

Answer on Question 59958, Physics, Electric Circuits

Question:

The electric potential at a point in free space due to a charge Q coulomb is $Q \cdot 10^{11}$ volts. The electric field at that point is?

Solution:

By the definition, the electric potential created by a point charge Q , at a distance r from the charge (relative to the potential at infinity) given by the formula:

$$V = k \frac{Q}{r} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r}, \quad (1)$$

here, $k = 1/4\pi\epsilon_0$ is the Coulomb's constant, ϵ_0 is the permittivity of free space.

From the definition of the electric field of a point charge we have:

$$E = k \frac{Q}{r^2} = \frac{1}{4\pi\epsilon_0} \frac{Q}{r^2} = \frac{V}{r}. \quad (2)$$

Let's find r from the equation (1):

$$r = \frac{Q}{4\pi\epsilon_0 V} = \frac{Q}{4\pi\epsilon_0 Q \cdot 10^{11}} = \frac{1}{4 \cdot 10^{11} \pi \epsilon_0}.$$

Substituting r into the equation (2), we can find the electric field at that point:

$$E = \frac{V}{r} = \frac{Q \cdot 10^{11}}{\frac{1}{4 \cdot 10^{11} \pi \epsilon_0}} = 4\pi\epsilon_0 Q \cdot 10^{22} \frac{V}{m}.$$

Answer:

$$E = 4\pi\epsilon_0 Q \cdot 10^{22} \frac{V}{m}.$$