

INSTRUCTIONAL GUIDE

Contents

- Van de Graaff Generator
 - Dome: 25 cm
 - Height: 76 cm
 - Maximum current: 10 μ A
 - Maximum potential: 350 kV
- Instructional Guide

Recommended for activities:

- [Discharge Electrode \(P6-3310\)](#)
- Candle
- [Electric Whirl \(P6-3340\)](#)
- [Volta's Hail Storm \(P6-3320\)](#)
- [Neon Wand \(P6-3360\)](#)
- [Flying Ball Silver Snake \(P6-3330\)](#)



Introduction

The Van de Graaff Generator is designed to attain potentials up to 350,000 volts or more under favorable operating conditions. Potentials of 250,000 volts are perhaps more usual and provide more than enough voltage for forceful demonstrations. All units are shipped completely assembled, ready to operate. The Van de Graaff Generator consists essentially of a motor driven belt that runs between pulleys, one on the motor shaft and the other inside the dome at the top of the column. The variable speed motor is controlled by a rheostat whose knob is on the front panel. When the Van de Graaff is new, it is normal for the motor to not start turning until the rheostat is almost at full speed. This is because the bearings in the motor and the upper pulley are still relatively tight. Over time those bearings will loosen up and the unit will start more easily.

Set-Up

As received, your Van de Graaff is ready for use. In a very small number of instances, the Generator may not initially perform to your expectations. This will almost always be the result of its most recent temperature cycling experience. If the unit is unpacked in a nice warm building after a number of hours in a cold delivery truck, there will be immediate moisture condensation on the belt and pulleys and no or very little charge may result. If, for any reason, your new Van de Graaff fails to perform, send an email to helpdesk@arborsci.com. Include your name, phone number and the best time to call. A technical representative will contact you with help to get back up and running.

Experiments

The Disruptive Arc:

One of the more attention-getting demonstrations using the Van de Graaff Generator is the arc discharge. Bring a round object, such as the Discharge Electrode, within 3 or 4 inches of the dome. Be

sure you have properly grounded the unit to the binding post on the top of the generator base. If the generator is operating up to voltage, there will be a sharp crack and a bright bluish-white arc as it jumps from the dome to the smaller electrode. With a discharge electrode of this size, about 4 inches in diameter, you can estimate the voltage on the dome at approximately 50,000 volts per inch of the maximum arc length. With a smaller diameter discharge electrode, the arc length would be greater but the intensity would be less.

Continuous Discharge:

If you point a finger at the dome from a distance of about 3 inches, you will feel a slight tingle on a continuing basis. If there is more of an intermittent zap, move your finger a little closer until the current flow is continuous. Instead of a finger, now hold a common nail or metal screwdriver pointed at the dome. Be sure to hold the screwdriver on some part of the metal and not by the handle. The effect of the metal point is more pronounced than the finger but, in both cases, we are continuously discharging the dome. If you now bring the Discharge Electrode near the dome while holding the nail, you will not get an arc as before. When this demonstration is performed in the dark, you will see a faint glow around the point of the nail. This is called a corona discharge. It is the continuous excitation and ionization of the air, causing the emission of light.

The Electric Wind:

Repeat the previous demonstration while holding a candle flame between the point (nail) and the dome, but nearer the point. You will see that the flame is bent over by a wind that is blowing away from the dome. The effect is caused by charged particles of air trying to get away from the dome and from each other. (Like charges repel one another.) The same wind effect can be seen by placing the N-127 Point Terminal on the side of the dome and holding the candle several inches away. A child's plastic pinwheel or thin sheets of facial tissue are excellent demonstration devices.

The Electric Whirl:

Bring an Electric Whirl near the dome when it is up to voltage. The three-arm pivoted assembly will immediately begin to turn. The direction of rotation will be away from the pointed ends of the spokes. What is happening is that the arms are being charged negatively by leakage from the dome and the points are in turn ionizing the air nearby. As these charged particles are repulsed by the point, there is also a reaction force that causes the arms to turn.

Volta's Hail Storm:

Bring the Volta's Hail Storm near the dome of the Generator and the small particles of vermiculite will immediately begin to jump up and down. They are first attracted to the upper plate, but when they get there, they receive a charge that causes them to be repelled. When the particles again reach the grounded lower plate, they lose their charge and then the process will repeat. Just holding the base will usually provide enough grounding for successful operation.

Smoke Precipitation:

Remove the vermiculite from the Volta's Hail Storm and stand the little piece of wire screen on edge. If necessary, roll the screen into a partial cylinder to help it stand on its side. Fill with smoke, replace the top and then bring the unit near the dome of the Generator. The smoke will immediately become charged and be attracted to one of the electrodes. It will vanish almost instantly.

Neon Wand:

The Neon Wand is a very sensitive indicator of the extent of the electrostatic field near the dome of the generator. Pointing the glass tube at the dome from a distance of 2 or 3 feet will cause it to light up with the typical neon glow. As you bring it closer to the dome, it will become brighter. Sticking a small piece of foam on the contacts at the end of the tube will give the very brightest output. In this case, the foam is providing a small amount of insulation so that the dome has to build up to a high charge level before it can arc to the tube. The neon tube receives quickly repeating high-energy discharges that cause more light to be discharged than with the continuous current flow.

