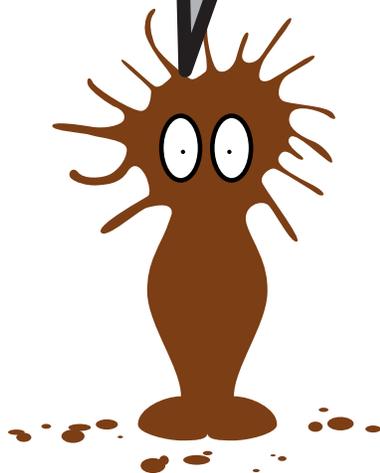
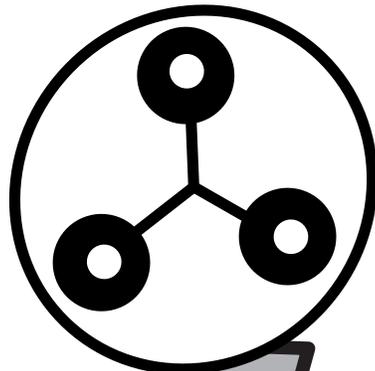
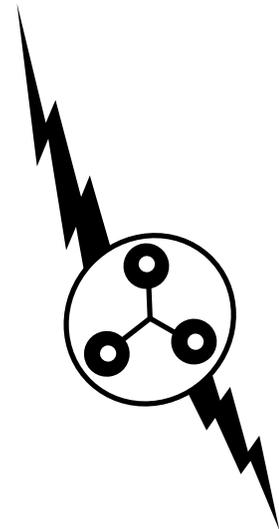


# Electrostatics



# **Electrostatics**

## **WHAT HAPPENS TO DIFFERENT OBJECTS WHEN THEY ARE ELECTRICALLY CHARGED?**

1. In this experiment, a device called a Van de Graaff generator will be used to place extra electrons on different objects, giving them a negative charge. Use the **Electrostatics Data Chart** to predict the outcome of some of the experiments.
2. Watch what actually happens and record the outcome on the **Electrostatics Data Chart**.
3. Ask bunches of questions and have fun!

### **Electrostatics Data Chart**

**The Experiment:** A container full of packing foam is placed on the Van de Graaff generator.

**Your Hypothesis:**

**What happened?**

**Why did this happen?**

**The Experiment:** A bunch of string is placed on the Van de Graaff generator.

**Your Hypothesis:**

**What happened?**

**Why did this happen?**

**The Experiment:** A person touches the Van de Graaff generator.

**Your Hypothesis:**

**What happened?**

**Why did this happen?**

## Reading About Charges and Electricity

### THE DEMONSTRATIONS WITH THE VAN DE GRAEFF GENERATOR SHOWED HOW CHARGES BEHAVE.

**Directions:** Read the following passage. Fill in the blanks with words that make sense. Remember to use context clues that come before and after the blanks.

Atoms, the basic building blocks of matter, are made of three basic components: protons, neutrons and electrons. The protons and neutrons cluster together to form the nucleus, the central part of the atom, and the   1   orbit about the nucleus. Protons and electrons both carry an electrical charge. The charges they carry are opposite to each other; protons carry a   2   electrical charge while electrons carry a negative electrical charge. Neutrons are   3   charged - they carry no charge at all.

Electricity is the movement of charged particles, usually electrons, from one place to another. Materials that electricity can move through easily are called conductors. Most metals, such as iron, copper and   4  , are good   5   of electricity. Other materials, such as rubber, wood and glass, block the flow of electricity. Materials which   6   the flow of electricity are called insulators. Electrical cords are usually made with both conductors and   7  . Electricity flows through a   8   in the center of the cord. A layer of insulation   9   the conductor and   10   the electricity from 'leaking' out.

Objects usually have equal numbers of positive and negative charges, but it isn't too hard to temporarily create an imbalance. One way scientists can create an imbalance is with a machine called a   11   generator. It creates a large static charge by placing electrons on a metal dome using a motor and a big rubber band. Since like charges   12  , the electrons push away from each other as they collect on the dome. Eventually, too many electrons are placed on the dome and they leap off, creating a spark that looks like a bolt of lightning.

Have you ever received a   13   after having walked across a carpet? This shock was caused by extra electrons you collected while walking across the carpet. Your body became like the dome of the Van de Graeff generator, full of extra electrons looking for a way to get away. The path back to the carpet was blocked by the   14   you were wearing, but they were able to move through your hand and into the object that you touched, causing the shock. So, the next time you shuffle across a carpet and shock your friend on the ear, tell them you were just trying to be a Van de Graeff generator!

