17D Calculating Electric Fields and Forces

Read:

Electric field strength can be described in two ways. Sometimes scientists describe electric field strength in newtons per coulomb of charge (N/C). However, in many situations the unit volts per meter (V/m) is used. The two units are equivalent. Later, you will be given an opportunity to figure out why this is true.

The force on a charge in an electric field is equal to the charge in coulombs multiplied by the electric field strength. This equation is written as:

Electric force in newtons (F) = charge in coulombs (q) × electric field strength (E)

or

$$F = qE$$

Examples:

Example 1: The electric field strength in a region is 2,200 N/C. What is the force on an object with a charge of 0.0040 C?

   Solution:

$$F = qE$$
$$F = (0.0040 \text{ C})(2,200 \text{ N/C}) = 8.8 \text{ newtons}$$

Example 2: If an object with a charge of 0.080 C experiences an electric force of 7.0 N, what is the electric field strength?

   Solution:

$$E = \frac{F}{q}$$

$$E = \frac{7.0 \text{ N}}{0.080 \text{ C}} = 88 \text{ N/C}$$

Practice:

1. What is the force of an electric field of strength 4.0 N/C on a charge of 0.5 C?

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2. An electric field has a strength of 2.0 N/C. What force does it exert on a charge of 0.004 C?

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3. A charge of 0.01 C is in a 120 N/C electric field. What is the force on the charge?

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4. If an object with a charge of 0.08 C experiences an electric force of 5.0 N, what is the electric field strength?

5. An object with a charge of 4.0×10^{-9} C experiences a force of 20×10^{-9} N when placed in a certain point in an electric field. What is the electric field strength at that point in N/C?

6. A charge of 0.2 C experiences an electric force of 5 N. What is the strength of the electric field in N/C?

7. **Challenge!** Given that 1 joule = 1 newton × 1 meter and 1 volt = 1 joule per coulomb, show that the units newtons/coulomb and volts/meter are equivalent.