615-3155 (10-615) Volta's Hailstorm

For use with a Van de Graaff Generator

Caution:

People with cardiac pacemakers or other such electronic medical implants or devices should never operate a Van de Graaff generator or come in contact with it. Discharge of static electricity could cause the electronic device to be damaged or to malfunction.

Other Materials Required:

- **Van de Graaff generator**
- **Discharge Wand**
- **Connection to Van de Graaff**

Safety:

Use care when performing experiments with a Van de Graaff generator. It is recommended that you touch the Van de Graaff generator and Volta's Hailstorm *only* with a Discharge Wand.

Description:

The Volta's Hailstorm consists of a chamber on an insulated base in which charge particles react. We supply tiny polystyrene beads to use in the chamber. When in the vicinity of a Van de Graaff generator, these polystyrene beads transfer charge between the two end plates of the chamber.

You can also demonstrate Coulomb's Law qualitatively and illustrate the method of smoke control based on the electrostatic removal of solid particles from the smoke screen.

12" in height, the chamber is large enough to be seen from a distance by an entire class.

Experiments:

Demonstrate smoke control

You need:

Alligator clip leads

Smoke

1. Remove the polystyrene balls from inside the chamber. Place a small piece of conventional wire screen on the bottom of the plate. Roll the screen material so that it will stand on end, in a partial cylinder, if necessary. Fill empty chamber with smoke and replace the lid.
2. With the Van de Graaff off, connect the top metal ball of the chamber to the generator dome by means of alligator clip leads.
3. Turn the Van de Graaff on. The smoke quickly clears, by attraction to the screening or by precipitation.

This demonstrates the method of smoke control based on the electrostatic removal of solid particles from the smoke stream.

Demonstrate Volta's Hailstorm

You need:

Polystyrene balls (included)

Can also use: pith, Kix® cereal and other small particles

Discharge wand (optional)

Wire connector between Volta's Hailstorm and Van de Graaff (not included)

1. Place the balls or other small conductive particles in the chamber.
2. With the machine off, set the Volta's Hailstorm on a table or other grounded object close to a Van de Graaff generator. You may need to experiment to determine the optimum distance. Connect the bottom (floor) of the chamber to the dome of the Van de Graaff by means of a wire connector.
3. Turn the Van de Graaff generator on and watch the results. The bottom of the chamber becomes positively charged, thus giving it a high electric potential. This bottom transfers positive electric charge to the polystyrene beads resting on it. The polystyrene beads will fly up to the uncharged top of the chamber, where the potential is lower, and touch the top plate. As the particles hit the top of the chamber, they transfer their positive charge to it. After transferring their charge, the now-neutral particles fall to the bottom. Eventually the top plate accumulates so much charge that it has the same electric potential as the bottom. As a result, no further particles will rise. At this point some of the balls will stick to the walls of the chamber.
4. Take the discharge wand and tap the top of the chamber. (Or connected a grounded wire to the top of the tube). This removes the charge from the top plate and causes the positively charged particles from the bottom of the tube to rise up, yield their charge to the top and fall back to the bottom. This creates the "hailstorm" effect. Eventually the charge transfer stops when the top is at the same potential as the bottom.

The electric field induces an opposite charge in the small balls. They are pulled to the top, take on the charge of the chamber's top plate and are pushed back down. As the induced charge reverses, the balls leap up and down like popping corn.

*The same effect is used today in **electrostatic precipitators.** These pollution-control devices remove fine particles from smokestack gases. Instead of bouncing back and forth, the particles are trapped in special electrodes.*

Theory:

Smoke precipitation:

The smoke particles can be looked at in two different ways based on their behavior. They can be considered to *have* an electric charge or to *not have* an electric charge.

The electric field set up by the Van de Graaff acts upon the charged particles with a force along or against the direction of the lines of force. They then move until they arrive at a limitation such as a wall, where they lose their charge and begin to pile up. Those particles which do not have an electric charge also move when in the vicinity of the non-uniform field.

This can be visualized by considering a single smoke particle to be a small sphere with its charges evenly distributed. In a non-uniform field, the electric field on one side of the smoke particle will be stronger than on the other side. Picture this as more lines of force on one side of the smoke particles than on the other.

Since we are assuming the charges on each side of the smoke particles are roughly the same but the electric field is different on each side of the particle, it follows that the force will be different for each side of the smoke particle.

The force is the product of the electric field strength and the charge and can be stated mathematically as:

F = EQ

The greater force will move the smoke particle.

Energy density also helps explain the behavior of the smoke. Any particle without net charge which is motionless in a region of uniform field (i.e., $E_{left} = E_{right}$) is moved away from the field by collisions with particles in motion.

Volta's Hailstorm:

Every point around a charged object, such as a Van de Graaff generator dome) has an electric potential. The potential near a *positively charged* Van de Graaff is positive, while the potential far away from it is lower. The potential near a negatively charged object is negative, and thus lower still.

The Volta's Hailstorm demonstrates attraction and repulsion of electric charges. A particle with a charge +q, when brought near the positively charged Van de Graaff, tends to move to the position where voltage is lowest. This is another way of saying that the particle has been repelled. The attraction and repulsion occur with conductive particles (in our case, balls) and have a path to ground to get rid of the repelled charge. They occur upon dipoles or poles of higher order when there is no path to ground or the bodies are nonconductors.

Sometimes the dampness of the atmosphere renders dielectrics (non-conductors) slightly conducting and the effects are due to a combination of causes. The polystyrene balls are repelled from the metal floor of the chamber because they pick their charge from it. Upon losing it on the chamber ceiling, they fall due to gravity. They are also repelled from the upper plate if they stick long enough to pick up a new charge.

Warranty:

We replace all missing or defective parts free of charge. All products guaranteed free from defect for 90 days. This does not include accident, misuse, or normal wear and tear.

Van de Graaff products:

The following products are manufactured by Science First® and are available directly from us or from most science education distributors.

615-3115 and 615-3135 Discharge Wand

For Science First® 615-3100 and 615-3130 Van de Graaffs, respectively. With cast metal tripod base and 7" diameter oblate. Used to draw a discharge.

615-3160 Static Spinner

Like a pinwheel, this device will spin when close to a Van de Graaff due to the effect of electric wind.

615-3165 Lightning Leaper

Shows that electricity will follow the path of least resistance, even if it is not the shortest.

615-3100 Small Van de Graaff

With 200,000 volt potential. Ideal for schools. Raise hair instantly - no shock hazard. Sparks up to 5" and operates in humidities up to 90%. 7" diameter aluminum globe.

615-3130 Large Van de Graaff

With 400,000 volt potential, an amazing machine. Clear butyrate column affords full view of circling neoprene belt. Detailed instructions with experiments, 12.5" diameter stainless steel globe.

Pith Balls

615-3045 - Pack 12. Balsa wood, hole.

615-3050 - Pith balls with thread. Pack 6

615-3055 - Conductive, graphite-coated with thread, Pack 6.

615-3190 Wimhurst Machine

This classic device generates static electric charges and discharges, producing a higher current, with lower voltage, than the Van de Graaff generator. It consists of two high resistance plastic discs with equally spaced metal sections. The discs rotate in opposite directions with a hand crank. You can collect induced charge with the brushes and adjust the electrodes and Leyden jar capacitors for higher potential.

615-3116 Mylar Foil - 6 strands

For experiments in electrostatic repulsion. Tape to the dome of a Van de Graaff generator.

615-3172 Ball and Snake

When placed near a Van de Graaff generator, the mylar "snake" and the conductive ball behave in very different fashions.