Utah State University Junior Engineering

Lesson # 25

Lesson Plan
Revised 7/06

Utterly Shocking

Grade Level: 3 - 4

Teachers, this is a basic lesson plan that you may modify at your discretion.

WARNING!! Turn off all computers in the area of the Van De Graaf Generator!!

Modifications to Video: There may have been changes to the lesson plan since the video was made. This lesson plan reflects the latest updates made as a result of suggestions from teachers who have presented the lesson during the daytime program. Please continue to send us your ideas!

Overall Educational Objective: Students will directly experience the concepts of static electricity and be able to apply this knowledge through hands-on experience.

Associated Standard and CORE Objective:

- **3050-0503** Show the properties of static electricity. Demonstrate the buildup and release of static electricity. Distinguish between attraction and repulsion of charged materials.

Materials List:

- 1 - Van de Graaf generator
- 1 - Plasma Ball
- 2 - Electroscopes (beaker w/stopper)
- 1 - electrostatic whirl
- 3 - rubber rods
- 7 - plastic rods
- 1 - neon tube

- 5 - 10 balloons
- - pieces of silk
- - pieces of wool
- - pieces of fur
- - synthetic fur
- 1 - power strip
- 1 - extension cord

Lesson Activities:

Static electricity is demonstrated with objects that "give up" electrons easily such as human hair and wool cloth. When electrons are transferred from one material to another, the material with the excess electrons becomes negatively charged, and the material that has a deficiency of electrons is positively charged. That may be seem confusing, but more electrons equals a negative (-) charge, and less than normal (or a neutral charge) is a positive (+) charge!

1. **Balloons:** You can generate static electricity by rubbing an inflated balloon briskly on your hair on a dry day. Your hair loses electrons (electrons are negatively charged particles) and becomes positively charged. The balloon gains electrons and becomes negatively charged. Since your hair and the balloon are now oppositely charged, they are now attracted to each other.
2. **Electroscope:**

   - Produce static electricity by rubbing a glass rod with a piece of fur or a silk cloth. The rod becomes positively charged, and the cloth becomes negatively charged. Now put the tip of the rod at the top of the

electroscope. The positive electrical charge will transmit to the electroscope foil pieces. Notice what happens. The foil pieces should be repelled because the whole radiometer is filled with the same charge.

- Ask the students what will happen if you touch the metal ball. Touch the ball to show that the charge is transferred to your body.
- What happens with the plastic rod? What happens when different rods are rubbed with different materials? Have the students experiment.

3. **Electrostatic Whirl:** Ask your students to predict what will happen if you charge a rod and hold it close to one of the points of the whirl. Demonstrate. Did it repel or attract? Try it with different rods rubbed with different materials. Have the students experiment.

4. **Plasma Ball:** High voltage (30,000 volts) is distributed to the inner ball. The charge will be transmitted from this inner ball to the outer ball. This is very similar to the way storm clouds in the atmosphere become charged to a different level than the earth and eventually will transmit that charge to the earth as lightning. In the Plasma Ball, electrical transmission will go from the inner ball to your fingers (when the glass is touched) because your body is at a lower **potential** than the inner ball charge. In other words, the hand is the nearest pathway that the spark can travel or discharge through to the ground. That's why tall buildings and barns have lightning rods. The lightning will strike the rod (the nearest thing with a lower potential (charge)) and be channeled in a controlled manner rather than striking and wrecking the building.

5. **Neon Tube:** The tube contains a gas. When one end is touching the running plasma ball, the electrical charge from the plasma ball will ionize the gas (electrons are taken from the gaseous elements leaving the element positively charged) and make it glow. If the tube is held in the middle, the electrons will only move up the tube to where it is held, then the electrons will go through the person's hand that is holding it to the ground.

6. **Van de Graaf Generator:** The motor turns a belt that rubs on wires and builds up a static charge. An electrical charge will always go to the outside surface of an object, so the charge will go from the wires to the metal shell. Turn the generator on to observe the discharge of electricity from the shell to the discharge ball. Be careful, as anything (i.e. hand, pen, etc.) placed closer to the shell will draw the charge away from the discharge ball.

