7.3.3: Electric Fields

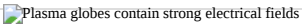

Figure 15.2.1

A plasma globe, such as the one pictured above, is filled with a mixture of noble gases and has a high-voltage electrode at the center. The swirling lines are electric discharge lines that connect from the inner electrode to the outer glass insulator. When a hand is placed on the surface of the globe, all the electric discharge travels directly to that hand.

The Electric Field

Coulomb's Law gives us the formula to calculate the force exerted on a charge by another charge. On some occasions, however, a test charge suffers an electrical force with no apparent cause. That is, as observers, we cannot see or detect the original charge creating the electrical force. Michael Faraday dealt with this problem by developing the concept of an **electric field.** According to Faraday, a charge creates an electric field about it in all directions. If a second charge is placed at some point in the field, the second charge interacts with the field and experiences an electrical force. Thus, the interaction we observe is between the test charge and the field and a second particle at some distance is no longer necessary.

The strength of the electric field is determined point by point and can only be identified by the presence of test charge. When a positive test charge, q_t, is placed in an electric field, the field exerts a force on the charge. The field strength can be measured by dividing the force by the charge of the test charge. Electric field strength is given the symbol E and its unit is Newtons/coulomb.

$$E=F_{onqt}/q_t$$

The test charge can be moved from location to location within the electric field until the entire electric field has been mapped in terms of **electric field intensity.**

Example 7.3.3.1

A positive test charge of 2.0×10−5 C is placed in an electric field. The force on the test charge is 0.60 N. What is the electric field intensity at the location of the test charge?

Solution

$$E=F/q=0.60\ N/2.0\times10^{-5}\ C=3.0\times10^{4}\ N/C$$

Launch the Hockey simulation below and try to use the electric field to help you score a goal:

Summary

- An electric field surrounds every charge and acts on other charges in the vicinity.
- The strength of the electric field is given by the symbol *E*, and has the unit of Newtons/coulomb.
- The equation for electric field intensity is E=F/q.

Review

1. The weight of a proton is 1.64×10^{-26} N. The charge on a proton is $+1.60\times10^{-19}$ C. If a proton is placed in a uniform electric field so that the electric force on the proton just balances its weight, what is the magnitude and direction of the field?
2. A negative charge of 2.0×10^{-8} C experiences a force of 0.060 N to the right in an electric field. What is the magnitude and direction of the field?
3. A positive charge of 5.0×10^{-4} C is in an electric field that exerts a force of 2.5×10^{-4} N on it. What is the magnitude of the electric field at the location of the charge?
4. If you determined the electric field intensity in a field using a test charge of 1.0×10^{-6} C and then repeated the process with a test charge of 2.0×10^{-6} C, would the forces on the charges be the same? Would you find the value for E?

Explore More

Use this resource to answer the questions that follow.

1. What does it mean when a force is called a non-contact force?
2. What symbol is used to represent electric field strength?
3. What is the relationship between the direction of the electric field and the direction of the electric force?

Additional Resources

Study Guide: Electrostatics Study Guide

Real World Application: Using Static, Homemade Static Electricity

Interactive: Touch Screen

Video: