Investigate Electrostatic Property

What is Electroscope?

NaRiKa Corporation

What is Electroscope?

1. Learning Outcome

This sub-unit is to enhance students' understanding of the principle of Ball Electroscope and Leaf Electroscope that accelerates their comprehension of "Electrostatic Properties".

Hence, teachers need to teach the principles and by demonstration enhance students' better understanding on how materials are/are not charged and the charge transfer.
Note that this sub-unit is inevitable to advance to the upcoming section "Students' research activity".

2. Historical Background

Electroscope is regarded as the first electrometric equipment originally invented by W. Gilbert (1544-1603, UK) for measuring intensity of electrostatic charge of a human body. His invention is called "Virsorium" similar to the compass in form.

Afterward, in 1754, John Canton (1718-1772, UK) invented the "Pith-ball electroscope", followed by the "Gold-leaf electroscope" invented by Abraham Bennet (1749-1799) in 1787.

They had been exploring the properties of static electricity by using these electroscopes.
Hereafter, students will work on comprehending the principles and researching the properties of static electricity by using the Ball electroscope and Leaf electroscope.

Gilbert's Virsorium

Pith-ball electroscope

Gold-leaf electroscope

http://en.wikipedia.org/wiki/Electroscope

Nowadays, the pendulum-shaped electroscope (Electric pendulum) and/or the Leaf electroscope, shown below, are widely used as science educational equipment.
On the other hand, for the industrial purpose, the "Ne-light-emitting Electroscope" and/or the "Electrical circuit Electroscope" are widely used to secure workers' safety during electrical equipment inspection.

Large Electric Pendulum (Narika B10-1131)

Leaf Electroscope LE-A (Narika B10-1170)

3. Experiment

1. What is Electroscope?

You need to monitor (the behavior) of static electricity in order to confirm its properties. Hence, you should introduce an electroscope to students as an approach to measure the intensity of static electricity.
Also provide to the students a brief explanation about the properties of static electricity along with the supplementary information that are related to demonstration of Ball Electroscope by John Canton(1718-1772, UK) in 1754 and of Leaf Electroscope by Abraham Bennet (1749-1799, UK) in 1787.

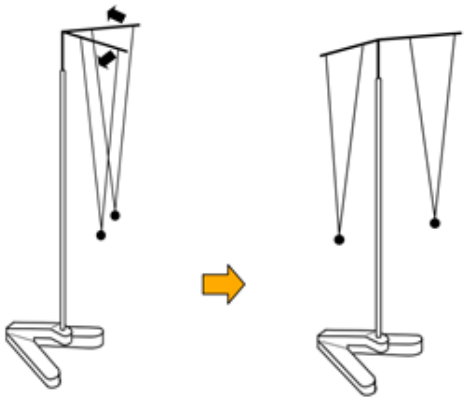
2. Ball Electroscope

As we confirmed in the previous unit through the demonstration of the “Butterfly and Balloon” and the “Electric Jelly Fish”, we learned: 1) Eelectrostatic charging occurs by rubbing different materials, and 2) there are two types of forces: attracting force/repelling force.
In this unit, we will learn the principle of and how to use the **Ball Electroscope** as an advance preparation for upcoming in-depth experiments.

1. What to prepare

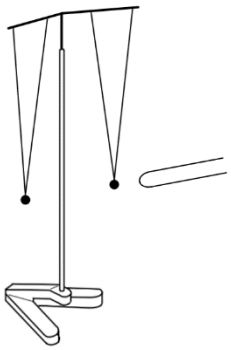
- Electrodes (Polyvinyl chloride (PVC), Acrylic)
- Felt or Wool
- Large Electric Pendulum EP-A (Narika B10-1131)
- PVC board (as a setting board)

2. Experimental Procedure

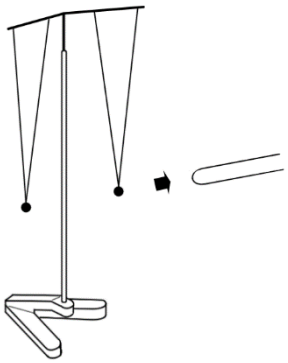


1) Separate the two balls to each other by moving the bars.