   CAUTION: Do not touch the vandegraff generator and a computer at the same time, even if the computer is turned off. The shock you feel when touching the vandegraff can damage a computer whether on or off. If you have a student who is uncomfortable with electricity, have them stand back during this part of the demonstration.

   Turn the Van de Graaf generator **off**. Have a student put his or her hand on it. Turn the generator on. Have the student hold hands with another student and so on. Each student that takes a hold will be charged to a higher potential (charge) and be able to distribute this charge (by a shock) to the next person that takes a hold. Experiment to see how many students the charge can pass through.

Place a fur, soft side down, on the shell and turn the generator on. Have the students explain what's happening. See what happens when a student places both hands on the shell. If it's arid enough, their hair should start to lift. Try holding your hand over their head.

Teacher Tips:

- Explain the words attract and repel. Ask the students to raise their hand if they have ever used mosquito repellent. Then ask what the mosquito repellent was supposed to do (keep mosquitoes away). We use the same word to explain what magnets do. The magnets are repelling or attracting each other. Alike charges repel; opposite charges attract.

- Activity: Hold up two + or two - signs and tell the students that if the charges are alike they will repel or push away from each other. Hold up one + and one -. Then, tell the students that these charges are different and will attract each other. Hold up one or more cards and have the students tell whether they will attract or repel. Repeat until the students are confident with the idea. Give each student a card with a + or – sign on it. Instruct them not to look at the card or to let anyone else see it. When each student has a sign, tell them that they will be trying to find a charge to be attracted to. Have them look at their signs and assist them in finding a match. Have any students who haven't found a match come and stand with you. Explain that if the students were electrical charges, those who did not find a match would be looking around for an opposite charge.

- Darken your classroom as much as possible. The plasma ball and the neon tube are much more effective in a darkened room.

- Hang a balloon from a string. Put a face on it and call the balloon Pete. Have a child stand near the string and then rub the balloon with fur. The balloon will "follow" the child around. Take another balloon with a face (call her Patty) and rub each of them with fur. Then say that Patty is looking for Pete and as she comes closer, have the kids predict what will happen. They nearly always say that Patty will kiss Pete. However, because they are both negatively charged they will repel each other. The students have fun watching Patty chase Pete around.

- If there is time, or as a handout to take home, have the students fill out this word search for static electricity.

Safety Precautions: Before using the fur, check to see if any students have allergic reactions to rabbit fur or wool. Pacemakers or other medical or electronic equipment can be adversely affected by the Van de Graaf generator and the Plasma Ball. If students have a heart condition or if helpers are pregnant, do not let them near the generator.

Please make your students aware that this lesson relates to the following:

Career Fields:

Science, Technical

Occupations:

- **Computer Engineer:** Plan, design, and build computers and other related products. They also plan and design computer systems tailored for individual companies and organizations. They might also install these systems or modify already existing ones.

  Education: Bachelor's Degree

- **Electrical Engineer:** Design, develop, test, and supervise the manufacture of electrical and electronic equipment. Electronic equipment includes power generating and transmission equipment used by electric utilities, electric motors, machinery controls, and lighting and wiring in buildings, automobiles, and aircraft. Electronic equipment includes radar, computer hardware, and communications and video equipment.

  Education: Bachelor's Degree

- **Physicist:** Explore and identify basic principles governing the structure and behavior of matter, the generation and transfer of energy, and the interaction of matter and energy. Some use these principles in theoretical areas, such as the nature of time and the origin of the universe; others apply their physics knowledge to practical areas such as the development of advanced materials, electronic and optical devices, and medical equipment. They design and perform experiments with lasers, cyclotrons, telescopes, mass spectrometers, and other equipment. They attempt to discover laws that describe the forces of nature, such as gravity, electromagnetism, and nuclear interactions. They also find ways to apply physical laws and theories to problems in nuclear energy, electronics, optics, materials, communications, aerospace technology, navigation equipment, and medical instrumentation.

  Education: Doctor of Philosophy

Review Questions:

1. How is static electricity produced?

2. what are some methods we used to produce static electricity?
3. Does the Van de Graaf Generator produce static eletricity? How?
4. Why does lightning usually strike the highest points around?
5. What types of electric charges attract to each other? What types repel each other?
6. Can our bodies “conduct” electricity? Is this dangerous?

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