# 7th Grade: ENERGY (Electricity)

## Rational of this unit

Electricity is indispensable to our life. In addition to light bulbs that provide illumination during the night, IT devices, such as computers and cell phones, work using electricity. An unending variety of goods we use in daily life operate on electricity to generate light, provide heat, give signals, or carry out other tasks.

What is electricity? This unit aims to clarify the true characteristics of electricity in order for pupils to understand the basics of electricity and its regularity, to learn about the natural phenomena associated with familiar electrical appliances or electric power, and to use them safely.

## Objectives: what pupils are expected to achieve in this unit

- Understand sources of electricity.
- Make a simple circuit to check whether some materials can conduct electricity.
- Know how to use home electrical appliances to understand safety measures.

## Interrelation of contents of each grade

* *The order below is as shown in the syllabus.*

| Grade | What to teach (Energy) |
|---|---|
| 1st Grade | • Sources of light (the sun, fire, torches, candles, lamps, electricity, fireflies and glow worms, matches)<br>• Sources of sound (animal's calls, drums, bells, whistles, and vehicles) |
| 2nd Grade | • Casting shadows<br>• Making sound by plucking strings<br>• Making sound by beating something |
| 3rd Grade | • Reflection of light<br>• Direction of sound (how sound travels in all directions)<br>• Special sounds (laughter, ambulance sirens, screams, telephone ringing tone, fire engine sirens)<br>• Measuring centigrade temperatures |
| 4th Grade | • Using light<br>• Importance of electrical lighting at home (e.g. providing a clear view, safe movement, to keep harmful insects/pests under control and enabling comfortable reading)<br>• How to light the home (from windows, sky lights, artificial light sources, etc.)<br>• Heat sources (the sun, flames, electricity, gas, etc.)<br>• Uses for heat (cooking, heating, ironing, drying, etc.) |
| 5th Grade | • Types of sounds (noise and quiet)<br>• Noise (damage to ears from continuous and irritating sounds)<br>• Thermal conduction (conduction, convection and emission)<br>• Materials that easily conduct heat and materials that do not conduct heat easily<br>• How to use materials that conduct heat easily or with difficulty |
| 6th Grade (This unit) | • Under what conditions will light reach?<br>• Transparent, translucent and opaque substances<br>• Reflection of light<br>• Light sources and light reflected by smooth, shiny surfaces.<br>• Refraction of light<br>• Apparent refraction of light in the air and water (using a ruler or pencil)<br>• Demonstrating how rainbows are made |
| 7th Grade | • Sources of electricity (torch cells, the battery in a car, a bicycle's dynamo, hydroelectric generators, gasoline and diesel engines, geothermal power generators, wind-driven turbines (wind power generator), and solar panels)<br>• Simple circuits<br>• Conductive and non-conductive materials<br>• How to use home electrical appliances (irons, radios, TV sets, cookware, and electric kettles)<br>• Safety measures when electrical appliances are used (do not touch with wet hands, do not insert a pencil or wire into the power supply socket in the wall, and avoid overloading the wall socket)<br>• Safety measures to prevent damage or injury from lightning (lightning arresters, avoidance of walking in open areas during rain, and avoidance of sheltering under a tree during rain) |
| 8th Grade | • Meaning of energy<br>• Different types of energy (chemical, thermal, light, magnetic, electrical, and sound energy)<br>• Transformation of energy (electric circuits, food, fuel, radios, and simple electromagnets)<br>• Conserving energy (moderate use, efficient appliances, and renewable energy including wind, the sun, natural gas, and tree planting for fuel wood) |



(ENERGY/7th Grade)

## Before starting this unit

**Current learning status of the pupils**

Seventh-grade pupils have not learned about electricity intensively, but they should know about devices that use electricity, such as torches and bells as light and sound sources, respectively, in the 1st grade and understand electric heat sources in the 4th grade. It is expected that through this unit, many pupils are aware of the strange characteristics of energy produced by invisible electricity.

Meanwhile, many teachers and pupils are aware that electricity is a useful thing produced by humans through the use of a variety of electrical appliances in their daily life, but that it is difficult to learn about electricity because it is invisible.

Therefore, this unit raises the pupils' interest in electrical phenomena by letting them experience the static electricity produced around them.

**Preparatory notes**

- Raise the pupils' motivation for learning by getting them interested in electricity through electrostatic play activities and observing the phenomena of static electricity, as well as activities to make simple devices.
- Conduct this unit while relating it to daily life to enable the pupils to think about the true characteristics of electricity, while gaining an understanding the relationship between static electricity and electric current.



## Objectives to be achieved by competency

**Interest, motivation, and attitude**

1. Taking an interest in electrostatic play activities and observing the phenomena of static electricity, and trying to actively experience them.
2. Taking an interest in the types and mechanisms of generators, and investigating them through self-discovery.
3. Taking an interest in the functions of electrical appliances used at home, and examining them willingly.

**Scientific thinking and communication activities**

1. Ability to generate static electricity and to think about and describe the regularity of the resulting force.
2. Ability to describe the regularity of a simple circuit for lighting a miniature bulb by examining the difference between the successful and unsuccessful ones.
3. When two dry calls are connected in parallel, a bulb light dark in comparison with a simple circuit.
4. Ability to check whether a material is conductive or nonconductive and to organize the results in a table.

**Knowledge, understanding, and skills in observation and experimentation**



1. Ability to describe that static electricity is positive or negative, and that two charged objects repel or attract each other if both are of the same type or of a different type, respectively.
2. Understanding that a bulb lights up when the circuit is closed but not when it is open.
3. Understanding that connecting two dry cells in a series makes the bulb brighter than with one cell.
4. Knowing that there are conductive and nonconductive materials in the surroundings of the pupils.
5. Telling the names of electrical appliances used at home and understanding their functions.
6. Skills in describing how to safely use electrical appliances at home.
7. Skills in describing how to seek shelter when there are lightning flashes.

## Ideas behind the structuring the unit

In modern societies, electricity is used in almost any place where people are living. Therefore, many pupils recognize that electricity is essential for electrical appliances that are made by humans and that turning on the switch enables them to run automatically. In this unit, the pupils start with experiencing the static electricity that is produced around them in order to actually feel the presence of this invisible electricity.

Because conducting an experiment with a circuit is new to the 7th-grade pupils, a long time for trial-and-error activities is given to it. Moreover, this unit aims to raise the pupils' awareness of electricity through the introduction of various generators and electrical appliances as well as presentations on how to use them safely and the various measures to prevent damage or injury from lightning.

## Unit teaching plan

**(14 periods + 2 periods for the Final Unit Evaluation Test)**

* The numeric value in parentheses represents the corresponding period (e.g. 1) means the first period).

* *(Evaluation: Knowledge and Skills 1), (Evaluation: Interest 1)*, etc. indicate the points at which teachers can check whether the pupils have attained the goals specified in the section *Objectives to be achieved by competency*.

| Sub-unit | Description |
|---|---|
| 1. Sources of electricity (4 periods) | 1-2) The pupils have a discussion on what they know about electricity, and then learn the characteristics of familiar sources of electrostatic electricity as part of understanding electricity.<br>• Talking about electricity and thinking of what it is.<br>→ Where is electricity used in daily life?<br>→ What are the advantages of electricity?<br>→ What are your concerns about electricity?<br>→ What is the source of this electricity?<br>• Experiencing and thinking about electrostatic phenomena.<br>• Rubbing a plastic ruler on the hair and lifting the ruler up. |

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|---|---|
| | → The hair is raised.<br>• Rubbing a plastic ruler on the hair and attracting fragments of paper to the ruler.<br>→ The ruler attracts the paper.<br>• Rubbing a bundle of pieces of polyethylene string using tissues.<br>→ The end of the bundle spreads out.<br>• Walking on a carpet and then touching a doorknob.<br>→ The hand receives an electric shock.<br>• Knowing that rubbing two objects together generates static electricity.<br>• Observing the movement of balloons charged electrostatically and inferring the regularity.<br>→ Inflate two balloons and tie the opening with thread.<br>→ Hold the thread and bring them close together; nothing happens.<br>→ Simultaneously rub the two balloons against your clothes the same number of times and then bring them close together; this makes them repel each other.<br>→ Wipe the two balloons with a piece of wet cloth, dry them, and bring them close together; nothing happens (because the static electricity has been discharged).<br>→ Rub the two balloons with different objects and bring them close together; this makes them attract each other.<br>• Finding out that electricity is classified into two types: one is static and the other flows.<br>• Static electricity is stationary in an object, while the electricity used for appliances flows.<br>• When a large amount of static electricity flows at one time in the air, this causes flashes of lightning.<br>*(Evaluation: Interest 1, Thinking and Representation 1)*<br>3-4) Through an experiment in which the gathered static electricity lights a lamp, pupils find out that moving static electricity acts like an electric current and they then understand the points of commonality and the differences between static and flowing electricity. In addition, they find out how to generate the electric current that is used at home.<br>• Rubbing a plastic sheet with a piece of cloth to produce static electricity.<br>• Making one end of a neon tube come into contact with the charged sheet.<br>→ The tube lights up.<br>• Thinking of the difference between static and flowing electricity.<br>→ Static electricity is positive or negative.<br>→ Two objects charged by rubbing them with the same material or object repel each other, while those rubbed with different materials or objects attract one another.<br>→ Static electricity can light up a lamp, but the period is short.<br>→ Electricity is not useful in daily life unless it flows continuously.<br>• Examining how to generate the electricity used at home.<br>• Knowing that flowing electricity is produced artificially and that there are a variety of generation methods.<br>→ Hydraulic, thermal, geothermal, diesel, solar, and wind power generation<br>→ Dry cells and storage batteries<br>*(Evaluation: Interest 2, Knowledge and Skills 1)* |
| Intermediate review<br>(No time allotted) | Give the "1st **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| 2. Simple circuits<br>(3 periods) | 5-6) The pupils examine how to connect a dry cell and a piece of wire in order to light a miniature bulb as well as infer and describe the reasons why the bulb lights up or does not light up. Moreover, they learn the meaning of open and closed circuits and have the ability |





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| | to explain how to modify an open circuit to light the bulb.<br>*(Evaluation: Thinking and Representation 2, Knowledge and Skills 2)*<br>7) Pupils examine how to connect two dry cells and a piece of wire to light a miniature bulb and understand that connecting the two cells in a series makes the bulb brighter than with one cell.<br>*(Evaluation: Knowledge and Skills 3)* |
| Intermediate review<br>(No time allotted) | Give the "2nd **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| 3. Conductive and nonconductive materials<br>(2 periods) | 8-9) Pupils work on how to identify a material as conductive or nonconductive, insert various items in a closed circuit to check whether the bulb lights or not, and organize the results in a table. As a result, they find out the significance of conductive and nonconductive materials, and have the ability to infer how to use the latter.<br>*(Evaluation: Thinking and Representation 3, Thinking and Representation 4, Knowledge and Skills 4)* |
| Intermediate review<br>(No time allotted) | Give the "3rd **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| 4. How to use home electrical appliances<br>(1 period) | 10) Pupils examine electrical appliances used at home to organize their purpose and functions.<br>• Presenting electrical appliances used at home.<br>→ Lamp, electric kettle, iron, refrigerator, motor, electric cooker, and TV set<br>• Discussion about the purpose of electrical appliances.<br>→ Brightening, heating, cooling, and moving<br>• Organizing electric functions from the viewpoint of how to use electricity.<br>→ Emitting light, generating heat, and supplying power<br>*(Evaluation: Interest 3, Knowledge and Skills 5)* |
| Intermediate review<br>(No time allotted) | Give the "4th **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| 5. Safety measures when electrical appliances are used<br>(2 periods) | 11-12) Pupils check how to use electrical appliances and organize precautions. In addition, they summarize the characteristics of electricity they have learned so far.<br>• Reading the manuals of electrical appliances to find out how to use them and organizing the precautions that are common or particular to each appliance.<br>→ Do not use them when your hands are wet, read the manual thoroughly, do not touch any metal parts with your bare hand.<br>• Summarizing the characteristics of electricity learned so far.<br>→ Materials are conductive or nonconductive.<br>→ Electricity flows when the circuit is closed, but not when it is opened.<br>• Creating a pamphlet entitled "How to Use the Electrical Appliance Safely" in consideration of the usage and precautions common to electrical appliances and the features of circuits.<br>*(Evaluation: Knowledge and Skills 6)* |
| Intermediate review<br>(No time allotted) | Give the "5th **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| 6. Safety measures to prevent damage or injury from lightning<br>(2 periods) | 13-14) The pupils have a discussion about lightning and the damage that they know it causes. They have the ability to describe safety measures to prevent damage or injury from lightning on the basis of the knowledge about electricity that they have learned.<br>→ Lightning flashes when the clouds are thick. |

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| | → Lightning flashes and then thunder is heard.<br>→ An object or place that is struck by a flash of lighting is burned black.<br>→ In many cases, the flash of lightning will strike metallic objects.<br>→ Tall objects including large trees are susceptible to lightning.<br>→ Lightning is an aspect of electricity.<br>• A lightning rod prevents a flash of lightning from striking the surrounding area by positively arresting it and diverting it into the ground.<br>• The human body is conductive since it has a high water content, so wearing nonconductive clothing is a means to prevent the effects of lightning.<br>• Because metal is conductive, there is a risk of it being struck by a flash of lightning. Accordingly, metal objects should be removed from the body when there is the possibility of a lightning strike.<br>• If you hear thunder, do not approach any tall tree.<br>• During a thunderbolt, you should be in a car with nonconductive clothes on.<br>*(Evaluation: Knowledge and Skills 7)* |
| Intermediate review<br>(No time allotted) | Give the "6th **Sub-Unit Review Test**".<br>(Homework can be given depending on the progress of the class.) |
| Unit End Review<br>(2 periods) | 15-16) Teacher gives the "**Final Unit Evaluation Test**". |