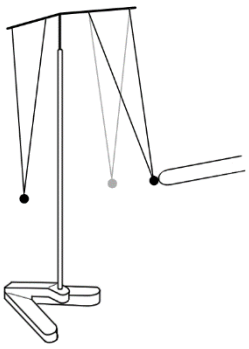
2) Charge the PVC electrode by rubbing it with a felt cloth.



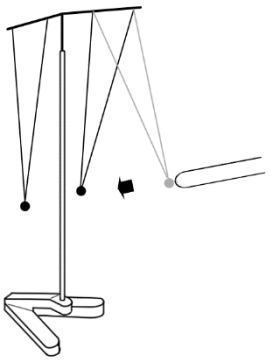
3) Slowly bring the charged PVC electrode near either of the balls.



4) The ball is coming close to the charged PVC electrode.



5) The ball and the PVC electrode touch each other.



6) The ball separates from (repels) the electrode.

[Tips for the demonstration:]

- During the above procedure 3), do not touch the ball with the electrode.
- Sufficiently dehumidify the classroom.
- As needed, set the electroscope on the PVC board (as a setting board) to avoid electrical leakage to the table.

3. Leaf Electroscope

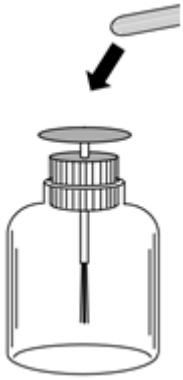
As we confirmed in the previous unit through the demonstration of the “Butterfly and Balloon” and the “Electric Jelly Fish”, we learned: 1) Eelectrostatic charging occurs by rubbing different materials, and 2) there are two types of forces: attracting force/repelling force.
In this unit, we will learn the principle of and how to use the **Leaf Electroscope** as an advance preparation for upcoming in-depth experiments.

1. What to prepare

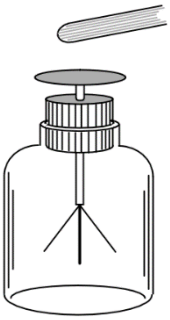
- Electrodes (polyvinyl chloride (PVC), acrylic)
- Felt or Wool
- Leaf Electroscope (Narika B10-1170)
- PVC board (as a setting board)

2. Experimental Procedure

1) Rub the electrode with a felt cloth or a wool.

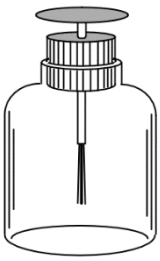


2) Bring the charged electrode near the metal circular plate of the Leaf Electroscope.



3) Observe the leaves in the electroscope bottle spread.

4) Separate the electrode from the Leaf Electroscope.



5) Observe the leaves in the electroscope bottle unspread.

[Tips for the demonstration:]

- Leaf Electroscope has to be properly cleaned. If covered by dust, the experiment will fail.
- Do not dismantle the Leaf Electroscope. Once dismantled, it will never work again. Try not to touch the electrode with the metal circular plate of the Leaf Electroscope. If touched, the leaves remain spread. In order to reset the spread leaves, just touch the metal circular plate with your finger.

4. Technical Description (Ball Electroscope/Electric Pendulum)

As confirmed in the previous unit through the demonstration of the "Butterfly and Balloon" and the "Electric Jelly Fish", you should raise question to your students if they have comprehension in that electrostatic charging occurs by rubbing two different materials.

Originally two electroneutral materials become charged when they are rubbed with each other and the electrons of one material are transferred to the other material. This is the proof that static electricity consists of two types electrical charges: "plus (+)" and "minus (-)".