**Directions:** Choose the word that fits the context of the passage.

1. a. neutrons            b. protons            c. electrons            d. quarks
2. a. negative            b. positive            c. neutral            d. strong
3. a. negatively            b. positively            c. neutrally            d. strongly
4. a. wood            b. paper            c. nitrogen            d. aluminum
5. a. keepers            b. protectors            c. insulators            d. conductors
6. a. allow            b. create            c. help            d. prevent
7. a. conductors            b. insulators            c. metals            d. plugs
8. a. conductor            b. insulator            c. neutron            d. cord
9. a. surrounds            b. warms            c. looks at            d. hears
10. a. speeds up            b. replaces            c. prevents            d. allows
11. a. Rube Goldberg            b. Van de Graaff            c. Big Bad            d. Einstein
12. a. jump            b. join            c. repel            d. attract
13. a. dollar            b. book            c. shock            d. cat
14. a. freckle            b. shirt            c. pants            d. shoes

## Electrostatics Data Chart

**The Experiment:** A container full of packing foam is placed on the Van de Graaff generator.

**Your Hypothesis:** *I think the packing foam will spark.*

**What happened?** *The foam flew out of the container.*

**Why did this happen?** *Electrons gathered on the foam, making them repel each other.*

**The Experiment:** A bunch of string is placed on the Van de Graaff generator.

**Your Hypothesis:**

**What happened?**

**Why did this happen?**

**The Experiment:** A person touches the Van de Graaff generator.

**Your Hypothesis:**

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3. a. negatively            b. positively            **c. neutrally**            d. strongly
4. a. wood            b. paper            c. nitrogen            **d. aluminum**
5. a. keepers            b. protectors            c. insulators            **d. conductors**
6. a. allow            b. create            c. help            **d. prevent**
7. a. conductors            **b. insulators**            c. metals            d. plugs
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14. a. freckle            b. shirt            c. pants            **d. shoes**

# Electrostatics

This is an activity in which students discover how charges behave.

## Objectives:

In this activity students will:

- make predictions of the outcomes of several experiments
- observe experiments
- record their outcomes

## Questions to Ask:

1. Why did the foam fly out of the container when placed on the Van de Graaff generator?
2. What charge do electrons have?
3. How do opposite charges react to one another? Like charges?
4. Why does a persons hair stand on end only while they are standing on the stool?

## Travel Book Activities:

- Reading About Charges and Electricity

## Virginia State Standards of Learning

### **Science 6.2 Demonstrate Scientific Reasoning and Logic**

- by investigating ideas through asking for and actively seeking information
- by basing conclusions on scientific evidence obtained from a variety of sources

### **Science 6.4 Force Motion and Energy**

- by understanding that electrical energy can be described in volts

### **Science 6.5 Matter**

- by understanding that atoms are made up of electrons, protons, and neutrons

### **PS.1 Plan and Conduct Investigations**

- by making valid conclusions after analyzing data

### **PS.11 Investigate and Understand Basic Principles of Electricity and Magnetism**

- by understanding static, current, and circuits

# Electrostatics

## Teacher Overview and Materials List

### Background:

Although atoms contain both negatively and positively charged particles, they do so in equal amounts and carry no net charge. This balance can be temporarily disrupted by rubbing one material against another. One device, known as a Van de Graaff generator, uses a fast moving rubber belt to charge a metallic dome to nearly 200,000 Volts. This activity uses a Van de Graaff generator to study the behavior of electrical charges.

### Minimum Materials Needed:

Van de Graaff generator  
Grounding dome  
Insulated platform, such as a rubber stool  
Suction cup with strings attached to it  
Container full of packing foam  
Long nail