# Lesson Plan

## 2. Simple circuits (3 periods: 5th -7th period)

**Goals of this sub-unit**

- Ability to examine how to connect a dry cell and a piece of wire to light a miniature bulb as well as to infer and describe the reasons why the bulb lights up or does not light up
- Ability to explain how to modify an open circuit to light the bulb by knowing the meaning of open and closed circuits
- Ability to examine how to connect two dry cells and a piece of wire to light a miniature bulb and to understand that connecting two cells in series makes the bulb brighter than with one cell

**Material Preparations**

- Dry cells, pieces of wire, and miniature bulbs
- Worksheets for the experiments

**Periods 5-6: Circuits successful and unsuccessful in lighting a bulb**

| | Learning flow and activity | Teaching hints and advice |
|---|---|---|
| **Introduction**<br>20 mins | • Using a dry cell and a piece of wire to turn a miniature bulb ON. | • Before starting the experiment, describe the mechanism of a dry cell and how to use the piece of wire.<br>• First, let all pupils connect the parts in the same fashion and check the procedures for ensuring correctness and the parts for any failure. |
| | → The end with a projecting terminal is positive, while the other flat end is negative.<br>→ Pupils remove part of the sheath at both ends of the wire to expose the conductor.<br>→ Pupils connect one end of the wire to the bulb and the other end to the negative terminal of the cell, and then make the complete loop contact of the bulb come into contact with the positive terminal of the cell to light the bulb. | |
| **Question** | What is the difference between the successful and the unsuccessful circuits? | |
| **Experiment**<br>35 mins | • Pupils try to connect the end of the wire and the bulb to various points on the cell to check whether each circuit lights the bulb or not, and record the results.<br>• Pupils discuss and present points that are common to circuits that are successful in lighting the bulb.<br>→ When the ends of the wire and bulb are connected to the positive and negative terminals of the cell, the bulb lights up.<br>→ In addition to connecting the bulb directly to the cell, inserting a wire between both turns the bulb ON.<br>→ The reverse connection of the cell lights up the bulb.<br>• The pupils work on how to change an unsuccessful circuit shown in the diagram to light the bulb, and confirm their ideas. | • Let pupils investigate not only successful circuits but unsuccessful ones.<br>• Tell them that two pieces of wire can be used.<br>• Give the pupils sufficient time to examine the process.<br>• Let pupils illustrate the results in the worksheet.<br>*(Refer to pg. 262 regarding worksheet)*<br>• Let pupils check the points that are common to successful circuits and think of the reasons for the unsuccessful ones.<br>• Teach the meaning of open and closed circuits.<br>*(Evaluation: Thinking and Presentation 2)* Ability to describe the regularity of a simple circuit for lighting a miniature bulb by examining the difference between the successful and unsuccessful circuits. |
| **Presentation**<br>15 mins. | • Pupils describe how to modify the open circuit to light the bulb in consideration of the reasons why the bulb lights up or does not light up.<br>• When the electric path is looped, that is, the circuit is closed, the bulb lights up.<br>→ If no connection is made at either the positive or negative terminal, the bulb does not light up. | (*Evaluation: Knowledge and Skills 2*) Understanding that a bulb lights up when the circuit is closed but not when it is open. |

**Period 7: When two dry cells are connected to each other**

| | Learning flow and activity | Teaching hints and advice |
|---|---|---|
| **Introduction**<br>10 mins. | • Using two dry cells by adding one.<br>→ It is expected that two cells will make the bulb brighter than with one cell.<br>→ How are the cells connected to each other? | • Get the pupils to think of various connections and then start the experiment. |
| **Questions** | How do you connect the two cells to each other to light the bulb? Does the brightness change between the use of a single cell and the double cells? | |
| **Experiment**<br>15 mins. | • The pupils examine how to connect the two cells to light the bulb, and record the results in the | • Get the pupils to record the results in the worksheet. |

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| | worksheet. | *(Refer to pg. 263 regarding worksheet)*<br>• Tell the pupils that connecting the positive terminal of one cell to the negative terminal of the other cell is called a series connection. |
| **Presentation**<br>10 mins. | • The pupils present their discoveries.<br>→ When the positive terminal of one cell is connected to the negative terminal of the other cell, the bulb lights up.<br>→ If the same terminals are connected to each other, the bulb does not light up.<br>→ The two cells connected in series makes the bulb brighter than with a single cell.<br>→ A certain circuit does not change the brightness (parallel connection). | *(Evaluation: Knowledge and Skills 3)* Understanding that connecting two cells in series makes the bulb brighter than with one cell. |

## 3. Conductive and nonconductive materials (2 periods: 8th -9th period)

**Goals of this sub-unit**

- Ability to work on how to identify a material as conductive or nonconductive, to insert various items in a closed circuit to check whether the miniature bulb lights or not, and to organize the results in a table
- Ability to know the significance of whether a material is conductive or nonconductive and to infer how to use the latter

**Preparation**

- Dry cells, pieces of wire, and miniature bulbs
- Materials to be checked for conductivity:
  → Plastic products, paper, rope, glass, thread, wood, nails, needles, coins (made of copper, aluminum, and silver), rubber, aluminum foil, etc.
- Worksheet for the experiment

**Periods 8-9: Conductive and nonconductive materials**

| | Learning flow and activity | Teaching hints and advice |
|---|---|---|
| **Introduction**<br>5 mins. | • What kinds of materials conduct electricity?<br>→ Shiny things<br>→ Metallic materials<br>→ Balloons<br>→ Hair | • Because learning static electricity in the introduction section of this unit, some pupils may believe that objects that are charged electrostatically are conductive. In this period, without denying that thought, elicit opinions from the pupils and let them find out the truth in the next experiment section. |
| **Question** | •How do you check whether a material is conductive or nonconductive? | |
| **Discussion** | • The pupils work on how to check whether a material is | • Give the pupils a hint—the difference between |





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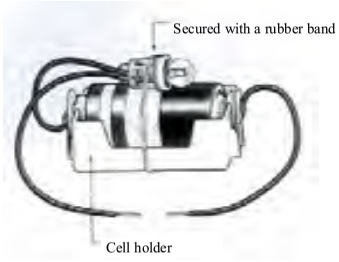
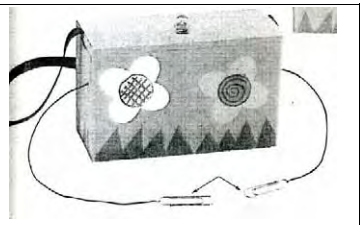
| 10 mins. | conductive or nonconductive.<br>→ If cutting a closed circuit and connecting the "object" between both ends lights up the bulb, then the inserted item may be conductive.<br>→ If connecting an "object" to an open circuit lights up the bulb, then the inserted item may be conductive because the circuit is closed. | open and closed circuits learned in the previous period.<br><br>*(Evaluation: Thinking and Presentation 3)* Ability to think of how to check whether a material conducts electricity or not by using the regularity of circuits. |
| **Fabrication**<br>15 mins. | • The pupils use a miniature bulb, dry cell, wire, pin, and so on to make a tester.<br>  <br><br>→ The holder is not mandatory. | • In this section, let pupils make a tester based on the method of connecting the test piece between the exposed ends of two pieces of wire to learn about conductive and nonconductive materials, and then improve it, for example, by covering the main body with a nonconductive material. |
| **Question** | • Let's use the tester to check whether a material is conductive or nonconductive. | |
| **Experiment**<br>20 mins. | • The pupils use the tester they have made to check various "objects" for conductivity, and organize the results in a table.<br>→ A nail lights up the bulb.<br>→ Wood or paper does not light up the bulb.<br>→ Some shiny things are nonconductive. | • Get pupils to record the results in the worksheet.<br>*(Refer to pg. 263 regarding worksheet)*<br>• Use as many kinds of materials as possible.<br>• Use various coins because some pupils believe that every shiny thing is conductive.<br>• Tell the pupils that a material that conducts electricity is called a conductor, while one that does not conduct electricity is called a nonconductor (insulator).<br><br>*(Evaluation: Thinking and Presentation 4)* Ability to check whether a material is conductive or nonconductive and to organize the results in a table. |
| **Fabrication**<br>10 mins. | • The pupils improve their testers.<br>→ Changing the contact to a hard and conductive material makes the checks easy. | • Example of improvement |

| | | |
|---|---|---|
| | → Covering the main body with a nonconductive material guarantees safe inspections. |  <br>• Get the pupils to use the improved tester to examine familiar items used at home. |
| **Discussion**<br>10 mins. | • The pupils observe familiar electrical appliances and discuss where conductors and insulators are used.<br>→ Conductors are used mainly in non-accessible places, such as the inside of wires, switches, heaters, etc.<br>→ Insulators are used for the accessible parts, such as the sheath of a cord, the handle of an iron, and switches on a radio or TV set. | • Knowledge in this sub-unit is important to the subsequent ones in which pupils learn safety measures. Get the pupils to understand that a nonconductor can be used as an insulator.<br><br>*(Evaluation: Knowledge and Skills 4)* Knowing that there are conductive and nonconductive materials in the surroundings of the pupils. |



(ENERGY/7th Grade)

**[Worksheet]** ---------- * To be used in 5th-6th Periods

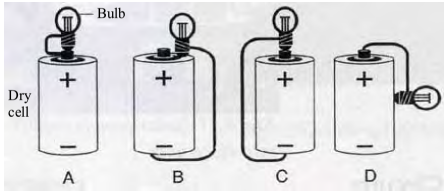
## Let's examine how to make a circuit to light a miniature bulb.

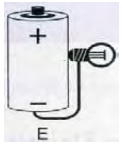
**Date:** **Class:** **Name:**

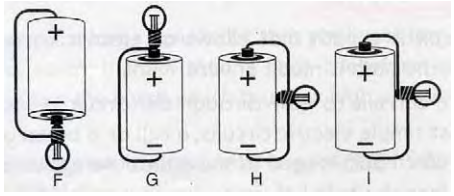
1. **Preparation**
   A miniature bulb, a dry cell, and a piece of wire

2. **Procedures**
   (1) As shown in the accompanying figure, let's connect the wire between the bulb and cell to light up the bulb.

   (2) Check whether the following circuits turn the bulb ON. Color the illuminated bulb.




   (3) Summarize the features of the successful and unsuccessful circuits.

   (4) How do you change the unsuccessful circuit to light the bulb? Put an "×" against a wrong line and add a red line.

**Keep this worksheet for the next class.*

**[Worksheet]** ---------- * To be used in 7th Period

## Let's use two cells to check how the bulb lights up.

**Date:** **Class:** **Name:**

1. **Preparation**
   A miniature bulb, two dry cells, and the required pieces of wire

2. **Procedures**
   (1) On the basis of a lighting circuit in which a bulb, cell, and a piece of wire are connected as shown in the accompanying figure, add another dry cell to make various circuits to light the bulb.

   (2) Illustrate successful circuits in the following boxes.

   (3) Compare the brightness between the single and double cells.

| (Circuit) | (Circuit) | (Circuit) |
|---|---|---|
| | | |
| (Brightness) | (Brightness) | (Brightness) |

   (4) Summarize the features of the successful circuits with the single and double cells.





**[Worksheet]** ---------- * To be used in 8th-9th Periods

## Let's examine conductive and nonconductive materials.

**Date:** **Class:** **Name:**

1. **Preparation**
   A miniature bulb, a dry cell, pieces of wire, and test pieces

2. **Procedures**
   (1) Make a circuit by connecting the bulb, cell, and a piece of wire.

   (2) Cut the circuit, connect the test piece between both ends to check whether electricity passes through it (whether the bulb lights up), and record the results in the table below.

   * Let's use the self-made tester to make checks as well.

| Conductive material (the bulb lights up) | Nonconductive material (the bulb does not light up) |
|---|---|
| | |

| Partially conductive material | |
|---|---|
| Conductive part (the bulb lights up) | Nonconductive part (the bulb does not light up) |
| | |

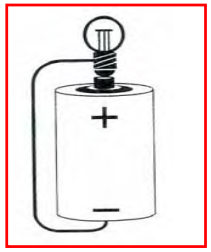
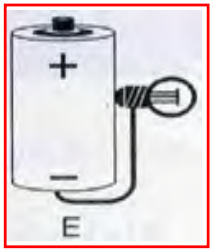
   (3) Summarize your understanding, any uncertain points, and the subjects you want to examine further.

# 2nd Sub-Unit Review Test

* given after end of 7th period

Class: Name:

1. **Illustrate two circuits: one makes a bulb light up and the other does not.**
Materials needed: A miniature bulb, a dry cell, and a piece of wire

| Circuit that turns the bulb ON | Circuit that does not light up the bulb |
|---|---|
|  |  |

2. **Describe the difference between the successful and unsuccessful circuits shown in Problem 1.**

- The bulb lights up when the positive and negative terminals of the cell are connected to the complete loop contact of the bulb, respectively. The unsuccessful circuits include: the same terminal is connected to the complete loop contacts of the bulb and no connection is made at either terminal.

