

Van de Graaff Generator

User Guide



Cautionary and Warning Statements

- This kit is designed and intended for educational purposes only.
- Use only under the direct supervision of an adult who has read and understood the instructions provided in this user guide.
- Read warnings on packaging and in manual carefully.
- Always exercise caution when using sharp tools.
- This product produces static electricity discharge. Persons with known heart conditions or cardiac pacemakers should not use this product.

How the Generator Works

Invented by American physicist Robert J. Van de Graaff in the 1920s, the Van de Graaff generator experiment has been a part of science classes for decades. It is an easy way to show students how an electric charge can be transferred.

So how does a Van de Graaff Generator work? The explanation can get quite complicated, but following is a short version.

The charge begins with the belt and rollers. As you crank the generator, the rollers become electrically charged as they come into contact with the moving band. When the band goes around the lower roller, it collects negative charges (electrons) on the surface of the band. As the band travels up and touches the upper roller, some electrons are transferred to the roller and to the metal globe. This gives the globe a negative charge, and that, with the negative charge of the band, creates an electric field on the surface of the globe.

Then we see the Faraday Ice Pail Effect come into play. This effect was discovered by 19th-century scientist Michael Faraday when he put an object with a small charge into an ice pail and noticed that the object would transfer its charge to the pail. In our case, the steel globe is the pail.

Materials Included

Warning: When sorting the parts, do not touch the surfaces of the white and silver rollers. Oil from fingers can cause them not to work. Handle them by the metal dowel ends sticking out or use a tissue to cover the roller.

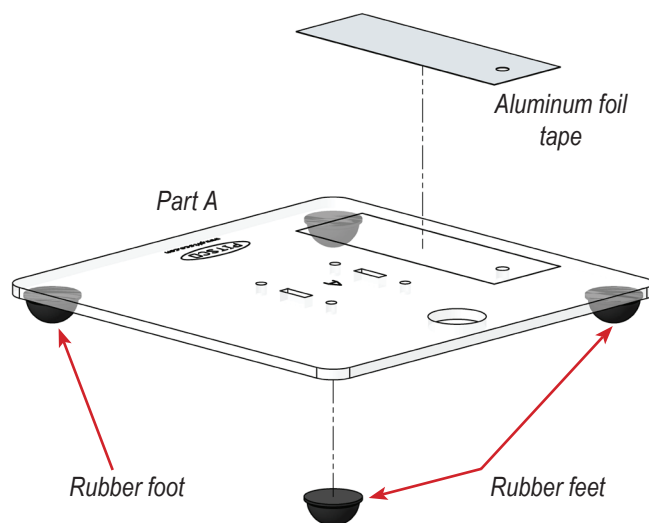
- 9 laser-cut parts
- 2 large rubber bands (1 extra)
- 4 – 4-40 x 1/2" screws
- 4 small hex nuts
- 2 large hex nuts
- 12 – 6-32 x 3/8" screws
- 2 – 6-32 x 3/4" screws
- 2 – 6-32 x 1" screws
- 4 – 1" stand-off posts
- 4 kep nuts
- 2 acorn nuts
- Nylock nut
- 5/8" nylon spacer
- #4 nylon flat washer
- #6 nylon flat washer
- 6 bushings
- Silver roller
- White roller
- 1-3/4" metal dowel pin
- 10-tooth pinion gear
- 60-tooth gear
- 2 leads with alligator clips
- 2 wires with ring terminals
- Aluminum foil tape
- 4 self-adhesive rubber feet
- Steel globe

Items Required (not included)

