Name_____ Section_____ Date_____

CONCEPTUAL PHYSICS · Hewitt/Baird | **Tech Lab**

Electrostatics — A Potential Puzzle

Greased Lightning

Purpose

To determine the likelihood of getting a "carpet shock" (based on controllable variables), and to avoid or produce such shocks under a series of challenging conditions

Apparatus

computer — PhET simulation, "John Travoltage" (available at http://phet.colorado.edu)

Discussion

When you walk across a carpet and touch a metal doorknob, you might feel a small shock. The friction between the different materials in your footware and the carpet gives you a static charge. (Physicists call it a *triboelectric* charge, meaning a charge from frictional contact.) The metal doorknob is a conductor, so the excess charge on your body jumps to the knob rapidly, creating the spark. Your nerves are sensitive to electrical impulses, so you feel the shock.

In the simulation, John Travoltage's foot can be rubbed across a carpet so that his body collects charge. His arm can be rotated so that a spark will jump from his finger to the doorknob.

Procedure

Step 1: Start the computer and allow it to complete its startup process.

Step 2: Launch the PhET simulation, "John Travoltage." If you need assistance, ask your instructor for help.

Step 3: Rub John Travoltage's foot back and forth against the carpet until a spark jumps from his finger to the doorknob.

How does John Travoltage react when the spark jumps?

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Step 4: Explore the simulation.

a. Move John Travoltage's hand close to the doorknob, then rub his foot on the carpet again. Compared to the process you observed in Step 3, what happens differently this time?

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b. How can you get the maximum charge built up on John Travoltage without producing a spark?

c. Under what circumstances—if any—will a spark jump from John Travoltage's ***foot*** to the doorknob? Why do you suppose this is (in terms of the physics involved)?

Step 5: Meet the challenges.

a. Rotate John Travoltage's arm so that his finger is pointing ***directly at*** the doorknob. Carefully rub his foot against the carpet without producing a spark.

   What is the greatest number of charges you can get onto John Travoltage's body? (How many small spherical charges can be collected on his body ***before*** a discharge occurs?)

b. ***Produce*** the longest spark possible: the spark is between John's hand pointing directly ***away*** from the knob and the doorknob, itself. (Hint: The correct procedure requires less than a minute to complete.)

   How did you do it?

c. ***Sustain*** the longest spark possible. Now that you know how to initiate the longest spark, determine a method to sustain the spark for several seconds (at least 10 seconds).

   How did you do it?

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Summing Up

1. Under which conditions is a spark ***most likely*** to jump between John Travoltage and the doorknob? Describe in terms of the amount of charge on his body and the distance between his hand and the doorknob.

2. Consider two variable quantities: the amount of charge Q on John Travoltage's body and the distance d from his finger to the doorknob. How do these quantities relate to the likelihood S of a spark jumping? (This is a rough approximation, not an exact equation.)

   ____ S ~ Qd ____ S ~ Q/d ____S ~ d/Q ____ S ~ 1/(Qd)

3. Write a statement that conveys what your expression in question 2 means.

4. When John Travoltage's hand is turned away from the knob, no spark will ***start***. But in Step 5, you ***sustained*** a spark from that configuration. What does this say about the conductivity of air?

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