3. **How do you change the unsuccessful circuit to light the bulb? Revise the illustration above and explain the reasons.**

- The unsuccessful circuit is open, so closing it lights up the bulb.
- Connecting the positive and negative terminals of the cell to the complete loop contacts, respectively, lights up the bulb.





# 3rd Sub-Unit Review Test

* given after end of 9th period

Class Name:

1. **Write the symbols ○, ×, or △ against the conductive, nonconductive, or partially conductive objects, respectively.**

| | | | | | |
|---|---|---|---|---|---|
| Nail | ○ | Scissors | △ | Notebook | × |
| Wooden chair | × | Plastic | × | Aluminum foil | ○ |
| Miniature bulb | △ | Spoon | ○ | Needle | ○ |
| Copper coin | ○ | Glass cup | × | Cutter | △ |
| Rope | × | Cloth | × | Rubber band | × |
| Shoes | × | Chalk | × | Iron weight | ○ |

2. **Select one from the objects labeled △ and describe the reason why it is partially conductive.**

Example: Scissors
Concerning a certain pair of scissors, electricity passes through the blades but not through the handles. In another pair, both conducted electricity. Accordingly, this phenomenon depends on the materials used in them.

# Final Unit Evaluation Test

* Done at Unit End

Class Name:

**1. Answer the following questions:**

(1) Which one of the following objects attracts fragments of paper when it is rubbed with a piece of woolen cloth? Record the corresponding symbol.

[Answer: (C)]

(A) Tree branch (B) Stone (C) Plastic ruler (D) Metal bar

(2) Record the reasons for the answer to the question above.

(The reason is that rubbing plastic and wool generates static electricity.)

(3) How does a storage battery in a car produce electricity? Select the corresponding symbol.

[Answer: (B)]

(A) Water (B) Chemicals and metal (C) Diesel (D) Oil

(4) Which one of the following is difficult to use as a power source? Select the corresponding symbol.

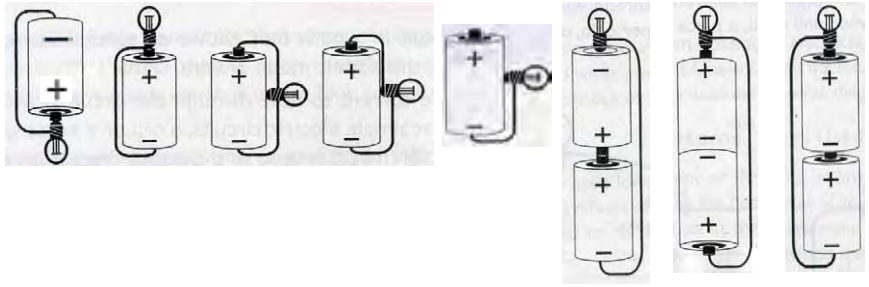
[Answer: (C)]

(A) Dry cell (B) Storage battery (C) Lightning (D) Geothermal power generation

**2. The figures below show experiments in which a miniature bulb, one or two dry cell(s), and a piece of wire are connected to each other. Answer the following questions:**

(1) Select the figures that show an unsuccessful circuit and the one that presents the highest brightness, and record the corresponding numbers.

1 2 3 4 5 6 7 8







(2) Write the reasons for your selections in (1).

| Miniature bulb | Number | Reason |
|---|---|---|
| Unsuccessful circuit | 2,3,5 and 7 | The circuit should be closed; otherwise the bulb cannot be turned ON. [All of 2, 3, 5, 6 and 7 are open circuits, so the bulb does not light up.] |
| Circuit presenting the highest brightness | 8 | Connecting two cells in series makes the bulb much brighter than with one cell. |

**3. From the following materials, select the nonconductive ones and record this using the corresponding symbols.**

[Answer: (D) and (E)]

(A) Copper wire (B) Iron wire (C) Zinc plate (D) Glass rod (E) Plastic

**4. Which one of the following descriptions is wrong? Record the corresponding number.**

[Answer: (2)]

(1) A copper wire conducts electricity.
(2) You can see electricity that flows through a copper wire.
(3) It is possible to store electricity.
(4) Hydraulic power generation takes advantage of falling water.

**5. What kind of electrical work do the following appliances use?**

| Appliance | Electrical work |
|---|---|
| Power drill | Moving an object |
| Iron | Generating heat |
| Radio | Making a sound |
| Torch | Emitting light |

**6. Write four or more precautions to observe when using an electrical appliance.**

( Do not handle an appliance with wet hands. )

( Do not overload sockets by plugging in many electrical appliances in a single socket.)

( Do not insert a stick into the slot of a wall socket. )

( Do not try to repair an appliance while it is plugged in. )

( Before using an appliance, thoroughly read the notes to users in the manual. )

( It is dangerous to use an appliance with the plug or cord damaged. )

**7. Answer the following questions about safe evacuation when you hear thunder.**

(1) Which areas are dangerous?

( The vicinity of thin and tall objects that are easily struck by lightning. )

(2) What kinds of things should you avoid having in your hands?

( Metal items )

(3) What kinds of shoes are safe?

( Nonconductive shoes, such as rubber sandals )





## Student Questionnaires

**1. What kinds of studying have you done in the past for the above test problems?**

| | | |
|---|---|---|
| 0. | None at all | This was done 10% of the time for all problems. |
| 1. | No | This was done 30% of the time for all problems. |
| 2. | Average | This was done 50% of the time for all problems. |
| 3. | Yes | This was done 70% of the time for all problems. |
| 4. | Absolutely yes | This was done over 90% of the time for all problems. |

**Answering Questions using Pictures and Diagrams in the Textbook or Illustrations Drawn on the Blackboard**

1. The Students answered the questions by walking up to the board and drawing diagrams or writing words.
   0. 1. 2. 3. 4.

2. The teacher asked and answered the questions by drawing diagrams or writing words on the board.
   0. 1. 2. 3. 4.

3. Questions were answered using pictures and diagrams in the textbook.
   0. 1. 2. 3. 4.

**Experiments**

1. Did the students conduct any experiments or observations?
   0. 1. 2. 3. 4.

2. The teacher conducted the experiments.
   0. 1. 2. 3. 4.

3. The students conducted the experiments by following the teacher's instructions.
   0. 1. 2. 3. 4.

**Discussion and Thinking**

4. We talked with friends in the class and thought about the problems.
   0. 1. 2. 3. 4.

5. We thought about the problems carefully with friends and stated our ideas logically.
   0. 1. 2. 3. 4.

6. We thought about the problems carefully when coming up with a hypothesis and after the experiment.
   0. 1. 2. 3. 4.

**Understanding Ideas**

7. I was able to understand new ideas.
0. 1. 2. 3. 4.

8. I was able to see new viewpoint of looking at and thinking about science.
0. 1. 2. 3. 4.

9. I was able to grasp the principles hidden beneath the facts.
0. 1. 2. 3. 4.

**Application of Knowledge**

10. I was able to apply the new knowledge that I learned in school in my daily life.
0. 1. 2. 3. 4.

11. The teacher has explained that the new knowledge things the students are learning in school are connected with actual life.
0. 1. 2. 3. 4.

12. I was able to learn that the new principles and viewpoints toward science can be applied to a variety of different phenomena.
0. 1. 2. 3. 4.

**Pursuing Knowledge through Problem Solving**

13. We were first given a problem and then were to solve that problem.
0. 1. 2. 3. 4.

14. We made predictions, put then to the test, formulate scientific explanations, and put them to practical use.
0. 1. 2. 3. 4.

15. The students were asked to verify through the experiment that they had created a hypothesis as well as a plan for the observation.
0. 1. 2. 3. 4.

**2. When you learned each unit for the above test problems, did you become interested in the material?**

| | | |
|---|---|---|
| 0. | None at all | This was true 10% of the time for all problems. |
| 1. | No | This was true 30% of the time for all problems. |
| 2. | Average | This was true 50% of the time for all problems. |
| 3. | Yes | This was true 70% of the time for all problems. |
| 4. | Absolutely yes | This was true over 90% of the time for all problems. |

**Interest and Motivation**

1. I was very interested in science lessons.
0. 1. 2. 3. 4.

2. I became more motivated to learn.
0. 1. 2. 3. 4.





3. I was interested in what we were learning from start to finish.
0. 1. 2. 3. 4.

**Concentration and Involvement**

4. I was actively engaged in learning the topic.
0. 1. 2. 3. 4.

5. I enjoyed learning the topic so much I lost track of time.
0. 1. 2. 3. 4.

6. I was very focused on learning topic material but at the same time, I was also very excited and enjoyed myself.
0. 1. 2. 3. 4.

**Cooperation and Collaboration**

7. I enjoyed the learning process while collaborating with friends.
0. 1. 2. 3. 4.

8. I was able to learn through cooperation and mutual support with my friends.
0. 1. 2. 3. 4.

9. I shared my experiments and ideas with my friends and we all had a fun time learning together.
0. 1. 2. 3. 4.

**Level of Earnestness and Enjoyment during Experiments**

10. The experiments were very enjoyable.
0. 1. 2. 3. 4.

11. Since experiments need five senses, I carefully moved my hands and eyes when collecting the data.
0. 1. 2. 3. 4.

12. During the experiments, I recorded my observations accurately and carefully.
0. 1. 2. 3. 4.

**Spirit of Inquiry**

13. I began to have more an inquiring mind toward new discoveries.
0. 1. 2. 3. 4.

14. I became very excited and curious about challenging the unknown.
0. 1. 2. 3. 4.

15. I made a strong effort to learn what is known by trying to find examples, drawing illustrations, and through discussions and experiments.
0. 1. 2. 3. 4.

**Logic and Objectivity**

16. I attempted to find plenty of evidence and facts to check whether my hypothesis held true.
0. 1. 2. 3. 4.

17. I was able to confirm that the principles and concepts were true by applying them to actual life.
0. 1. 2. 3. 4.

18. The explanations were very convincing and easy to understand for the entire class. I was very satisfied with the interpretations which were logical and accorded with the truth.
0. 1. 2. 3. 4.





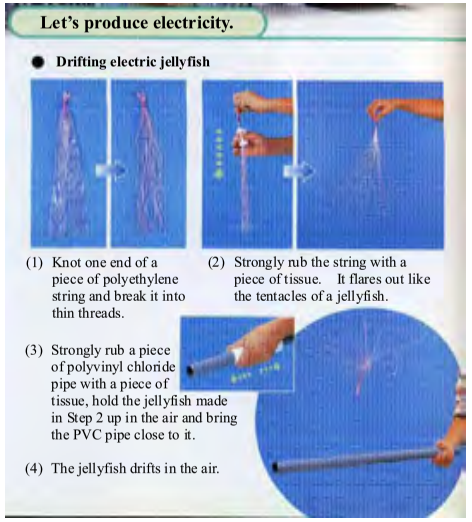
# Appendix

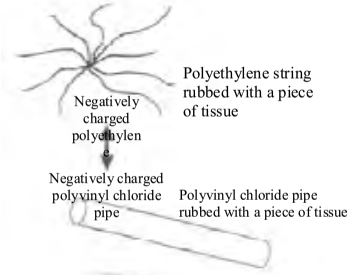
**Experiments in static electricity**

This unit first deals with two electric sources: static and current electricity. Many pupils may feel that electricity is strange and fearful because it is invisible. Therefore, in order for pupils to learn to positively appreciate electricity and actively solve problems, this lesson involves the following activities:

This is an experiment in which the pupils check, through play, that a polyethylene string and polyvinyl chloride pipe repel each other when both are charged with the same kind of electricity.

This simple experiment is a suitable one to enable pupils to become aware of electrostatic repulsion.




Like electric charge repel each other

Rub a piece of sheet plastic on your hair and then lift it up. The hair rises up to the sheet.


Rub a piece of sheet plastic on your hair and then lift it, resulting in the hair rising up to the sheet.

# Appendix

**Introduction of experiments in static electricity shown in the "Keirinkan's Textbook for the Japanese 7th Grade"**

The following experiments allow pupils to understand not only the electrostatic attractive force, but also the repellant force. Like the magnetic force, an electric force acts on an object even if both are apart from each other.

## Experiment 1 Let's examine electrostatic force.

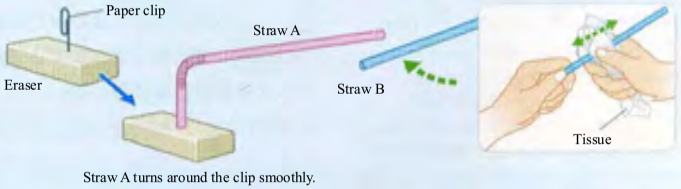
**Method**

**Making two straws approach each other**

(1) As shown in the figure below, insert a paper clip into an eraser, strongly rub Straw A with a piece of tissue, and cover the clip with the straw.

(2) Strongly rub Straw B with the tissue and bring it close to Straw A.

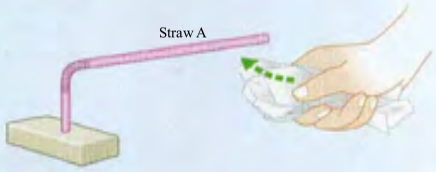
The dryer the air, the better the result. Great care must be taken to prevent the rubbed objects from coming into contact with each other and to avoid touching the rubbed part with the hands.