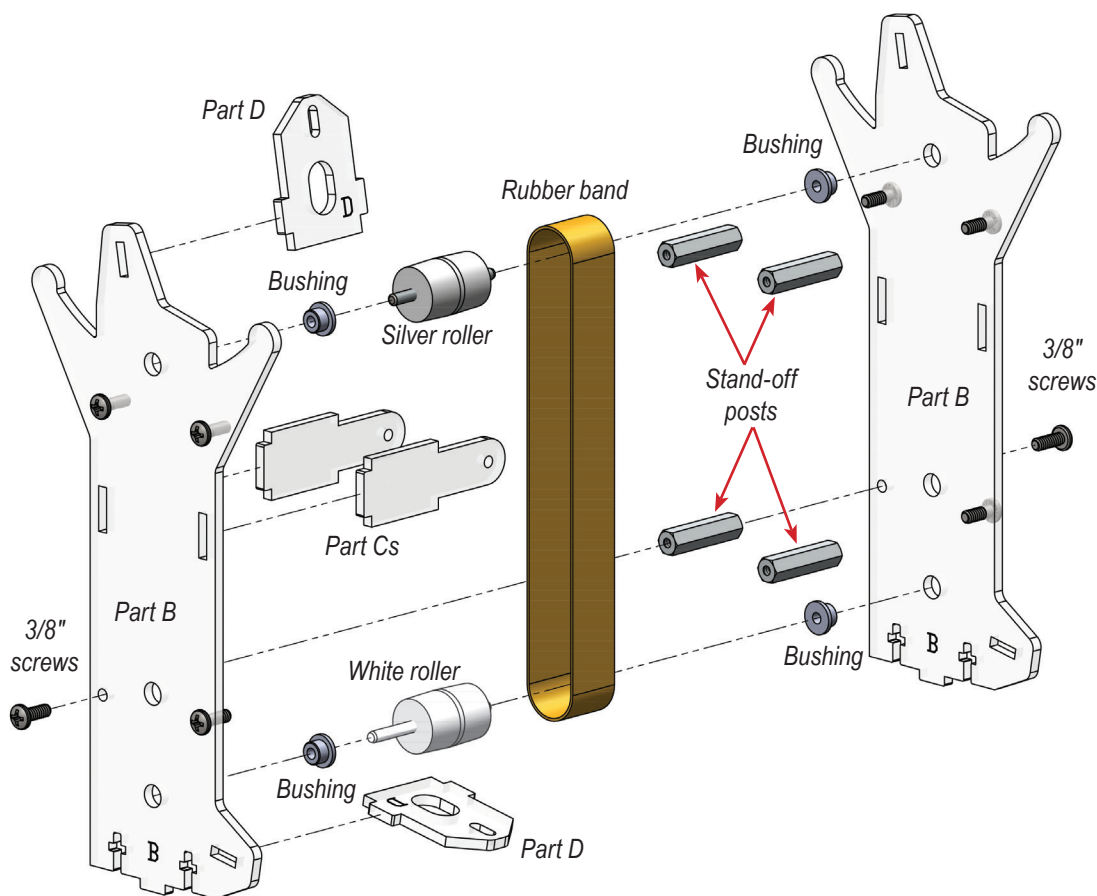
- Phillips screwdriver
- Scissors
- Transparent tape (for activities)
- Thread (for activities)
- Paper rings or paper punch holes (for activities)
- Paper clip (for activities)
- Tissue (optional)
- Aluminum (for activities)

Building the Generator

1. Peel off the backing from the laser-cut parts.
2. Peel off the backing from the self-adhesive rubber feet and apply them to the four corners of Part A, which is the base.
3. Cut the aluminum foil tape to fit the rectangular etching on Part A. Remove the backing from the tape and place it firmly over the etching. Where there is a small hole in Part A, punch a hole through the aluminum using the scissors.
4. Place the bushings into the holes down the center of the two Part Bs. To do this, lay the two parts as mirror images with the "toes" pointing away from each other. In the top and bottom holes, insert a bushing. Flip the two parts over and insert a bushing into the middle hole – the middle bushing needs to face the opposite direction as the others (shown on next page).



