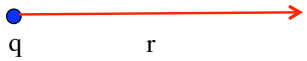
Problem 25.18

We know the following about the charge to the right:



$$V = k\frac{(-q)}{r} = -3000\ \text{V} \quad \text{and} \quad |\vec{E}| = k\frac{q}{r^2} = 500\ \text{V/m}$$

a.) What is "r"?

Taking the ratio of the two expressions gives us:

$$\frac{V}{|\vec{E}|} = \frac{k\frac{(-q)}{r}}{k\frac{q}{r^2}} = \frac{-3000\ \text{V}}{500\ \text{V/m}}$$

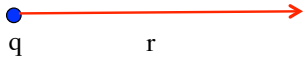
$$\Rightarrow \quad r = \frac{3000\ \text{V}}{500\ \text{V/m}}$$

$$\Rightarrow \quad r = 6\ \text{m}$$

Note: There is a tiny subtlety that, if you didn't notice it, would have given you a negative "r" value (which would have made no sense). The subtlety is that you only use electric field functions like $\left(k\frac{q}{r^2}\right)$ to determine field MAGNITUDES, which means you don't use the charge's sign in the calculation. With voltages, you DO include the sign. They aren't vectors, but negative charges are supposed to produce negative voltages!

b.) What is "q?"

Knowing the value for "r" and assuming we leave the sign embedded in the "q" term, we can write:



$$V = k\frac{(q)}{r} = -3000\ \text{V}$$

$$\Rightarrow \quad \left(9\text{x}10^9\ \text{N}\bullet\text{m}^2/\text{C}^2\right)\frac{(q)}{(6\ \text{m})} = -3000\ \text{V}$$

$$\Rightarrow \quad q = -2\text{x}10^{-6}\ \text{C}$$