Straw A turns around the clip smoothly.

**Bringing the tissue close to the straw**

(3) Bring the tissue used in Step 2 close to Straw A.




**Result**

1. How does Straw A move when Straw B approaches it?
2. How does Straw A move when the tissue approaches it?

**Preparation**

Two plastic straws (flexible type), a paper clip, an eraser (or rubber plug), and tissues

**Consideration**

What kind of force does static electricity generate?

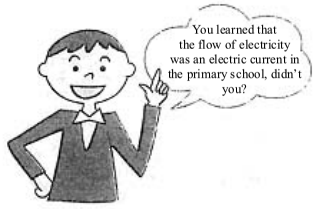
**Want to know for certain**

Let's rub two of the various objects together, for example a straw rubbed with a polyethylene bag, and bring the rubbed item close to Straw A.



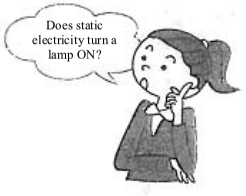


## 2. Let's light a lamp with static electricity.




Static electricity is stored in an object. Does it work like an electric current?

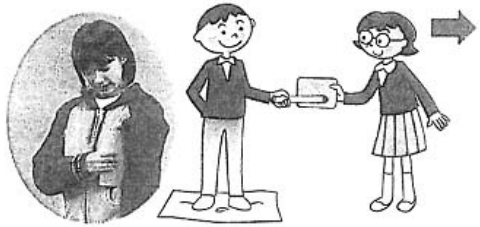
### How does static electricity relate to electric current?



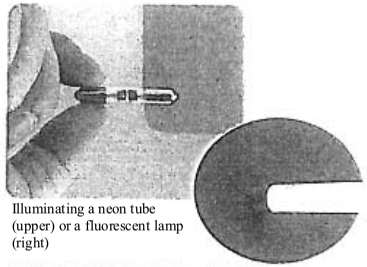

Static electricity generated by the experiment shown in Figure 1 can light a neon tube or fluorescent lamp. This is because as static electricity stored in the plastic sheet moves to the tube or lamp, electric current flows through it. This electric flow stops soon, so the tube or lamp lights up only for an instant*1. This experiment shows that static electricity changes to an electric current when it moves.

*1 Because a dry cell can supply electricity continuously, the miniature bulb continues to be illuminated.

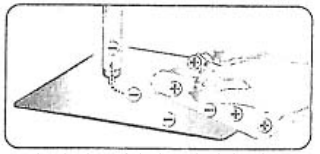
(1) One pupil spreads a large polyethylene bag on the floor and stands up on it holding a neon tube or small fluorescent lamp (rated at about 4 watts).
(2) Another pupil strongly rubs a piece of plastic sheet on a sweater made from chemical fibers.
(3) This pupil lets the plastic sheet of (2) come into contact with one end of the tube or lamp.



Conduct this experiment in a darkened room. The dryer the air, the better the result.



Illuminating a neon tube (upper) or a fluorescent lamp (right)



Putting the sheet of plastic on the desk and continuing to rub it with the tissue can light the tube or lamp successively.

**Figure 1: Experiment in which static electricity lights a neon tube or fluorescent lamp**

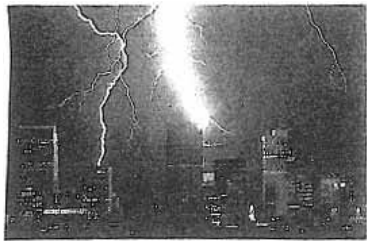


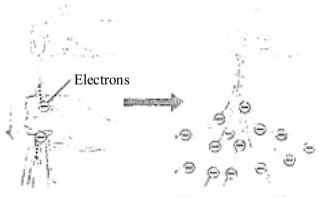
Figure2 Lightning (Shinjuku, Tokyo): This is the flow of static electricity stored in clouds.

Lightning that you can see in rainy season is a natural phenomenon in which the static electricity stored in clouds flows in one burst through the air, which does not normally conduct electricity (Figure 2). Such a phenomenon in which electricity moves in space or flows out from where it is stored is called a discharge. When you touch a doorknob on a dry day, your hand receives an electric shock. This is because the static electricity stored in your body is being discharged to the door handle.

**Scientific square** Want to know more

## The characteristics of an electric current

Do you hear the word “electron” in your daily life, such as “electronic oven” and “electrothermometer?” In fact, when static electricity is produced, negative ones move from one substance to another because very small particles with negative electricity (charge) move. These particles are called “electrons.”




(Electrons flow through the tube)

Every substance has electrons. When two kinds of objects are rubbed together, the movement of electrons depends on which object acquires them more easily than the other. If a polyethylene string is rubbed with tissue as shown in the upper photo on page 19, then electrons move from the tissue to the string as illustrated in the accompanying figure. These electrons have the same form of electricity, so they repel each other, which causes the string fibers to spread out.

In the experiment shown in Figure 1, the neon tube lights up because electrons stored in the rubbed sheet flow through the tube.

The phenomenon called electric current is the flow of such electrons. The direction of the current is the reverse of that of the direction of the flowing electrons because it was determined when the true characteristics of the electric current were unknown.





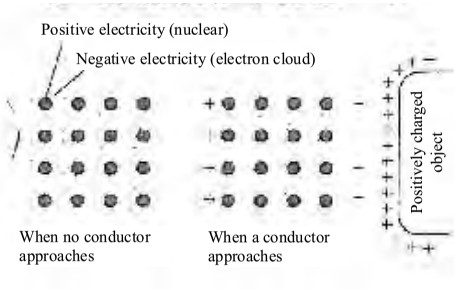
# Appendix

### Mechanism of static electricity

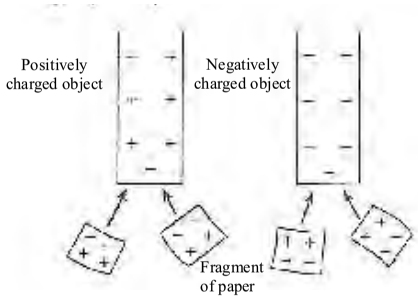
## Electrostatic induction

Bringing a charged object close to a conductor or nonconductor (insulator) gathers the other type of electricity at the closest end of the object and the same type of electricity at the far end. This phenomenon is called “electrostatic induction.”

In the case of a conductor, free electrons move, resulting in electrostatic induction. In the case of an insulator, no electrons can move between atoms or molecules, so only positional deviation occurs, as shown in the figure below. The latter phenomenon is called “dielectric polarization.”




Most of the daily phenomena related to static electricity consist of electrostatic induction. For instance, an acrylic bar or ruler charged positively and a straw or ebonite bar charged negatively both attract fragments of paper or polystyrene foam. This is because electrostatic induction gathers the other type of electricity at the closest end of each fraction, resulting in an attractive force.




Accordingly, you can simply check whether an object is charged or not by bringing small pieces of paper or polystyrene foam close to it and observing whether both attract each other.

The bending of water at the closest end of a charged object is a phenomenon caused by electrostatic induction.

## Troublesome and helpful electricity

**Examples of troublesome phenomena caused by static electricity**

- When you take off your sweater in the dry season, a phenomenon called peeling electrification occurs. In this case, you hear crackling noises and sometimes see small sparks. This peeling electrification may reach a voltage of 10,000 V depending on the combination of clothing materials.

- In dry weather, when you touch the door of your car, a spark often appears and your hand receives a shock . You may see a hanging metal chain or conductive rubber belt on the rear side of a vehicle, which leads static electricity stored in the vehicle to the ground to avoid a fire.

- After you polish a piece of furniture or a plastic product with a piece of dry cloth, it sometimes attracts dust. Moreover, wall sockets and plastic cords are easily charged electrostatically and attract dust, so care must be taken so that this does not cause a fire.

**Examples of helpful phenomena caused by static electricity**

- Copy machine: This machine has an electrostatically charged metal drum that attracts the ink called toner and copies it to a piece of paper.

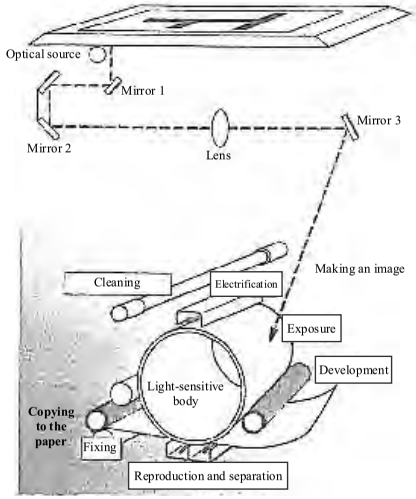
  (1) First, the machine illuminates the characters and illustrations on a manuscript, and copies them to the drum (made of a light-sensitive material) by taking advantage of the photoconduction that a semiconductor has. At this time, only the part including the characters and illustrations is charged positively.

  (2) Next, the machine uniformly spreads the black powder—toner charged negatively—over the drum. Thanks to the nature of static electricity, the toner only adheres to the positively charged part of the drum. As a result, the characters and illustrations can be reproduced.

  (3) Finally, the machine copies the toner to a piece of paper and heats it instantaneously to fix the toner to the paper. Through these processes, the machine makes a copy of the manuscript.



(ENERGY/7th Grade)

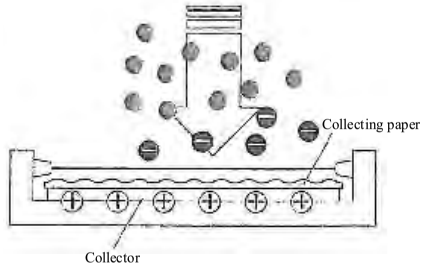



**Mechanism of a copy machine**

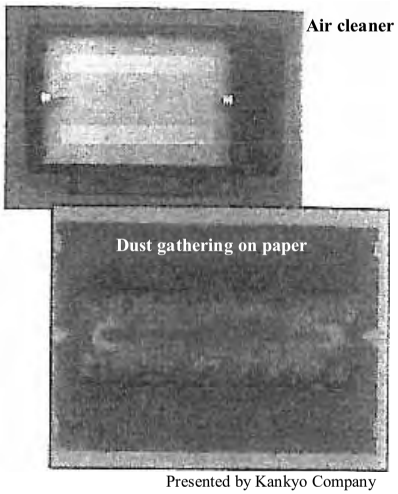
- Electrostatic air filter: This a machine that takes advantage of the fact that positive and negative static electricity attract each other to collect the dust suspended in the air in a room.

  (1) First, the machine negatively charges the dust in the air.

  (2) As a result, the dust adheres to a piece of collecting paper due to its attraction by the positively charged collector.




**Mechanism of an electrostatic air filter**

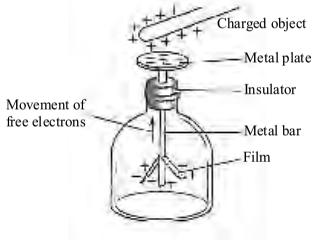



Presented by Kankyo Company

## Electro scope

One of devices that checks whether an object is charged or not is called an electro scope. As shown in the accompanying figure, it consists of two very thin metal films made of aluminum or tin, a metal bar from which both films are suspended, a glass container, and a metal plate attached to the tip of the bar.

If a charged object approaches an electrometer that is not charged (the films are closed), they then open. This is because electrostatic induction moves the free electrons in the conductors—the metal plate, bar, and films—to change the electrometer to an electrically distributed state shown in the figure below. As a result, both films repel each other.








## Solar cooker

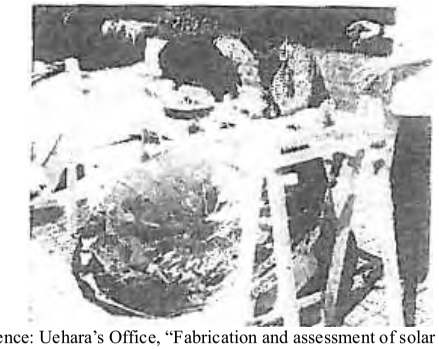
There are various kinds of solar cookers, and this section introduces three types that are frequently used.

**Box-type solar cooker with a reflector**

This solar cooker gathers sunlight in a box with built-in reflectors to operate as a food cooker. It can fold up to a compact size due to its knockdown construction.

**Parabolic solar cooker**

In this type, a parabolic reflector and cooking table are arranged so that sunlight reflected by the former gathers on the latter. One type of cooker consists of a reflector about 120 cm in diameter and a table heated at 150 to 200 degrees Celsius.



Reference: Uehara's Office, "Fabrication and assessment of solar cookers"
(http://bosei.cc.u-tokai.ac.jp/~uehara/)

**Panel-type solar cooker**

This solar cooker consists of a cooker and a curved reflector that stands at the back. The following describes how to fabricate it.

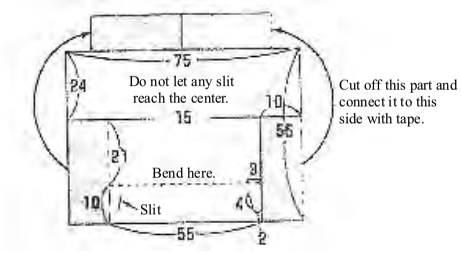
- **Materials needed**
  - An aluminum can (350 or 500 mL)
  - The lid of a glass jar (made from metal)
  - A plastic bottle (1.5 L)
  - Two clothespins
  - A piece of wire netting
  - An aluminum foil sheet that is used under a gas burner (the surface is smooth and the size is about 55 × 75 cm).

