



## 8.1 Van de Graaff generator

**Warning:** People with a heart condition, such as wearing a pace-maker, must not come into close contact with a Van de Graaff generator in operation.

**Aim:** To demonstrate an effect of ionisation of air, the effect of a lightning conductor to discharge a charged cloud, and to map the electric field around your head when charged.

### Equipment:

- A Van de Graaff generator
- An earthed metal sphere
- An electrostatic windmill: an J-shaped metal rod with tapered ends that can be balanced in the middle from a sharp vertical point, from the top of the Van der Graaff generator, so that it can rotate freely
- A sharp point
- A plastic step or box that can support the weight of a person
- Comb



### Demonstration 1

- Place the earthed metal sphere about 20 cm from the Van de Graaff generator. The best method to do this is to attach the earthing cable to the water supply. If the Earth used is the same as that of the Van de Graaff generator then the mains power might trip due to the current surge in the mains circuit during a discharge.
- Switch on the Van de Graaff generator and observe the discharges that jump between the generator and the earthed sphere.
- Switch off the generator and discharge it using the earthed sphere.

### Explanation

Due to the electric field set up between the generator and the earthed sphere, ionisation of the air occurs, providing a conduction path between the generator and sphere. As the discharge occurs light is generated that can be seen, similar to a lightning strike.

### Demonstration 2

- Repeat the above demonstration, but when the discharges between the generator and earthed sphere are occurring point a sharp point at the generator from a distance of about 1.5 to 2 m.
- Observe that the frequency of discharge reduces significantly or even ceases.
- Stop pointing the sharp point at the generator and the discharges resume.

### Explanation

Ionisation of the air occurs at the tip of the sharp point causing an ion beam to slightly reduce the charge on the generator. This means that the generator takes longer to charge up for the electric field to be sufficiently high to cause ionisation and a discharge between generator and earthed sphere. Lightning conductors not only provide a safe current path to Earth of a charged cloud, but also reduce the probability of a lightning strike by slowly discharging the cloud.



### Demonstration 3

- Attach the sharp point to the top of the generator on to which the electrostatic windmill can rest and rotate freely.
- Switch on the Van de Graaff generator and observe the electrostatic windmill rotate.
- Switch off the generator and discharge it using the earthed sphere.

### Explanation

Ionisation of the air occurs at the tips of the electrostatic windmill due to the accumulated charge at the points. This ionisation causes a stream of ions to be emitted away from the tips of the windmill. The tips of the windmill recoil, due to the conservation of momentum, resulting in a rotation of the windmill.

### Demonstration 4

- Ask a volunteer with medium length hair to stand on the insulating step or box whilst touching the generator with one hand and holding the comb in the other. To avoid an electric shock it is important that the volunteer does not let go of the generator or come in to close contact with an object at Earth potential.
- Switch on the Van de Graaff generator and observe the volunteers hair stand up on end. The volunteer can make a most impressive effect if the hair is combed in an upward direction.
- Switch off the generator and discharge it using the earthed sphere.

### Explanation

The hairs on the volunteer's body become charged and repel each other. On the head they move as far as possible from each other by standing on end. In fact, they follow the electric field lines.