Static Electricity in Our Life

NaRiKa Corporation

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1. Learning Outcome

Most of us have painful experience from sudden electrical shock by touching metallic doorknob of our homes, vehicles and so forth, especially, during the dry winter months. This phenomenon occurs when whole our bodies take static electricity by friction of our clothes.

In this chapter, through the experiments of acquiring static electricity by rubbing things around us, you should understand that electrostatic charging occurs by friction between different kinds of matter.

2. Historical Background

As early as 600 B.C., static electricity seems to be recognized as the phenomenon of attracting dusts when rubbing amber with fur.

In 1600, W. Gilbert (1544-1603, UK) discovered that electrostatic charging occurs when rubbing amber with cloth through the phenomenon of lightweight matter being attracted by another matter rubbed by cloths and so on. He also discovered that electrostatic charging occurs likewise when rubbing other materials than amber, such as diamond, crystal, glass and sulfur, through which observation he named this electrical phenomenon “electricity”, that is a Latin word for amber.

In the 17th century, in addition to the attracting action, the phenomenon of static electricity to repulse things was also discovered.

4. Teacher’s Demonstration (Teacher’s Experiment)

Teachers select one (preferable) topic out of below options to demonstrate for his/her students, repeating, if possible, several times in order to stimulate students’ better/deeper observations.

- Exp.1. “Electric Jelly Fish” (Bundled plastic strings floating in the air)
- Exp.2. “Butterfly and Balloon” (Butterfly-shaped polyethylene film floating above a balloon)
- Exp.3. Plastic and Static Electricity

Sufficient advance preparation and rehearsal are required for teachers. Note that effectiveness of experiment on the static electricity specifically depends on the experiment environment. Thus, pay attention to keep good condition of the laboratory room in accordance with weather of that day, especially, in terms of dehumidification.

Exp.1: "Electric Jelly Fish" (Bundled plastic strings floating in the air)

Objective of this experiment is to dynamically show students the phenomena of static electricity and its repelling property by using a set of bundled plastic strings floating in the air.

This is so-called "Electric Jelly Fish" experiment because the strings floating in the air resembles a "Jelly Fish" in the sea. Students should learn the occurrence of static electricity through the friction of two different things.

1. What to prepare:

- Plastic string: Nylon string generally used as packthread
- PVC pipe: 0.5 ~ 1.0 m long, larger than 5 cm in diameter
- PVC board: As large as letter size, around 1 mm thick
- Felt cloth: Any commercialized product

2. Procedure for making an "Electric Jelly Fish"

1) Cut off the plastic string of approx. 30 cm length.
2) Tie a knot in one end of the string.
3) With your fingers, tear the string lengthwise into narrow strips from the other end.
4) If the string is sufficiently torn into narrow strips as shown in the Figure 1 then, you have created a so-called "Electric Jelly Fish".

3. Demonstration (Teacher's Experiment)

1) Place the "Electric Jelly Fish" on the PVC board.
2) Rub the "Electric Jelly Fish" several times using felt cloth.
3) Leave the "Electric Jelly Fish" as it is on the PVC board.
4) Grab the PVC pipe with your hand.
5) Rub the PVC pipe with felt cloth.
6) Hold the PVC pipe with the hand.
7) Pick up the "Electric Jelly Fish" on the PVC board with the other hand and throw it into the air.
8) Swiftly set the PVC pipe beneath the "Electric Jelly Fish" in the air.
9) You should see the "Electric Jelly Fish" remaining suspended in the air due to the repelling force of static electricity occurred between the PVC pipe and the "Electric Jelly Fish".

4. Tips for the demonstration

- Minimize weight of the "Electric Jelly Fish" as much as possible, because the weight is one of the key factors to successfully make the experiment by remaining the "Electric Jelly Fish" suspended in the air.
- Optimize the length and width of each strip of the "Electric Jelly Fish", because they are also the key factors to successfully make the experiment.
- Throw the "Electric Jelly Fish" into the air as high as possible (preferably, close to the ceiling), so that you have enough time to set the PVC pipe beneath the falling "Electric Jelly Fish".
- Keep the PVC pipe charged enough by sufficiently rubbing it with felt cloth.
- Dehumidify the laboratory room sufficiently by using air-conditioning equipment, as needed, because high humidity adversely affects this experiment.

If your rehearsal cannot be successfully carried, we recommend you switch to another experiment (2. "Butterfly and Balloon"), because the Exp.1. is always significantly affected by the environment in the classroom.

Fig. 1.