- **How to make it**

(1) Use a cutter to remove the top of the can and color the outer surface using a black felt pen (aqueous ink). Color the outer surface of the lid of the jar as well.

(2) Cut off the upper part of the plastic bottle so that it is about 3 cm taller than the can.

(3) Slit the aluminum foil sheet as shown in the figure below. Bend the back half so that it forms a semicircular partition, insert both corners into the corresponding slits, and fix them with the clothespins to prevent them from becoming detached.




(4) Set the wire netting in the center and put the can containing the food to be cooked on it. Put the lid on the plastic bottle and cover the can with it.

Reference: “Solar cooking”





# Appendix

Examples of assessment questions which are used in Kenyan text books

**1** An electric current is:
(A) the flow of electricity in a circuit
(B) the flow of an electrical shock
(C) the flow of heat
(D) the flow of light in a circuit

**2** To help protect a building from lightning we must:
(A) use an insulator
(B) call an electrician
(C) switch off the electricity
(D) install a lighting arrester

**3** A device that is used to close and open electric circuits is a:
(A) battery (B) switch
(C) bulb (D) dry cell

**4** In torch batteries, electricity is produced by:
(A) solar power (B) charcoal
(C) a liquid (D) chemicals

**5** Which one of the following items is **not** a good conductor of electricity?
(A) iron wire (B) silver wire
(C) glass rod (D) carbon rod

**6** Which one of the following statements is **not** true about electricity?
(A) electricity is a form of energy
(B) lightning is visible electricity
(C) a bulb is a source of electricity
(D) electricity can be changed to other forms of energy

**7** Which one of the following statements is **not** true about lightning?
(A) lightning is visible electricity
(B) lightning appears as a white flash
(C) the ground can act as an earth for lightning
(D) lightning energy cannot be controlled

(Macmillan; Macmillan Primary Science, Pupil’s book 7 P.112)

1. Two forms of electricity are:
   A. Torch and solar
   B. Static and current
   C. Geothermal and hydro
   D. Car and solar
2. When a plastic pen is rubbed on the hair at one end, the charge:
   A. Spreads to the other end
   B. Remains at the rubbed end
   C. Disappears from that end
   D. Is conducted and the whole pen is charged
3. Two balloons are rubbed on the hair. When they are brought together they repel because:
   A. They are too big
   B. They are charged
   C. There is air in them
   D. There is air between them

(KLB; Primary Science Pupils' Book for Standard Seven P.128)

1. Two uncharged balloons:
   A. Attract (pull towards) each other
   B. Repel (push away) each other
   C. Attract and then repel each other
   D. Neither attract nor repel each other
2. Two balloons charged at the same time using the same material (like charges):
   A. Attract (pull towards) each other
   B. Repel (push away) each other
   C. Attract and then repel each other
   D. Neither attract nor repel each other
3. Two balloons charged using different materials (unlike charges):
   A. Attract (pull towards) each other
   B. Repel (push away) each other
   C. Attract and then repel each other
   D. Neither attract nor repel each other

(KLB; Primary Science Pupils' Book for Standard Seven P.109)





1. Which one of the following will pick pieces of paper if rubbed with cotton wool or a piece of cloth?
   A. A piece of wood
   B. A stone
   C. A plastic ruler
   D. A piece of metal
2. At Kindaruma and Kamburu dams, electricity is produced using water from the Tana River. The form of electricity produced is:
   A. Static electricity
   B. Current electricity
   C. Charged electricity
   D. Lightning
3. In car batteries, electricity is produced by:
   A. Water B. Chemicals C. Diesel D. Petrol
4. Which one of the following sources of electricity is **not** useful to us?
   A. Electricity from dry cells
   B. Electricity from a car battery
   C. Electricity from lightning
   D. Electricity generated from geothermal wells

(KLB; Primary Science Pupils' Book for Standard Seven P.126)

5. The material that is used to cover electrical wires should be
   A. a conductor.
   B. a non-insulator.
   C. an insulator.
   D. metallic.
6. Natural steam from the ground is used in
   A. hydroelectric generators.
   B. solar panels.
   C. geothermal generators.
   D. diesel generator.
7. Which one of the following does not use electricity?
   A. Bicycle
   B. Radio
   C. Wall clock
   D. Wheelbarrow
8. What is the best reason why we should not insert sharp objects in a socket?
   A. They can conduct electricity to the socket.
   B. They can create a short circuit and cause shock.
   C. The socket has three holes.
   D. All of the above.
9. Lightning is a flash of light in the sky caused by an
   A. electric shock.
   B. electric wire.
   C. electric spark.
   D. electric device.

(Oxford; Science in Action 7 P.81)





4. Which one of these is a good conductor of electricity?
   A. Rubber
   B Plastic
   C. Copper
   D. Wood

5. The diagram below shows a torch cell. Use it to answer the following questions.

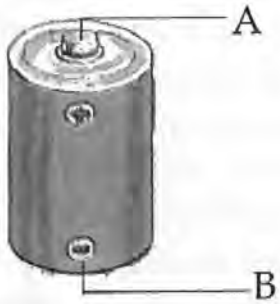
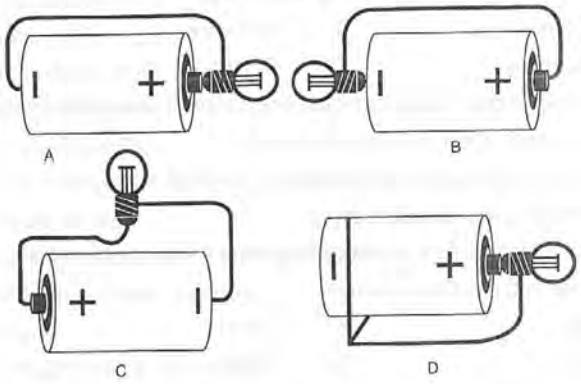



*Fig. 8.35: Torch cell*

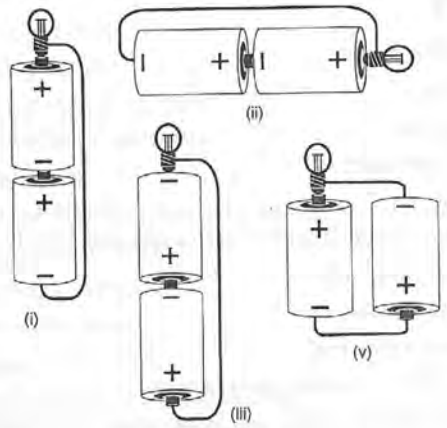
(a) label the parts shown as A and B.
(b) Draw a diagram to show how you would use a bulb and wires to make the bulb light.

(Longhorn; Understanding Science, Pupil's Book 7 P.67)

In which of the following arrangements will the bulb not light?




There are different ways in which we can arrange dry cells (batteries) in order to light a bulb.What will be observed in the following arrangements?




A. Only (ii) and (iv) will light
B. Only (ii) will not light
C. Only (iii) will light
D. All will light

(KLB; Primary Science Pupils' Book for Standard Seven P.127)





6. Hydro-electric generators are run by
   A. petrol.
   B. wind.
   C. moving water.
   D. electricty.

7. Which of the following is run by steam from the earth?
   A. Geothermal generator.
   B. Solar panel.
   C. Windmill.
   D. Diesel generator.

8. What name is given to an electric path along which an electric current passes?
   A. Electric circuit.
   B. Short circuit.
   C. Incomplete circuit.
   D. Good conductor circuit

(Longhorn; Understanding Science, Pupil's Book 7 P.67)

Which one of the following is a source of current electricity?

A. Static electricity
B. Rubbing of materials
C. Geothermal wells
D. Rubbed balloons

Current electricity is:

A. Static charge
B. Moving charge
C. Resting charge
D. Stationary charge

An electric generator is a machine used for:

A. Producing current electricity
B. Drilling
C. Producing static electricity
D. Heating

Thermal means:

A. Earth
B. Heat
C. Water
D. Electricity

(KLB; Primary Science Pupil's Book for Standard Seven P.129)

5. Match the following appliances with their uses:

| | |
|---|---|
| (a) iron | (i) information |
| (b) television | (ii) cooking food |
| (c) electric kettle | (iii) heating water |
| | (iv) drying food |
| | (v) pressing clothes |

6. Describe three safety measures when dealing with electricity.
7. List three safety measures for lightning.

(JKF; Primary Science Education Foundation Science 7 P.94)





Copy and complete the following sentences, using the words 'conductor' or 'insulator' to fill the gaps.
Most wires in circuits are made from copper metal, which is a good _____ of electricity. Copper is also used for the same reason in a lightning _____. Gold is an even better _____ of electricity and is used in computer keyboards. Water is a good _____. That is why it is dangerous to touch electrical appliances with wet hands. Electrical plugs and sockets are made from plastic, which is a good _____. Many materials such as iron and carbon are _____.

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.114)

If one bulb connected to one battery lights with normal brightness, say whether the bulbs in the circuit diagrams will light to normal brightness, or be brighter than normal, or less bright than normal, or will not light, when the switches are closed.

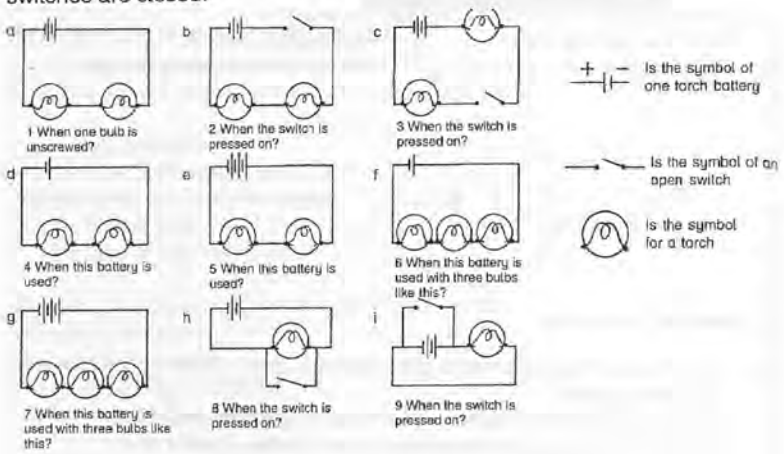



***Figure 8.21*** *Simple circuits*

(Macmillan; Macmillan Primary Science, Pupil's book 7 PP.113-114)

# Appendix

Examples of materials which are used in Kenyan text books

Sources of electricity

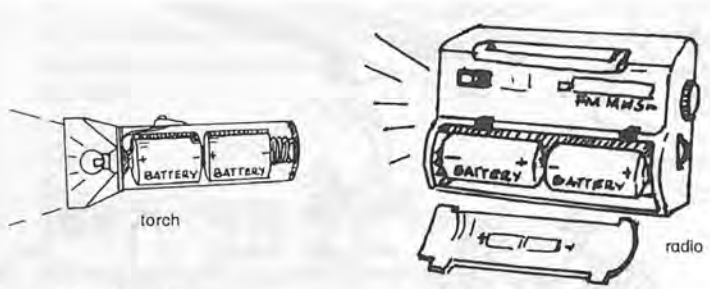



***Figure 8.2*** *Using batteries*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.98)

## Bicycle dynamo

This is an apparatus that produces a small amount of electricity for the cyclist to use for lighting his way in the dark.

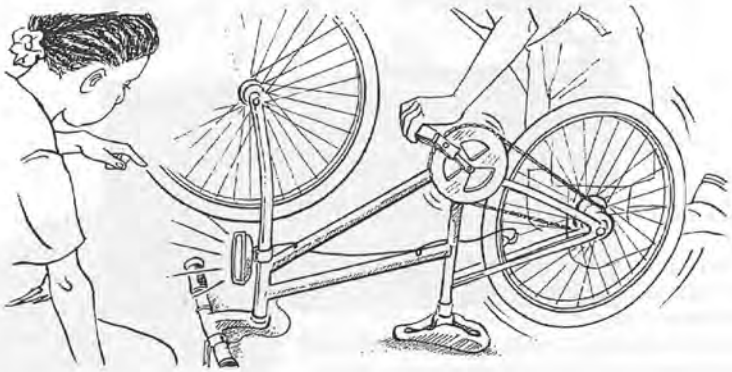


***Figure 8.4*** *A bicycle dynamo produces electricity*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.99)





- **Hydroelectric generators** produce electricity from moving water.