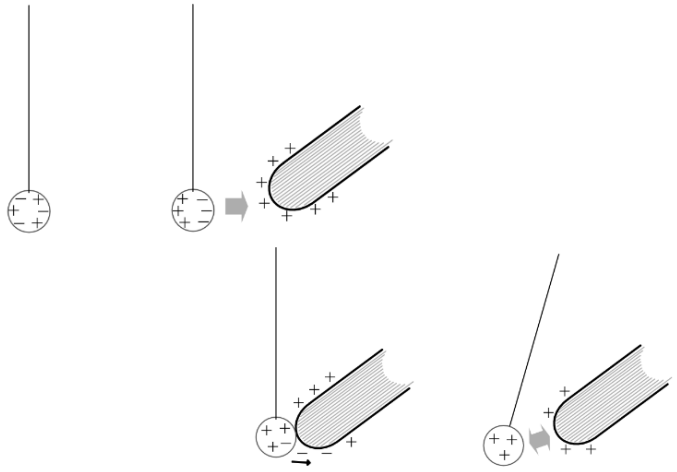
The same charge repels each other, while the different charge attracts each other.

Even though the type of the "Electrical-charge" cannot be detected by using **Ball Electroscope** (Electric Pendulum), same/different charge can be determined in accordance with the force (repulsing or attracting) occurred between the ball and the electrode.

When a charged electrode is brought near the ball, the ball also comes close to the electrode, which shows they move closer due to the different charge. If the charged electrode touches the ball, the ball separates from the electrode, which shows they repel due to the same charge.
Ball Electroscope's ball (Electric Pendulum) are carbon-coated conductive spheres: hence if a positively charged electrode is brought near the ball, the half side of the ball closer to the electrode becomes negatively charged and comes close to the electrode. In other words, the free

electrons in the ball are drawn towards the side nearer the positively charged electrode and the half side of the ball is negatively charged.
Meanwhile, the other half side of the ball farther from the electrode becomes positively charged due to the less number of electrons. This phenomenon is so-called “Electrostatic Induction”.

Also, when positively charged electrode touches the ball, the entire ball becomes positively charged as it allows the electrons to flow out from the ball causing the scarcity of electrons in the ball. Eventually, the ball repulses the electrode behaving as if it escapes from the electrode.

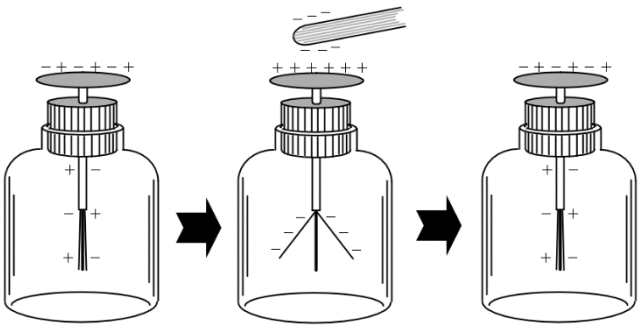


5. Technical Description (Leaf Electroscope)

The leaves inside the bottle of and the metal circular plate of the Leaf Electroscope maintain electroneutrality unless they are charged. Type of the “Electrical-charge” cannot be detected by using **Leaf Electroscope** likewise you can not do so by using Ball Electroscope (Electric Pendulum).

For instance, when a negatively charged electrode is brought near the metal circular plate of the Leaf Electroscope, the electrons in the plate move towards the leaves through the shaft repulsing the negative charge of the electrode.

There are two leaves and a small metal plate in between inside the bottle. When the leaves are negatively charged, they spread repulsing each other. The metal circular plate becomes positively charged after the electrons flow towards the leaves. If a electrode is separated from the metal circular plate, the leaves become unspread again as the electrons collected at the leaves go back to the metal circular plate.



6. Wrap-up and Bridge-building to the following Units

1. In this unit, we learned two types of electroscopes: Ball Electroscope (Electric Pendulum) and Leaf Electroscope.
2. You can understand how things are charged, however, cannot detect the polarity.
3. In the next unit, you will learn, through experiments of detecting polarity, that different materials have different ways of charging.

NaRiKa Corporation
http://www.global.narika.jp