5. Question

Guess what kind of force is there between PVC stick and "Electric Jelly Fish" (a set of bundled plastic strings)!

Exp2: "Butterfly and Balloon"

Objective of this experiment is to show students the phenomena of static electricity as follows.

[1] Prepare an inflated balloon and a "butterfly" made by polyethylene (PE) film (As shown in Figure 4, fold a square PE film in half and cut the film in shape of butterfly.

[2] Confirm the inflated balloon would stick with teacher's (or student's) clothes or wall if charged by being rubbed with felt cloth and being pressed against your clothes or wall. (See Figure 2 and 3.)

[3] Throw the "butterfly" (the PE film) overhead after rubbing it with felt cloth.

[4] Bring the charged balloon beneath the "butterfly" still in the air to show students the "floating-butterfly" above the balloon".

All of above triggers the students' curiosity for and interest in the phenomena of static electricity.

1. What to prepare:

- Prepare several different types of rubber balloons of dia. around 20 cm.
- Prepare a "butterfly" made of polyethylene (PE) film of 5 μm-thick.
- Prepare felt cloth (or silk cloth).

2. Demonstration (Teachers' Experiment)

1) Rub an inflated rubber balloon with felt cloth so that it becomes charged.
2) Bring the charged balloon close to your clothes and/or students' ones.
3) Show the students that the balloon would stick with the clothes.
4) Then, show them that the balloon would also stick to anywhere like ceiling and walls.
5) Rub the "butterfly" made by PE film with felt cloth (or silk cloth) so that it becomes charged.
6) Rub the balloon again with felt cloth (or silk cloth) so that it becomes charged.
7) Throw the "butterfly" overhead.
8) Bring the balloon beneath the "butterfly" while it is still in the air.
9) Show the students the "floating-butterfly" above the balloon

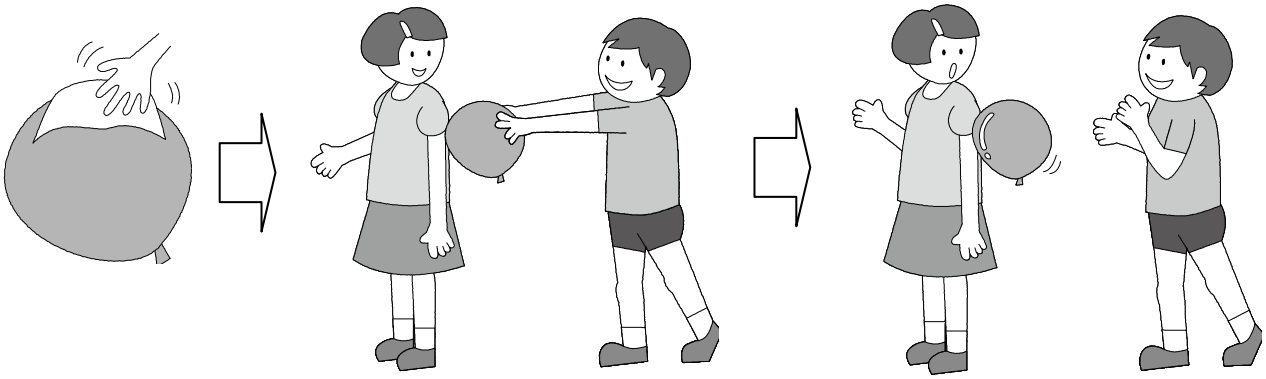

Fig. 2.

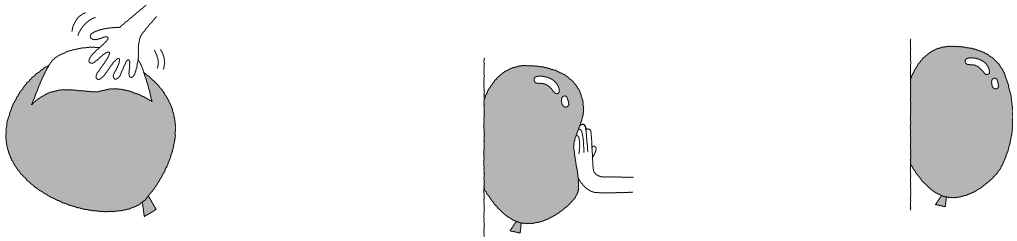

Fig. 3.