The Flying Ball:

Hold the "fishing pole" of the Flying Ball so that the ball is perhaps 6 or 8 inches from the dome. Note carefully that, at first, it is attracted to the dome, but if it touches the dome, it is then violently repelled. Until this newly acquired charge is dissipated, the ball will "fly" at the end of its thread and remain quite far from the dome. If you touch the ball and thereby remove the charge, the performance will be repeated. First, attraction by induction, and then repulsion after it touches the dome. The round, smooth shape of the ball allows it to hold a charge for quite a long time.

The Silver Snake:

The Silver Snake is a metallized ribbon that will be attracted to the dome, but repelled as soon as it touches. Its geometric shape with edges causes the loss of charge into the air very quickly and so the cycle repeats.

Charging a Person's Hair:

This is fun for all the class but not necessarily an easy demonstration to pull off. If you can raise the entire person to the voltage level of the dome, then their hair should act in much the same way as the electric plume did.

First, the Van de Graaff generator is not a huge machine, so the smaller the volunteer you have selected, the better. There will be less surface from which to lose charge. Second, be sure there are as few "points" of loss as possible. Things like rings on fingers, metal barrettes, and belt buckles should be avoided. Next, be sure the machine is in good operating condition and is putting out plenty of voltage. Do not even think about trying this demonstration on a day of high humidity. The generator output will be low and leakage will be high.

Now insulate your volunteer from the ground by having them stand on something like a sturdy plastic milk crate or some glass building blocks. You need to get the subject about one foot above the floor. A rubber mat or plastic sheet simply will not work.

Have your volunteer place their hand on the dome and then start the machine. The subject must understand that they are not to remove their hand or they will receive a shock when they put it back. In a minute or so, the volunteer will have been raised to about as high a potential as you're going to get. If their hair is now standing up, you have succeeded. If not, it's time to consider what might be wrong.

Note: The repulsive forces available are relatively small and are quite insufficient to untangle hair or overcome any type of hair spray. The best results come from clean, straight, dry hair of perhaps 3 or 4 inches in length.

Maintenance

Keep the dome and column free of dust and fingerprints. Clean with a soft cloth and an aerosol dusting polish. If dust and grime are allowed to accumulate, they present thousands of little discharge points on the surface of the dome. They can easily reduce the available voltage by 50%.

The latex transport belt is slowly attacked by the oxygen in the atmosphere, just as is an ordinary rubber band. The ozone created during operation is even more damaging, and so the belt will need to be replaced from time to time. We suggest that you have one belt on the machine and one spare.

Replacement belts are always readily available and may be purchased directly from our website: <https://www.arborsci.com/products/van-de-graaff-replacement-belt?variant=18112075104329>

Troubleshooting

When you do not get any charging action, there are a number of possible causes.

Humidity: One of the first hurdles to get past is the present level of humidity and its effect on the belt and the lower pulley. The felt will absorb moisture over time and may need to be dried with an ordinary hair dryer. To do this, remove the base of the cabinet and lay the machine on its side. Remove the belt from the lower pulley and blow on the felt for 15 to 20 minutes. Be careful not to overheat.

Aged Belt: If the belt is old (more than 1 year), it may be oxidized on the surface and needs to be replaced. Use a newly manufactured belt, not one that has been sitting on the shelf in its package for several years.

Moist Belt: If the belt is not old, it may have a small amount of moisture on its surface or absorbed into the light coating of talcum powder. It can often be revived by putting a small amount of fresh talcum powder in a plastic bag along with the belt. Shake it up for a minute or so to get it completely coated. Remove the belt and wipe it off with a clean, dry paper towel.

Brush Positioning: Finally, check the positioning of the upper and lower brushes. Both should be positioned with points or ends of the wires pointing directly at the belt (perpendicularly), leaving an air gap of about 4-5mm. Putting them closer does not improve performance – it only increases the chance of snagging the belt or scratching a pulley. In normal operation, the pulleys should last many years. If, however, the felt has worn away on the lower pulley or the coating on the upper pulley is embedded with grime and rubber particles, they should be replaced.

Related Products

Hand Crank Van de Graaff (P6-3400) Now you can demonstrate all of the classic Van de Graaff experiments for less! Our new hand-crank model can develop potentials of up to 200 kV and produce a spark 3.2 inches long.

Electrostatic High-Voltage Genecon (P6-2640) This hands-on alternative to traditional “Van de Graaff” generators allows electrical discharge experiments to be performed in the classroom with far greater ease and less cost. Gently turn the handle to generate more than 10,000V of high voltage static electricity!

Friction Rod Kit (P6-1600) Explore charging by friction, positive and negative charge, and attraction and repulsion with the friction rod kit. Includes glass and hard rubber rod, silk and faux fur pads, bubble wrap, glass rod mounted on pivot needle, and complete instructions.