

## Answer on Question 50799, Physics, Other

### Question:

Given that the units of permittivity of free space  $\epsilon_0$  are  $m^{-3}kg^{-1}s^4A^2$ , use base units to show that the equation of Coulomb's law is homogeneous.

### Answer:

Let us write the equation of Coulomb's law:

$$F_e = \frac{1}{4\pi\epsilon_0} \frac{|q_1||q_2|}{r^2}.$$

Here,  $F_e$  is the electric force between two point charges,  $\epsilon_0$  is the permittivity of free space,  $q_1, q_2$  are the signed magnitudes of the charges and  $r$  is the distance between the charges.

Let's show that the equation of Coulomb's law is homogeneous. If the equation is homogeneous, then the units on the left-side must be the same as on the right-side:

$$[N] = \frac{1}{4\pi} \cdot \frac{1}{\frac{[s^4] \cdot [A^2]}{[m^3] \cdot [kg]}} \cdot \frac{[C] \cdot [C]}{[m^2]},$$

$$[N] = \frac{1}{4\pi} \cdot \frac{[m^3] \cdot [kg]}{[s^4] \cdot [A^2]} \cdot \frac{[A^2] \cdot [s^2]}{[m^2]},$$

$$[N] = \frac{1}{4\pi} \cdot \frac{[m] \cdot [kg]}{[s^2]},$$

$$[N] = \frac{1}{4\pi} \cdot [N].$$

As we can see, the units on the left-side are the same as on the right-side, therefore, the equation of Coulomb's law is homogeneous.