Van de Graaff Generator Lesson Plan

Amount of time Demo takes: 1-2 mins.
Don’t try this at home!

Materials
- Van de Graaff Generator
- Plastic stool for volunteer to stand on
- Rabbit fur
- Heavy-duty extension cord - Needs electricity
- Pie plates
- Table, not shared, area away from other electrical demos
- Rubbing Alcohol

Set-up Instructions
1. Find sturdy surface to set base on. Insert copper mesh piece to base stand. The mesh needs to be close to the belt, but not close enough that it may touch the belt. You may need to adjust this a few times to get it just right. Place metallic sphere onto base.
3. Plug in wand; this wand has a long cord, if the cord touches or is near the plexiglass tube where the belt is, it will discharge to the cord. This could be disconcerting to participants. Be aware of where cord is.
4. Set out bucket in front of table for people to stand on.
5. Set out fur or other supplies near Van de Graaff generator.
6. Test Van de Graaff to ensure the copper mesh piece is correctly in place.
7. This generator is larger and will take longer to build up a charge. Discharge with the wand less frequently to get larger arcs. The shock delivered on a participant will be more powerful than the smaller Van de Graaff, keep this in mind especially with younger participants.

SAFETY!
- People with pacemakers should not touch the Van de Graaff, it could cause life threatening problems. Participants with insulin pumps should disconnect their pump and make sure it is in a safe place away from the Van de Graaff if they want to participate, insulin pumps are expensive and can be damaged by the shock.
• Make sure the participant is standing on the stool/crate/bucket.
• Don’t let anyone touch them while they are touching the Van de Graaff without their consent. Doing so will cause both people to get a small shock.
• Make sure you don’t discharge the wand on the volunteer - it can be pretty shocking for them. Keep wand at a safe distance from them.
• Have them remove any electronic devices so if they do get zapped their devices are safe. It will turn off cellphones etc. A small container is helpful to set things in.

Lesson’s Big Idea
• Everyday objects have equal amounts of positive and negative electrical charges. The metallic ball collects the positive charges while the wand holds a negative charge bringing the volunteers balance of negative and positive charges out of balance. This makes the electrical potential high as the charges are out of balance.

Instructional Procedure
1. Hold the wand to the generator and flip the switch on base to turn it on.
2. Wait for the generator to ramp up to speed.
3. Holding the wand to the generator, invite the volunteer step up onto stool and place both hands on the generator.
4. Remove the wand from the generator to allow a charge to build up.
5. Volunteers can use one hand to run through their hair for a more intense charge. Hold the wand and move it around the volunteer, this can cause their hair to stand up from the differences in charges. The longer the generator is on the more intense the field can get. If you put the wand too close to your volunteer the wand can cause a discharge that will shock your volunteer.
6. When they are ready to get down, have them remove their hands and step down from the stool.
7. To turn off the generator, place the wand on the sphere then turn it off. Do not remove the wand until the belt stops moving.
8. An additional demo you can do is to place the rabbit fur on the large metal sphere and turn on the generator.
9. Move the wand around over the fur and it will jump and raise up off the large metallic sphere as it is attracted to the wand.
10. When discussing how the Van de Graaff works you can ask them if they have ever rubbed a balloon on their head and had it stick, or walked across...
the carpet and felt a shock when they touched a door knob. There is a build up of electrical potential through friction and to equalize the electrons discharge when you touch a doorknob or other object that is conductive. The Van de Graaff builds up a large electrical potential. You can feel the electrical field surrounding it. You can hear the pop and see the spark as the wand discharges. The potential can reach 5 megavolts.

11. One additional demo to use as a challenge question is placing one pie plate on the Van de Graaff and letting it fly. Then place all of the pie plates on and ask what will happen? (Each plate will fly off one at a time because charges gather on the surface, so the top plate actually takes all of the charge. Then it is repelled because it has the same charge as the sphere).

**Background Information**

- **Everyday objects have equal amounts of positive and negative electrical charges.** There is a belt inside the Van de Graaff that goes around and causes a build-up of positive charges. The metallic ball collects positive charges while the wand holds negative charges bringing the volunteers balance of negative and positive charges out of balance while touching the large metallic ball. This makes the electrical potential high as the charges are out of balance.

- **Vocabulary**
  - Electricity - Form of energy resulting from the existence of charged particles (such as electrons or protons), either statically as an accumulation of charge or dynamically as a current.
  - Electrical charge - Property of matter that is responsible for electrical phenomena, existing in a positive or negative form.
  - Electrical potential - Potential energy per charge*Distance.

- **Schematic view of a classical Van de Graaf generator:**
  - Hollow metallic sphere (with positive charges)
  - Electrode connected to the sphere, a brush ensures contact between the electrode and the belt
  - Upper roller (for example in plexiglass)
  - Side of the belt with positive charges
  - Opposite side of the belt with
negative charges
- Lower roller (metal)
- Lower electrode (ground)
- Spherical device with negative charges, used to discharge the main sphere
- Spark produced by the difference of potentials

**Clean Up**
- Clean up between demos if needed. When completely finished gather all materials listed for this demo and make sure everything is accounted for. If something was used up, broken or damaged, let someone know so it can get replaced or fixed. Be sure to wipe down the ball, wand, and pie tins with rubbing alcohol when done.

**Assessment**
1. Can you feel the electrical field the Van de Graaff is making?
2. What do you think will happen to the pie tins/rabbit fur?

**References**

**Next Generation Science Standards**
- **K-5**
  - 3-PS2
  - 4-PS3
  - 5-PS1-1/3
- **6-8**
  - MS-PS2
  - MS-PS3
- **9-12**
  - HS-PS2-5
  - HS-PS3-5