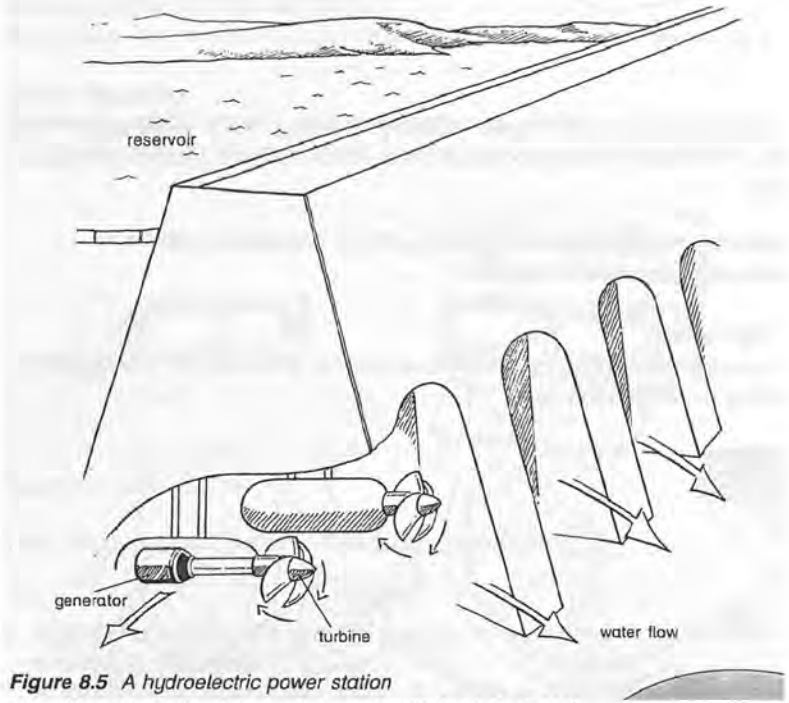



***Figure 8.5*** *A hydroelectric power station*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.100)

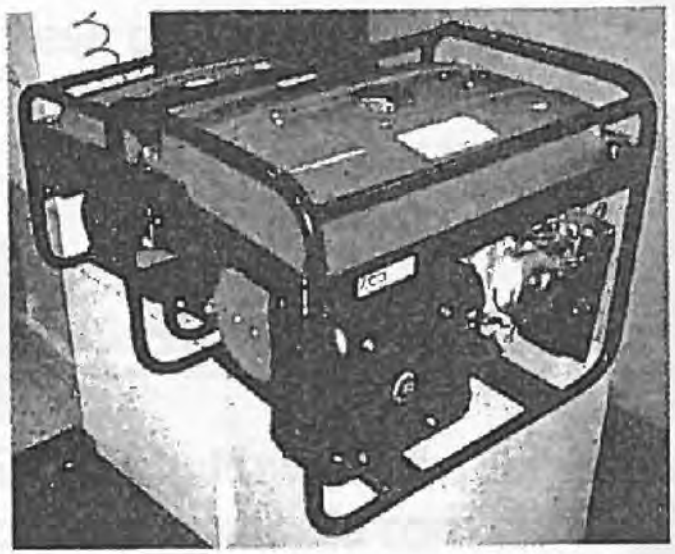


**Figure 8.6** *Diesel driven generator*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.101)



- **Geothermal generators** use moving steam heated by **geothermal energy** to produce electricity.

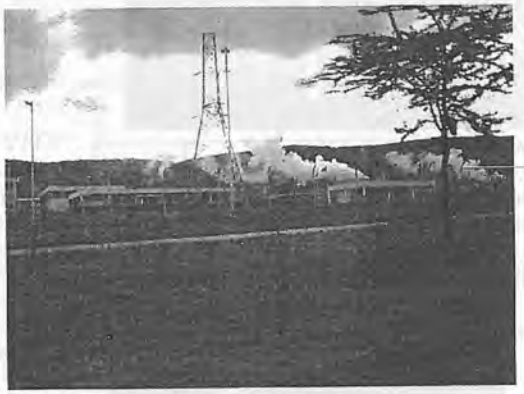



***Figure 8.7*** *Steam shoots out of the Earth as geysers*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.101)



- **Wind-driven turbines** use the energy from moving air to produce electricity.

***Figure 8.9*** *A wind farm with several wind turbines*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.102)

**Solar energy panels**

Solar panels produce electricity when sunlight falls on them. *Solar* means *sun;* therefore, a solar panel is a light sensitive cell that converts light energy from the sun to electricity.

*Fig. 8.11: Solar panels convert energy from the sun into electricity*

(KLB; Primary Science Pupils' Book for Standard Seven P.115)

Electric circuits

## B Simple electric circuit

Electricity flows through wires which are connected to the source of electricity to form a circuit. We can draw a diagram of a circuit using symbols to represent the different parts.

Figure 8.11 shows some symbols used in circuit diagrams.

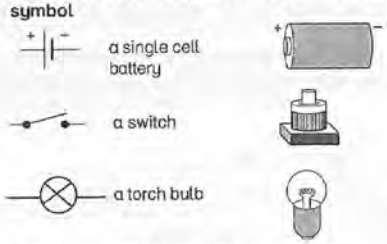



***Figure 8.11*** *Some symbols used in circuit diagrams*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.103)

***Figure 8.12*** *A simple electric circuit*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.103)





A **bulb** consists of a thin glass container filled with a gas which stops the filament from burning up.

Inside is a **filament** made of a metal called tungsten which has a very high melting point. The filament becomes white hot and emits light when electricity passes through it.

One end of the filament is connected to the metal side of the bulb and the other end is connected to the base of the bulb. Wires are connected to the base and sides to make a circuit.

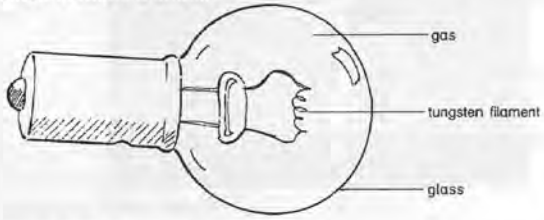



***Figure 8.13*** *The structure of a torch bulb*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.104)

The bulb lights when the correct points of contact for the bulb and the dry cell are established. When the bulb lights, we say you have a **complete simple circuit**.

(iv) Now make simple circuits as shown below.

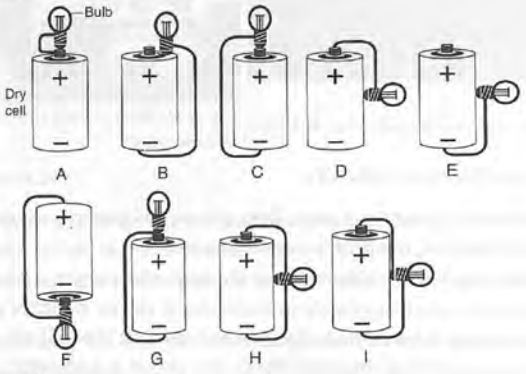



*Fig. 8.13: Some simple circuits*

***Procedure***

(i) Use two dry cells to make circuits as shown in figure 8.14.

(ii) Observe the arrangements and record.

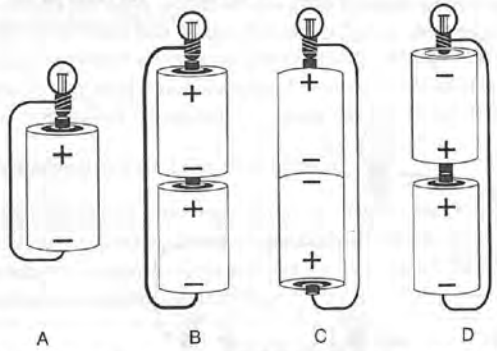



*Fig. 8.14: Establishing the correct contact points of a dry cell in a complete circuit*

***Questions***

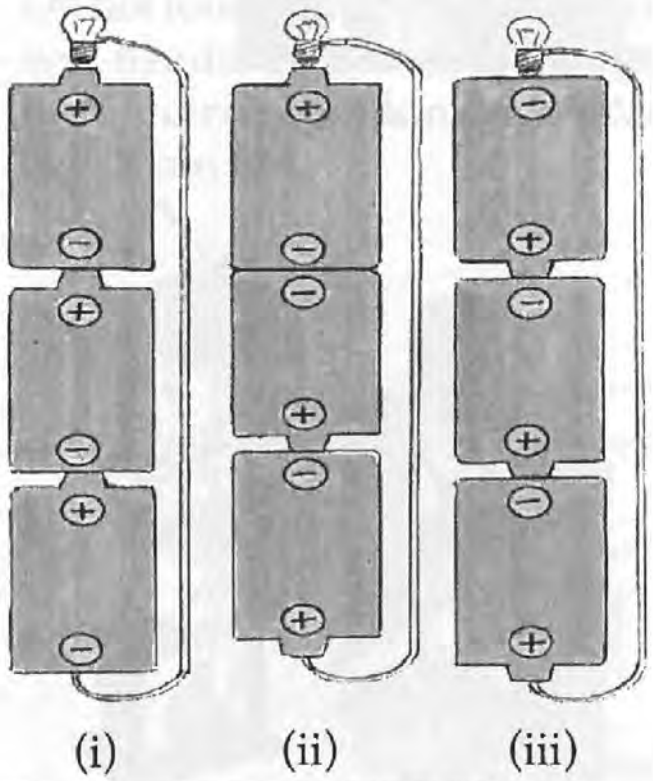
- In which arrangement does the bulb light?
- In which circuit does the bulb light brighter? Is it in a one-dry cell or in a two-dry cell circuit?

(KLB; Primary Science Pupils' Book for Standard Seven PP.116-117)





Use three cells and connect them as shown below. What happens in each case?




(Longhorn; Understanding Science, Pupil's Book 7 P.63)

Good conductors and bad conductors of electricity

***Materials needed***

(i) A length of wire, about 20 cm long, two dry cells and a bulb.

(ii) A collection of materials such as plastic objects, pieces of paper, ropes, pieces of glass, thread, wires of different materials, different types of metals, silver coin, copper coin, a nail, a piece of wood and aluminium foil.

***Procedure***

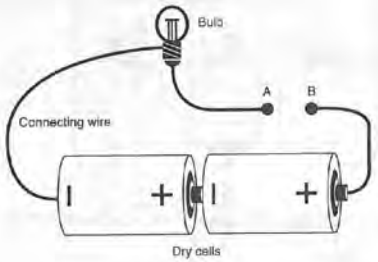



*Fig. 8.15: Investigating good and poor conductors of electricity*

(i) Arrange the wires, the bulb and the dry cells as shown in figure 8.15.

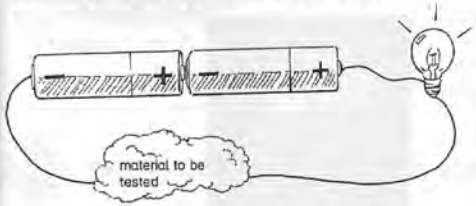
(KLB; Primary Science Pupil's Book for Standard Seven P.118)



***ACTIVITY***

***What to do***

Set up the circuit as in the picture. If the bulb lights brightly, the material is a good conductor. If the bulb does not light, the material does not conduct electricity. Record your results in a table.




***What you need***

two torch batteries
torch bulb
copper wire
iron wire clips for attaching materials to the copper wires
sticky tape
assorted materials to test: rubber, wood, coins, pencil lead, plastic, glass, paper, cloth, aluminium
exercise book
pencil

***Figure 8.15*** *Testing good and bad conductors of electricity*

***Materials which allow electricity to travel through them are called conductors.***

***Materials which do not conduct electricity are called insulators.***

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.105)



Write down your results in a table such as the one shown below.

Use ticks in the appropriate column.

| Material | Conducts | Does not conduct |
|---|---|---|
| nail | ✔ | |
| wood | | |
| glass | | |
| spoon | | |
| tin | | |
| cotton string | | |
| polystyrene paper | | ✔ |
| nylon bag | | |
| plastic bottle | | |
| comb | | |
| paper clip | | |
| needle | | |
| razor blade | | |
| Manila paper | | |

(Oxford; Science in Action 7 P.76)

Static electricity

## Static Electricity

Have you ever made the following observations?

- When a nylon cloth or a woollen pullover is removed suddenly from the body, a crackling sound is heard and sparks may be seen in darkness.
- When a cat is rubbed gently in darkness, you will observe that sparks are produced.
- When you comb dry hair using a plastic comb, a crackling sound is heard.
- When a mirror or a window pane is wiped using a dry duster or a piece of cloth on a dry day, dust particles or fluff from the duster or cloth stick to the glass.

The above are activities that demonstrate production of static electricity.

***Materials needed***

A pen or a plastic comb or a plastic ruler and pieces of paper.

***Procedure***

(i) Rub the plastic comb or ruler on your hair.
(ii) Hold it over the pieces of paper on a desk as shown in figure 8.1.
(iii) Observe what happens to the pieces of paper and record in your notebook.
(iv) Now try to pick the papers with the part of the ruler that has not been rubbed.

*Fig. 8.1: Static electricity makes the pieces of paper to stick on the plastic ruler/comb*

***Questions***

- Which part of the ruler or comb attracts/does not attract the pieces of paper?
- Why?