### Optional Materials:

Electroscope

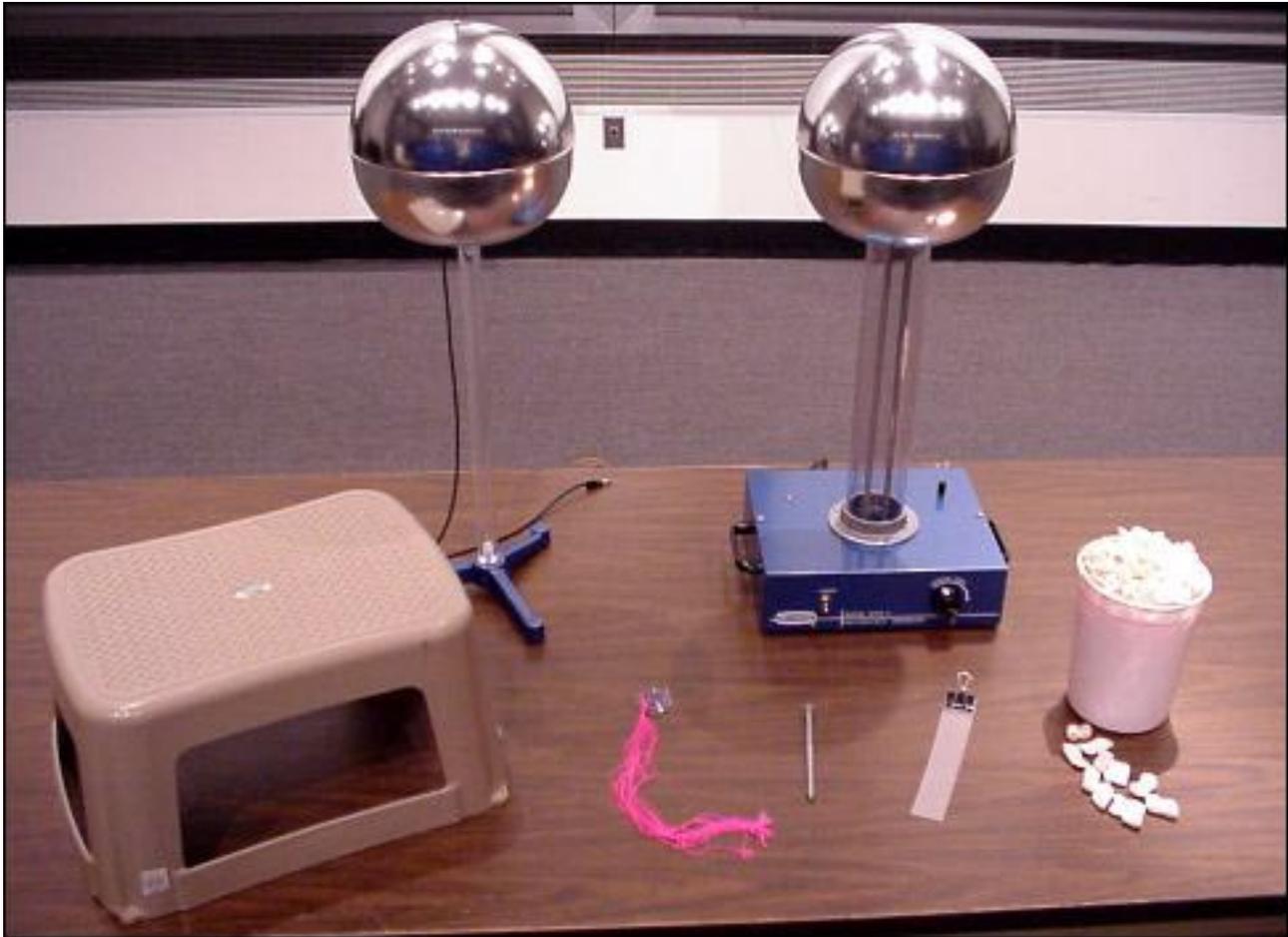
### Notes:

- Nearby computer equipment should be turned off prior to using a Van de Graaff generator.
- High humidity will prevent these experiments from working.
- A simple electroscope can be constructed from two strips of overhead transparency.
- The electroscope will need to be cleaned from time to time as it will collect oils from your fingers.