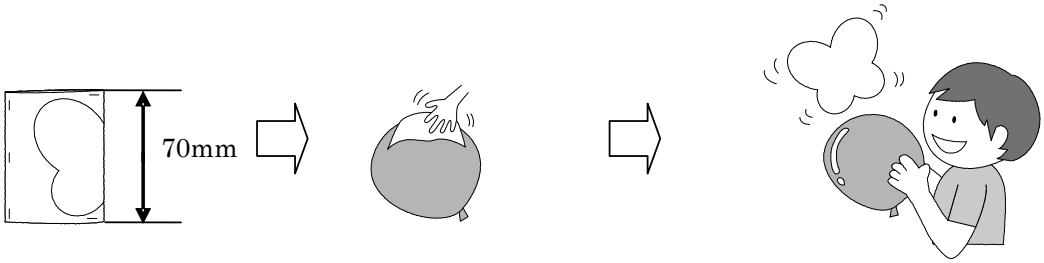

Fig. 4

3. Tips for the demonstration

1) Completely get rid of stains/dust on the surface of the balloon. Balloon becomes less electrifiable with stains/dust on its surface.
2) Keep the balloon dry because it becomes less electrifiable with humidity around it.
3) Demonstrate with student who is wearing clothes made from cotton fabrics or chemical fiber, which better attracts charged balloon.
4) The thinner the PE film for the "butterfly", the better performance you can expect.

4. Questions

Guess what kind of force is there between the rubber balloon and the wall!
Guess what kind of force is there between the rubber balloon and the "butterfly"!

3. Interaction between Plastics and Static Electricity

Hold a PVC board over slips of paper after rubbing it with felt cloth in order to show students that the paper slips jump to the board.

Likewise, show them how the paper slips behave (or not) by using an acrylic board or an electric-generating stick, instead of a PVC board, in order to enhance their understanding that electrostatic charging occurs by friction between matter.

1. What to prepare

●PVC board: 10x20 cm (Thickness of approx. 1 mm)

- Slips of white paper (Copier paper): Cut out many pieces of white paper, size 5 mm square shaped
- Black paper: Letter size
- Felt cloth
- Digital camera and monitor (if any)

2. Demonstration (Teacher's Experiment)

1) Place a black paper on the table.
2) Spread (scatter) the slips of white paper on the black paper.
3) Charge the PVC board by rubbing with felt cloth.
4) Bring down the charged PVC board slowly close to the spread slips of white paper.
5) With students, observe how the slips jump to the PVC board by using Digital camera connected with monitor.

3. Tips for the demonstration

- Sufficiently keep the black paper dry because wet papers would not be able to retain static electricity.
- Sufficiently keep the slips of white paper dry because wet papers would not be able to retain static electricity.
- Sufficiently charge the PVC board by rubbing it with felt cloth.

4. Discussion

Teachers should ask students questions about the phenomena found in the demonstration, describing students' feedbacks on blackboard as much as possible. It is recommended for teachers, in terms of effectiveness of the class, to drill down each phenomenon by repeatedly making questions based on one of the students' feedbacks.

A lot of feedbacks may be expected during the discussion time, and more importantly, teachers should nurture following learning outcomes in their students through the discussion time.

- Electrostatic charging (static electricity) occurs by friction between matter. This is why it is called "frictional electricity".

- Static electricity (static charging) has attracting force and repelling force; likewise magnet attracts/repulses each other.

As early as 600 B.C., static electricity seems to be recognized as the phenomenon of attracting dusts when rubbing amber with fur.

In 1600, W. Gilbert (1544-1603, UK) not only discovered that electrostatic charging occurs when rubbing amber with cloth, but also, interpreted the earth as a huge magnetic making the arrow on a compass always point north and south, further stating the difference between electrical attractiveness and magnetic attractiveness.

He also discovered that electrostatic charging occurs likewise when rubbing other materials than amber, such as diamond, crystal, glass and sulfur, through which observation he named this electrical phenomenon “electricity”, a Latin word for amber.

5. Conclusion and Bridge-building to the following Units

Lastly, it is recommended for teachers to wrap-up Unit 1 and to give question(s) to students as a bridge-building to the following Units, by emphasizing followings to students:

- Static electricity had already become known around 1600.
- Electrostatic charging (static electricity) occurs by friction between matter.
- Static electricity (static charging) has attracting force and repelling force.

More importantly, learning static electricity is the first and inevitable step to understand (dynamic) electricity that drives home electrical appliances around us. Ever since W. Gilbert (1544-1603, UK) discovered that electrostatic charging occurs when rubbing amber with cloth, scientific giants explored the study of (static) electricity that resulted in our utilization of electric energy.

Retracing the accomplishments of those scientific giants, following Unit more explores the study of static electricity to enhance the students’ understanding on it.