Exploded view of Steps 2-3



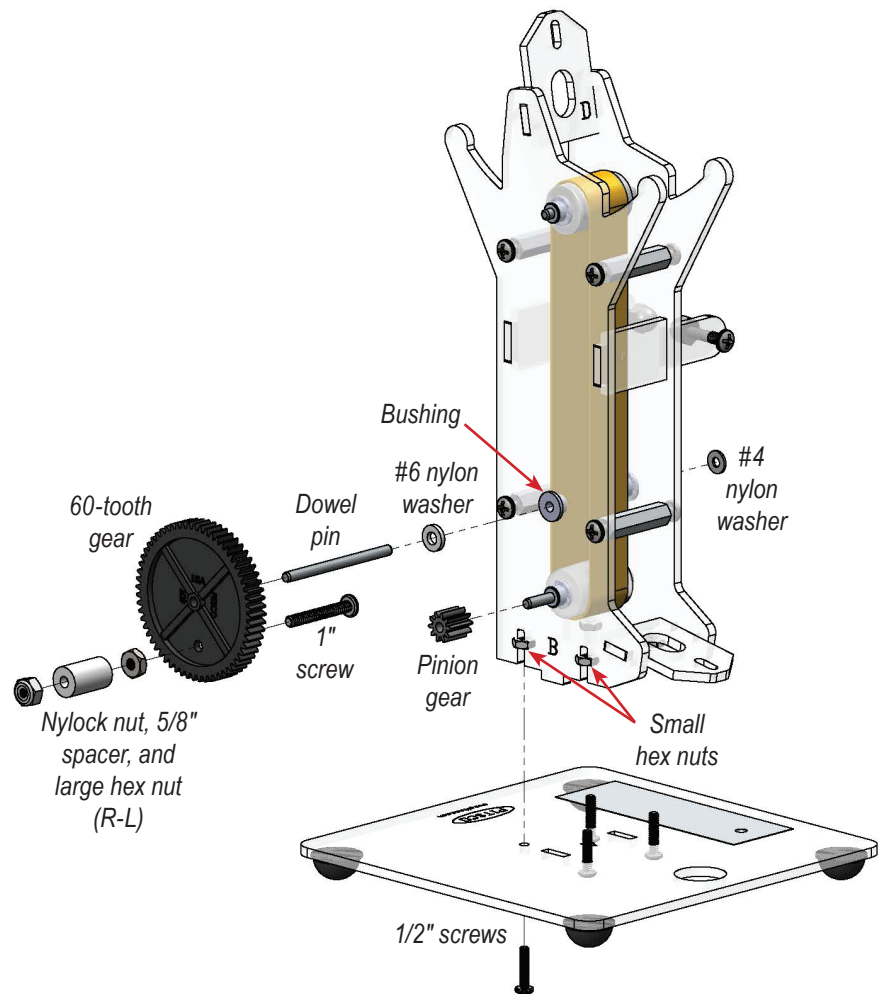
Exploded view of Steps 4-8

5. Take one Part B and note the four holes on the edges. In each of these, insert a 3/8" screw and thread a stand-off post onto the end of each screw.

Warning: When handling the white and silver rollers, do not touch the surfaces as oil from fingers can cause them not to work. Handle them by the metal dowel ends sticking out of the roller or use a tissue to cover the roller.

6. Take the silver roller and place a large rubber band over it. Insert the dowel end into a top middle hole in the Part B that has the stand-off posts. Holding the shorter dowel end, take the white roller and put it inside the other end of the rubber band, inserting the longer dowel end into the bushings in the bottom hole on the same Part B.

7. Take the two Part Cs and insert the small, notched ends into the slots toward the middle of Part B. Take the other Part B and place it over the curved ends of the Part Cs and onto the stand-off posts. It should mirror the other Part B. Using four more 3/8" screws, very loosely secure the remaining Part B stand-off posts (you want the assembly to be wiggly).
8. With the pointed end up, slip one Part D into the two notches at the top of the Part Bs. Slip the other Part D into the toes with the pointed end facing out. Now, completely tighten the screws on the stand-off posts.
9. Take the pinion gear and firmly place it on the longer dowel end of the white roller.
10. Place the entire assembly on top of the base with the toes over the base's large hole. With these together, hold in place a small hex nut into the small slot just behind the toes. Insert a 1/2" screw from under the base so it twists into the hex nut. Continue to tighten the screw. Repeat with the three other holes, hex nuts, and 1/2" screws.
11. Carefully push the metal dowel pin into the large gear's center hole so the pin is flush with the other side. Push a 1" screw through the side hole on the large gear and thread a large hex nut over it. Place the 5/8" nylon spacer over the nut. Secure using the Nylock nut. Place the #6 nylon washer over the dowel pin and insert the pin into the two middle holes with the bushings on the generator. Place the #4 nylon washer over the end to keep it in place.