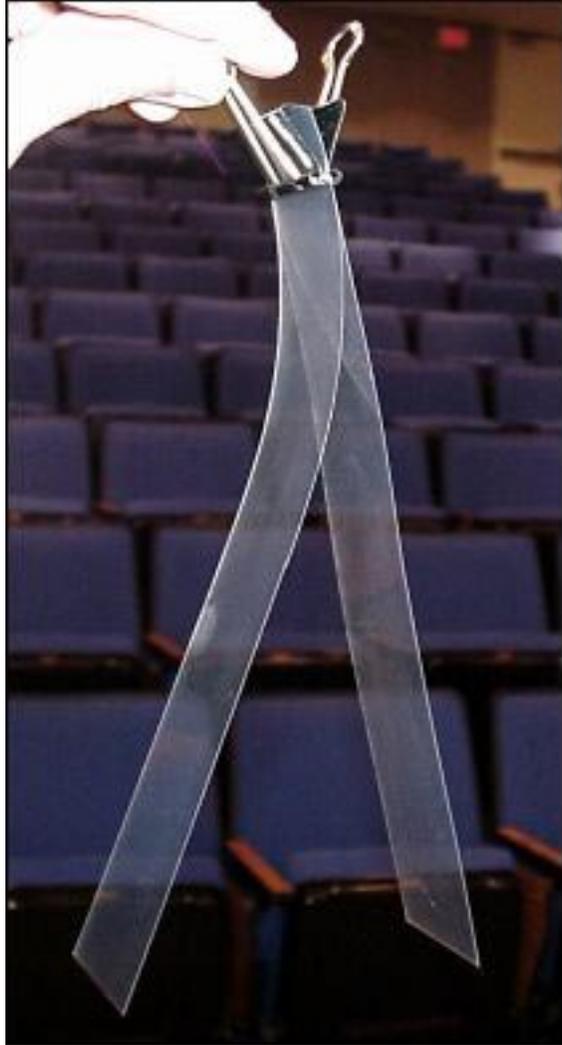
### Detailed Directions:

1. Rub your fingers between the electroscope's leaves.  
**results:** The leaves open since they both carry the same electrical charge (usually negative).
2. Place an insulator, such as a plastic pen, between the leaves of the electroscope.  
**results:** There is little or no effect. The electrons in the insulator are repelled by the extra electrons on the electroscope's leaves, but they cannot easily move away through the insulator.
3. Place a conductor, such as a metal nail, between the leaves of the electroscope.  
**results:** The electroscope's leaves jump to the conductor. The electrons in the conductor are repelled by the extra electrons on the electroscope's leaves. The electrons in the conductor easily flow away, leaving their parent atoms behind. The parent atoms, now missing a few electrons, now possess a net positive charge that attracts the negative charge on the leaves.
4. Turn the Van de Graaff generator on and place the grounding dome near it.  
**results:** A large spark will jump from the dome of the Van de Graaff generator to the grounding dome. As the grounding dome is brought closer to the Van de Graaff generator, the sparks become smaller but occur at a faster rate.
5. Place a container full of packing foam on the Van de Graaff generator and turn it on.  
**results:** The packing foam flies out of the container and away from the Van de Graaff generator. As the Van de Graaff generator charges, electrons collect on its dome, the container and the packing foam. Since the packing foam becomes negatively charged, it is repelled by the other pieces of foam and the Van de Graaff generator itself.

6. Place the suction cup with strings attached on the Van de Graaff generator and turn it on.  
**results:** All of the strings stand on end. As the Van de Graaff generator charges, electrons collect on its dome and the strings. Since the strings become negatively charged, they are repelled by each other as well as the Van de Graaff generator.
7. Stand on an insulated stool, place one hand on the Van de Graaff generator and turn it on.  
**results:** Your hair, if it is able to, will stand on end for the same reason the strings did.
8. While still charged, place your other hand on the Van de Graaff generator.  
**results:** There is no effect. Both of your hands are at the same potential so no current flows through your body. This is also why birds can land on electrical wires without receiving a shock.
9. While still charged, hold the nail in one hand while slowly bringing it toward the grounding dome.  
**results:** As you bring the nail towards the grounding ball, your hair will start to return to normal. Charges tend to leak off of objects with points, such as the nail. As the electrons flow toward the grounding dome, you lose charge and your hair falls. A spark will jump from the nail to the grounding dome once they get to within a quarter inch or so. Although there is a high potential difference between your two hands (on the order of 200,000 Volts), the electricity flowing through your body does not harm you because the current (the amount of electricity that is flowing through your body) is low.
10. Once you have fully recharged yourself, remove your hands from the Van de Graaff generator but do not step off of the insulated stool.  
**results:** Since you are insulated from the ground, your hair remains standing. It will slowly fall as the charges leak away from you.
11. While you still have some residual charge, step off of the insulated stool.  
**results:** Your hair falls flat as soon as your foot touches the ground. Although you are (hopefully!) wearing shoes, they usually don't provide enough insulation to prevent most of the excess electrons on your body from sparking through them to the ground.



Materials for Electrostatics



A Simple Electroscope