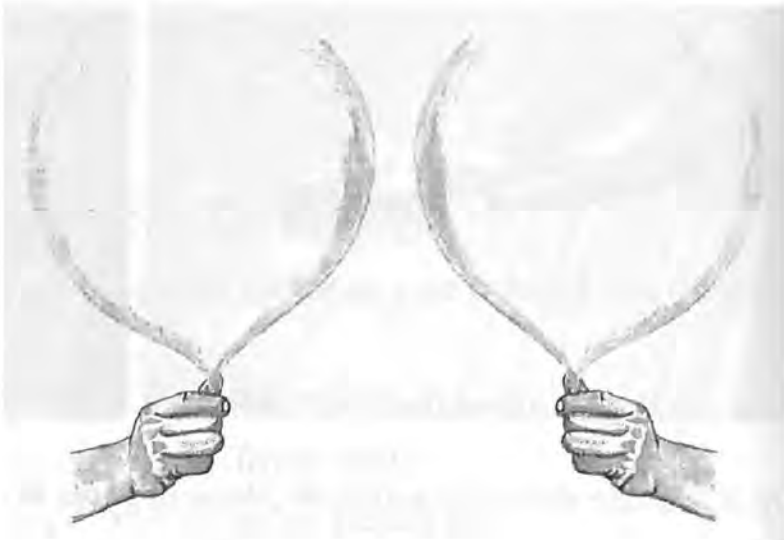


*Fig. 8.2: Producing static electricity by rubbing two balloons*

*Table 8.1: Producing static electricity by rubbing inflated balloons*

| Activity | Observation |
|---|---|
| Two uncharged balloons are brought close together | |
| A charged balloon is brought close to an uncharged balloon | |
| Two balloons charged at the same time with the same material are brought close together | |
| Two balloons charged using different materials are brought close together | |

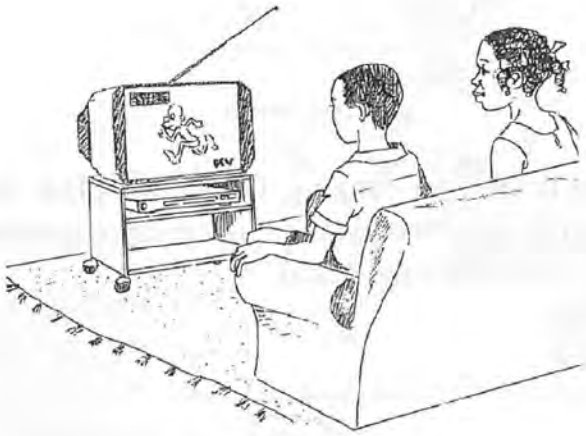
(KLB; Primary Science Pupil's Book for Standard Seven PP.106-109)

Electrical appliance and their uses

**Table 5:** Electrical appliance and their uses

| Appliance | Converts electricity to . . . | Used for . . . |
|---|---|---|
| **A) iron** | heat | pressing clothes to remove creases after washing. Ironing also helps to destroy irritating parasites on clothes, which are killed by the heat. |
| **B) radio** | sound | providing news and entertainment |
| **C) television** | sound and light | providing news and entertainment |
| **D) cooker** | heat | cooking food to make it edible and kill disease-causing germs |
| **E) electric kettle** | heat | boiling water to make it safe to drink by destroying disease-causing germs, and to make hot beverages |

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.107)



*Watching television*

(JKF; Primary Science Education Foundation Science 7 P.89)





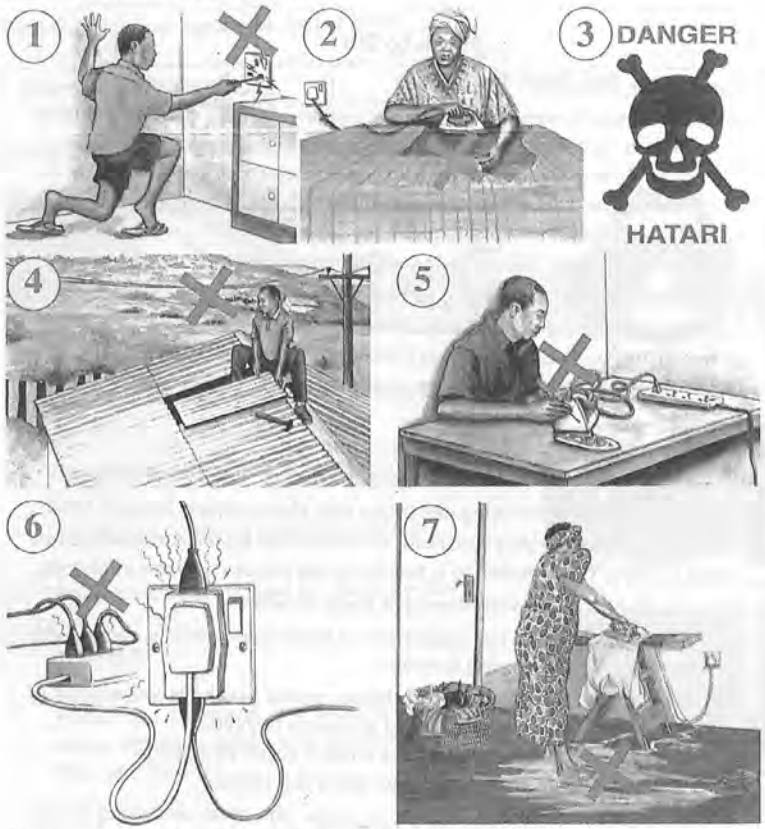
## Electrical appliances and their uses

An appliance is a machine or device used for a specific task in the home. Some appliances use electricity. Appliances that use electricity are called **electrical appliances**. Some electrical appliances found at home are shown in Figure 10.21.


*Figure 10.21: Electrical appliances*

(Oxford; Science in Action 7 P.77)

Safety when dealing with electricity




1. *Do not insert objects into electric sockets.*
2. *Do not use appliances with damaged plugs or wires.*
3. *Do not play near equipment with the sign DANGER or HATARI.*
4. *Do not work near mains or overhead electrical cables.*
5. *Do not repair an electrical appliance while it still plugged in.*
6. *Do not overload sockets by plugging in many electrical appliances in a single socket.*
7. *Do not operate an electrical equipment or touch a switch or a socket with wet hands or while standing in water.*

(KLB; Primary Science Pupil's Book for Standard Seven P.122)





Lighting

***Figure 8.18*** *Lightning is a static electricity*

We see lightning as very bright flashes of light during a thunderstorm. Thunder is the sound made by the lightning.
Lightning is a form of static electricity, which is made in clouds when air moves quickly over water droplets and ice crystals. The electric charge builds up in the cloud until it is discharged as a flash of lightning to earth or to another cloud. There is a very large amount of electricity in lightning, which is why it is dangerous.

- ***Lightning is a static electricity.***
  ***Lightning can damage buildings and kill people.***

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.109)

As the rain falls through the air, the clouds get charged. When these charges build up on the clouds, static electricity is produced. This is seen as a large bright spark across the sky and it is what we call lightning. Lightning is, therefore, a strong form of static electricity.

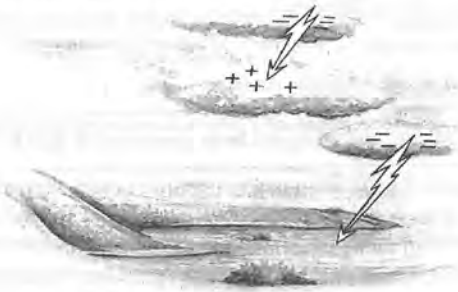


*Fig. 8.21: Lightning is a strong form of static electricity*

It is important to know the dangers of lightning. It causes fires and also destroys buildings. Lightning can lead to loss of human and animal life.

(KLB; Primary Science Pupil's Book for Standard Seven P.123)

Lightning always tries to take the shortest path from a cloud to the ground. It will therefore always strike the **highest object.** We can take certain safety measures to avoid being struck by lightning:

- During a rainstorm never walk in an open area. In the open you will be the highest object and if there is lightning, you may be struck.
- Never walk in pools of water during a rainstorm because the electrical energy from past lightning could be flowing in the water. You would then get a shock which could be fatal.
- Always wear shoes with rubber soles if you have to go out in a storm. The soles of the shoes will insulate you and prevent the lightning from passing through you into the ground if you are struck.
- Never shelter under a tree during a thunderstorm. Lightning may strike the tree and you could be injured or killed by falling branches.
- Tall buildings should be fitted with lightning arresters or conductors. These are metal rods or wires (usually copper) that are fixed to houses so that they carry lightning harmlessly to earth and prevent damage to the building.
- Avoid swimming during thunderstorms as water is a good conductor of electricity.

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.110)

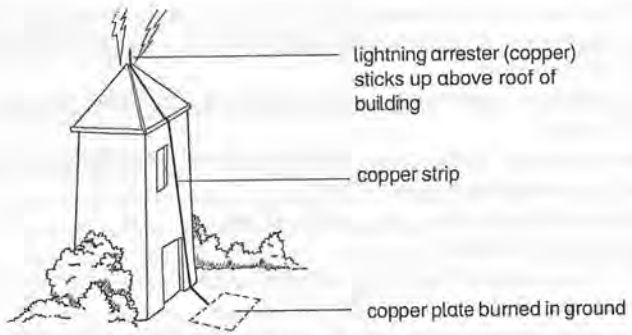



***Figure 8.19*** *How is this building protected from lightning?*

(Macmillan; Macmillan Primary Science, Pupil's book 7 P.109)





- Electricity is a form of energy.
- There are two forms of electricity: static electricity and current electricity.
- Rubbing two surfaces, one against the other, produces static electricity.
- Current electricity is produced from: hydroelectric dams, geothermal wells, diesel generators, torch cells, car batteries and solar batteries.
- Lighting is a very strong form of static electricity.
- Factories, schools and most homes use electricity generated from big dams, geothermal wells, diesel generators, solar cells and wind generators. This kind of electricity is called **current electricity.**
- Unlike static electricity which is at rest (stationary) current electricity can move. The movement of electricity from one point to another is called **electric current.**
- Current electricity is carried through wires.
- We use **dry cells** to operate our radios, torches and cameras.
- A **battery** is made up of two or more cells that are connected to produce current electricity.
- The terms, **positive** and **negative** are used to describe electric charges.
- The positive end of a dry cell is marked with a **plus sign (+).** The negative end of a dry cell is marked with a **minus sign (-).**
- An electric circuit is a path that allows an electric current to flow. In most electric circuits, the path is made of wire.
- Materials that allow electricity to pass through them are called **good conductors** of electricity. Materials that do not allow electricity to pass through them are called **poor conductors** of electricity.
- An electrical appliance is an instrument or device used for a specific purpose. Examples of electrical appliances are electric iron, electric kettle, electric cooker, electric radio and television.
- Electricity is useful when used cautiously. However, it can be extremely dangerous if used carelessly. It can kill! It is important to exercise great caution when using electricity to avoid accidents.
- It is important to know the dangers of lightning. It causes fires and also destroys buildings. Lightning can lead to loss of human and animal life.
- A **lightning conductor** or **arrestor** is a pointed metal rod that is fitted in a building so that it reaches higher than any other part of the building. If lightning strikes, the charge travels from the clouds to the ground through the lightning conductor.

(KLB; Primary Science Pupil's Book for Standard Seven P.126)

# Appendix

**Dr. Takemura's model classes that makes children active**

In the lower and middle grades, children are keen to learn a variety of activities, such as play, games, challenges and ranking, flower arrangement, scientific handcraft, nature games, breeding organisms, cultivation, nature observation, drama, *sugoroku* board game making, observation-based pictorial book compilation, scientific comic compilation, scientific newspaper publishing, harvest festivals, scientific playgrounds, devising scientific quiz, tours, and receiving guest teachers. However, upper-grade children are not active in science classes due to their stereotypical character. Therefore, I would like to propose several class models to get the pupils to become more active.

For an actual class, the teachers can select some of the examples in consideration of the pupils' capabilities.

**1. Child's idea reconstruction method**

**(1) Immature knowledge that children have**

Immature knowledge means uncertain information or knowledge. It leads to simple and wrong concepts as well as to a description of, an opinion on, a view of, or a thought on inappropriate things and phenomena. In other words, children have superficial knowledge or offer conceptual expressions. Immature knowledge is also called child living knowledge that is comparable to academic knowledge. It is known that children continue having academic and child living knowledge that are both opposed to each other unless they can reconstruct their living knowledge scientifically in a class.

For instance, such children think that an electric current flows out of the positive pole and is consumed at the miniature bulb, so it hardly reaches the negative pole, or that positive and negative electricity flows out of the positive and negative terminals of the dry cell, respectively, and both collide with each other to light the miniature bulb.

In the lesson "Connecting dry cells in series or in parallel," children normally think that two cells will make the lamp brighter than by using one cell. They also believe that the parallel connection of two cells presents the same brightness as one because neither is working.

**(2) Constructive and procedural knowledge children have**

**Constructive and procedural** knowledge is knowledge that children build by themselves or that relates to a certain procedure or method. The certainty of knowledge depends on the process of and experience gained from obtaining it. Children put a question, plan a learning process, choose and use observing and experimental tools and instruments correctly, and conduct an experiment. Moreover, they gather many facts and consider them critically and logically in order to generalize. They examine a variety of expectations according to the





grounds on which they are based. As a result, the children accept a hypothesis whose correctness is then proven by many pieces of evidence as a scientific concept. This concept is one that they build and reach at this stage. They define it operationally.

For instance, children come up with the following descriptions: "there are three types of connection of two dry cells: the first one does not light the bulb, the second one makes the bulb brighter, and the third one presents the same brightness as by using one cell," "because connecting two dry cells in series makes the bulb brighter, the bulb goes off if one cell is removed from the holder," and "if two dry cells are connected in parallel, the bulb continues to be illuminated with the same intensity after one cell is removed from the holder."

**(3) Scientific knowledge**

Children learn scientific terms from teachers and use them to describe a phenomenon correctly. Precise definitions and scientific terms clarify scientific principles, laws, and concepts. Children understand the deep significance of knowledge through scientific terms.