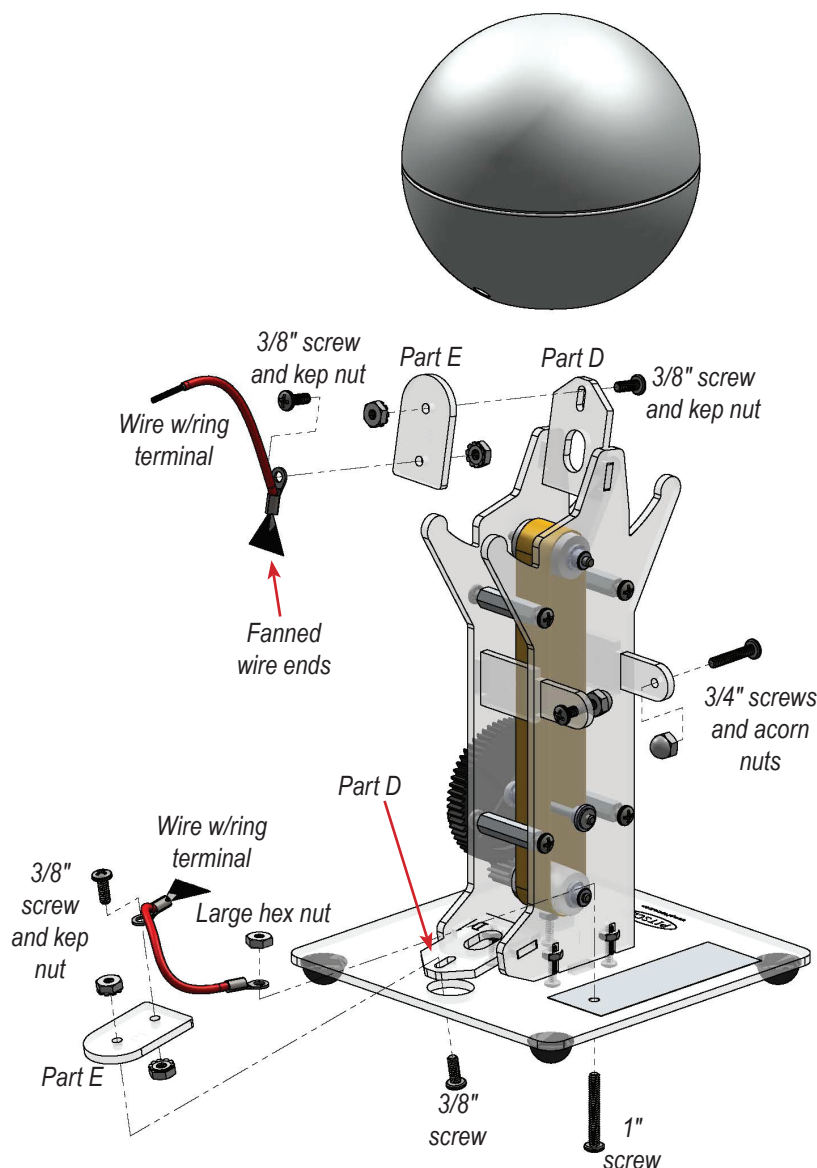


Exploded view of Steps 9-11

Wiring the Generator

1. Locate the two wires with ring terminals. On the ends that have exposed wire just above a terminal, flatten and spread out the wire ends like a fan. Trim the wire ends so the fan is straight across, but don't trim too much off the wire.
2. Bend the fan over so the terminal sticks out from the wire a bit. Place the fanned end of the short wire and secure it in the hole closest to the straight edge in Part E using a 3/8" screw and a kep nut. Take the other end of the wire and place the ring over the small hole in the aluminum. Insert a 1" screw from the underside of the base through the ring and secure it using a large hex nut.
3. Place Part E on top of Part D near the bottom of the generator. Slide Part E up so the wire fan is almost touching the rubber band. Secure Parts D and E together using a 3/8" screw and a kep nut, keeping the fan in that position.
4. Take the longer wire and secure the fan end of it to the other Part E using a 3/8" screw and kep nut part. Lay this part over the Part D on top of the generator, curved side up, so the end of the screw is in the slot on Part D. Slide this so the wire fan is almost touching the rubber band. Secure Parts D and E together using a 3/8" screw and a kep nut, keeping the fan in that position.
5. Using the 5/8" spacer as a handle, turn the rubber band enough to ensure the rubber band never touches either wire fan. If it does, readjust the Part Es so the wires do not touch the rubber band at any point but are very close to it.
6. Thread the two 3/4" screws, pointed at each other, into the ends of the Part Cs. On the end, screw the acorn nuts onto the screw ends.
7. Take the loose end of the top wire and make sure it is sticking up. Place the silver globe over the top, making sure the top wire touches the inside of the globe.

You are now ready to start experimenting! Check out the next section to see some activities for the Van de Graaff Generator.



Exploded view of Steps 1-7



Completed generator

Generator Activities

Caution: This product produces static electricity discharge. Persons with a known heart conditions or cardiac pacemakers should not use this product.

- Turn the globe so the small hole on the side is lined up with the bottom Part E. Clip one of the leads onto the small globe hole; clip the other end to the bolt handle (on Part C) nearest it. Take the other lead and clip one end to the screw end sticking up from the aluminum; clip the other end to the bolt handle on the right. Crank the generator (Figure 1) – you should hear a snapping sound and see an intermittent spark between the two acorn nuts.
- Tape a 6" to 8" piece of string on top of the globe. Turn the crank and watch as the static charge lifts the string ends off the globe. Add more strings at the top and see how many you can make lift from the globe. The string ends will also follow your finger due to the static electricity (Figure 2).
- Place a paper ring or several rings of different diameters on top of the globe (Figure 3). Crank the generator and watch them fly off. You can do the same thing using a pinch of paper punch holes.

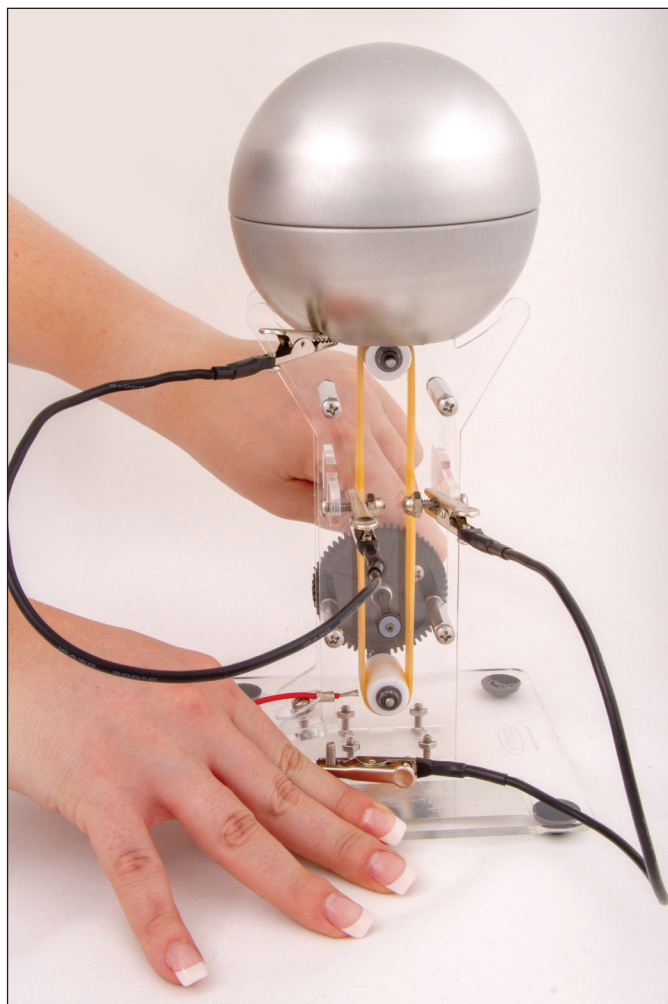


Figure 1



Figure 2



Figure 3

- Tie a piece of string on one end of a paper clip. Crush a small wad of aluminum around the other end of the paper clip. While one person turns the generator, the other hangs the aluminum ball so it touches the globe briefly and then pulls it away and slowly brings it closer again. The static electricity should repel and push away the ball (Figure 4).

Troubleshooting

- Heat and humidity can greatly hinder the generator's ability to work properly. Try to use it during colder weather with low humidity.
- To see if the generator works in your current conditions, you can clip the leads from a voltmeter to the wire ends. The voltmeter should be set to DC volts. Crank the generator – the voltmeter should read between 5 and 7 volts.
- If anyone accidentally touches the two rollers, wash them using regular Dawn dish soap and water. Dry them completely and quickly. Never soak the rollers in water.
- When using your Van De Graaff at very slow speeds, you might notice that the handle is hard to turn or sticks in certain locations. Please examine the large gear for a noticeable burr or flashing as noted in Figure 5. This could cause the gear to feel as if it were stuck. Eliminate this issue by using an object to carefully scrape or remove the burr or flashing from between the gear teeth.



Figure 4

Burr or
Flashing



Figure 5



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