For example, teaching pupils about a "closed circuit," "open circuit," "single circuit," "series circuit of dry cells," and "parallel circuit of dry cells" in African countries requires experimental tools and instruments, including a voltmeter and ammeter, and teachers should correctly use terms such as "current strength" and "current direction," to scientifically describe the constructive and procedural knowledge mentioned above.

**Pupils' ideas**

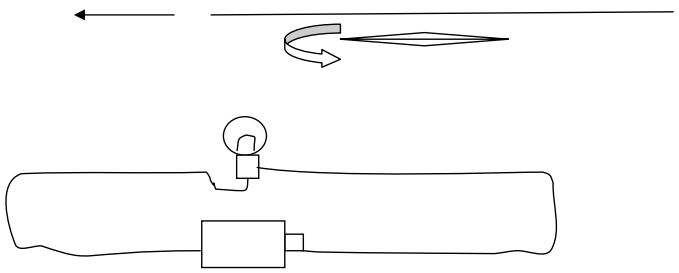
(1) An electric current flows out of the positive pole and is consumed at the miniature bulb, so it hardly reaches the negative pole.

(2) Positive and negative electricity flows out of the positive and negative terminals of the dry cell, respectively, and both collide with each other to light the miniature bulb.

(3) The dry cell continuously supplies electricity like a pump, resulting in electric current circulation. As the pumping power is small, the cell becomes exhausted.

**Verification methods**

Position a magnetic needle under a piece of straight wire. Holding the needle with your right hand while directing the thumb towards the direction of the current (from the positive to negative poles) turns the red N pole of the needle in the direction in which the remaining four fingers are pointing.

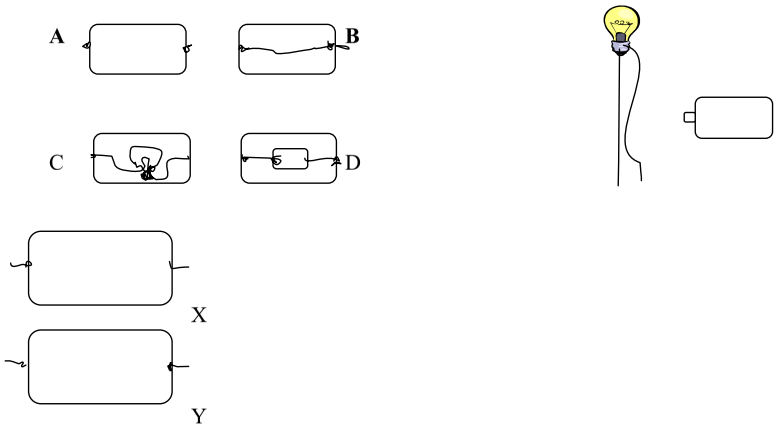


- Position the needle under the wire on the right side of the bulb and then on the left side. In both cases, the turning angle of the needle does not change. Accordingly, Idea (1) is wrong.
- Position the needle under the wire on the right side of the bulb and then on the left side. In both cases, the needle turns in the same direction. Accordingly, Idea (2) is wrong.
- As a result, the experiment above supports Idea (3).

Conclusion: The dry cell continuously supplies electricity like a pump, resulting in electric current circulation.

**2. Black box method**

This method aims to raise the conceptualization and decision-making ability of the class in which pupils solve a problem using their learned knowledge and skills as well as improve their competence in expressing themselves through discussion. As a result, they acquire both an experiential and a working knowledge of phenomena.




If you connect the miniature bulb and dry cell to the boxes A, B, C, or D, does the bulb light up? Let's examine your expectations. Which type of circuit do the black boxes X and Y have in them? Use the bulb and cell to



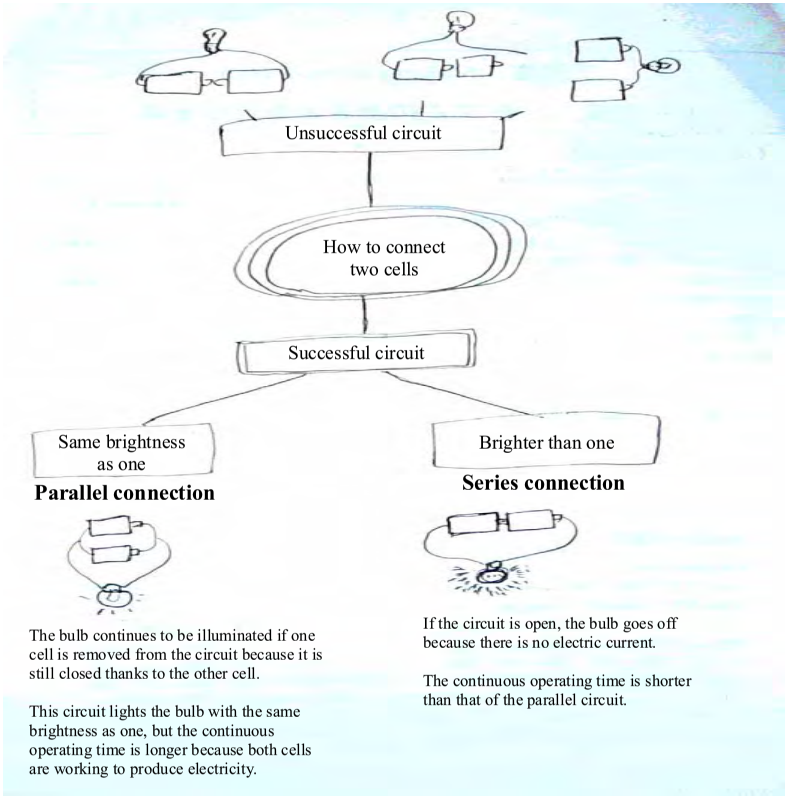


check that X and Y each corresponds to which one of A, B, C, and D.

**3. Mind mapping method**

This method of expression aims to expand ideas and facts through enabling children to radially connect images and keywords to a concept that they want to express and that is placed at the center while organizing the things they want to learn in their minds. Networking the meaning of understanding in the human mind helps the children form the structure of semantic memory by themselves.

Example shown by a certain pupil




**4. Jigsaw method**

This is the learning method of filling in blanks by supplementing or reinforcing imperfect parts like a jigsaw puzzle. The pupils are divided into groups of eight. The first group is called the home group. The teacher

instructs the home group intensively in basic knowledge and skills, for example, they learn how to make a circuit with a dry cell to light a miniature bulb. Next, each group is divided into four subgroups of two, who are specialists in a certain subject and experiment. The teacher prepares four kinds of experiments in applying knowledge separately on four tables, and each of the experts A, B, C, and D forms a new and special subgroup. Each expert reads a problem prepared on the corresponding table to conduct an experiment according to a given learning guide. Problem 1: A connects the clip to light the lamp. Problem 2: B uses the aluminum foil to light the lamp. Problem 3: C makes a switch. Problem 4: D makes a switch for turning a bulb ON/OFF by putting cellophane tape along a sheet of aluminum foil and moving a wire over it. After all the subgroups have completed their tasks, they go back with their experimental devices and learning guides, and each subgroup teaches the remaining six pupils how to solve the problem and to conduct the experiment. The purpose of this class is to improve the pupils' ability to think, make decisions, and express themselves by finding out what others have learned when solving applied problems, and to raise their competence in using knowledge and skills by teaching their classmates.

As a result, the pupils learn good teaching methods.

**5. Co-Op method**

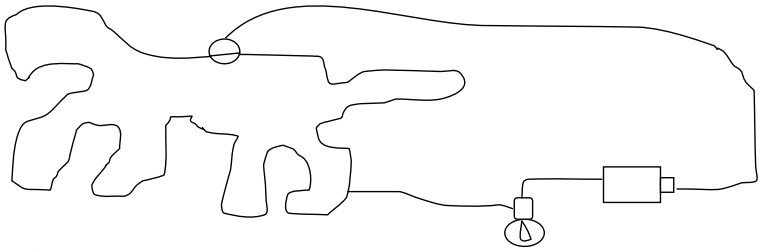
This method gives importance to both individual and group (cooperative) lessons. A unit consists of a series of subunits. After completing the unit, the teacher carries on the class to formatively check how the pupils solved the applied problems. The teacher divides the pupils into groups of six, whose members have shown the almost same level of learning achievement. Each member has an answer card. The pupils learn how to solve the applied problems. Different groups solve different problems. Each member puts down an answer on the card and places it with the back facing upwards. As a result, the six cards are piled up on a group basis. For example, two show one answer and four indicate another answer. Next, each group starts a discussion. The teacher gives advice if necessary. All the members of each group investigate the answers, present the evidence and facts, and reach an agreement on the correction of the wrong answer to find the correct answer. Mutual help and cooperation results in coming up with the correct answer. If four cards show the correct answer, the group gets four points. Each group conducts experiments one after another. It takes 2 or 3 teaching hours to finish this class. After completing all the experiments, the pupils sum up the points on a group basis. If any child fails to conduct an experiment or makes a mistake on the way, the teacher provides a supplementary advice to enable the pupils to find the correct answer. The purpose of this method is to raise the pupils' ability to think, make decisions, and express themselves and to polish their knowledge and skills, so that the teacher has to prepare problems related to the application of concepts taught in the sub-units from various aspects.

**Problem 1**

Move the ring attached to the wire end around the circuit without lighting up the bulb. Each player gets one point if successful, otherwise no point is given. Therefore, the six members can get up to six points.





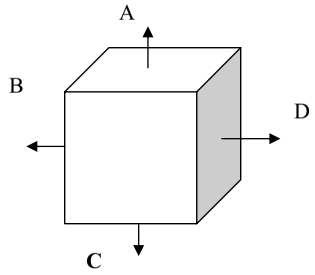


**Problem 2**

The box has four terminals, which are called A, B, C, and D. The tester shows that some connections light the lamp. The successful or unsuccessful pairs of terminals are represented by the symbols ○ or × , respectively.

A and B: ×; A and C: ×; B and D: ×; C and D: ×

A and D: ○; B and C: ○




How are the wires connected to the terminals in the box?

Illustrate your expectation of the answer.

Open the box to confirm the actual wiring.

Each player gets one point if the illustration is correct, otherwise no point is given. Therefore, the six members can get up to six points.

**Problem 3**

Determine whether each of the following objects conducts electricity or not.

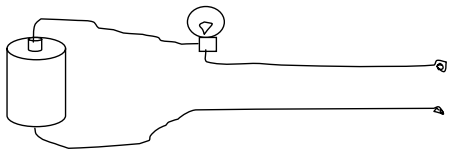
Put either the symbol ○ or × against the object or material that is a conductor or an insulator, respectively.

| | | | |
|---|---|---|---|
| Copper nail | New iron nail | Glass | Paper |
| Plastic | Dry wood | Ceramic container | Metal spoon |

Use your self-made tester to check your answer.

Each player gets one point if all the answers are correct, otherwise no point is given. Therefore, the six members can get up to six points.

Tester



**Problem 4**

Determine whether each of the following substances conducts electricity or not.

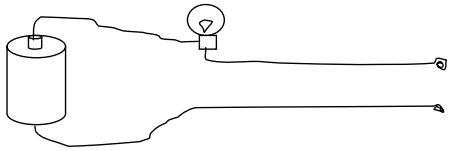
Put either the symbol ○ or × against the object or material that is a conductor or insulator, respectively.

Dense saline　　Sugared water　　Boiled water

Use your self-made tester to check your answer.

Each player gets one point if all the answers are correct, otherwise no point is given. Therefore, the six members can get up to six points.

Tester



**Problem 5**

Determine whether each of the following substances conducts electricity or not.

Put either the symbol ○ or × against the object or material that is a conductor or insulator, respectively.

Aluminum juice can coated with colored paint
Steel juice can coated with colored paint

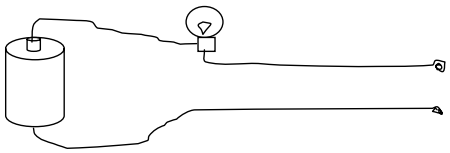
Use your self-made tester to check your answer.

Each player gets one point if all the answers are correct, otherwise no point is given. Therefore, the six members can get up to six points.





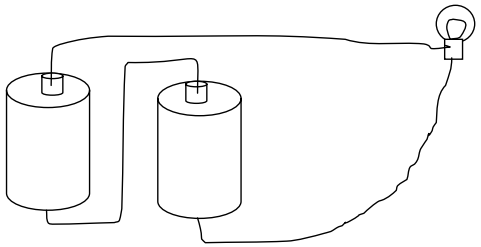
Tester

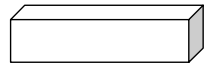


If the cans are nonconductive, change them so that an electric current flows to light up the bulb on the tester.

**Problem 6**

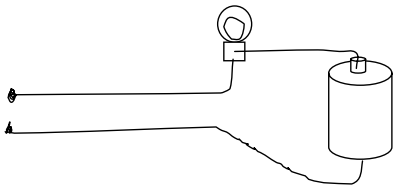
The bulb does not light. Why? Come up with several possibilities. Use the tester to check whether each of your assumptions is correct or not. After finding the correct reason, take out the necessary devices from the material box to change the circuit to light up the bulb. The box contains a new dry cell, a new miniature bulb, a piece of new wire, and a roll of plastic tape.





Materials box

Tester



Three points are problematic.

Have a group discussion within 15 minutes as to how to light up the bulb. No point is given to unsuccessful groups.

**6. Demonstration method**

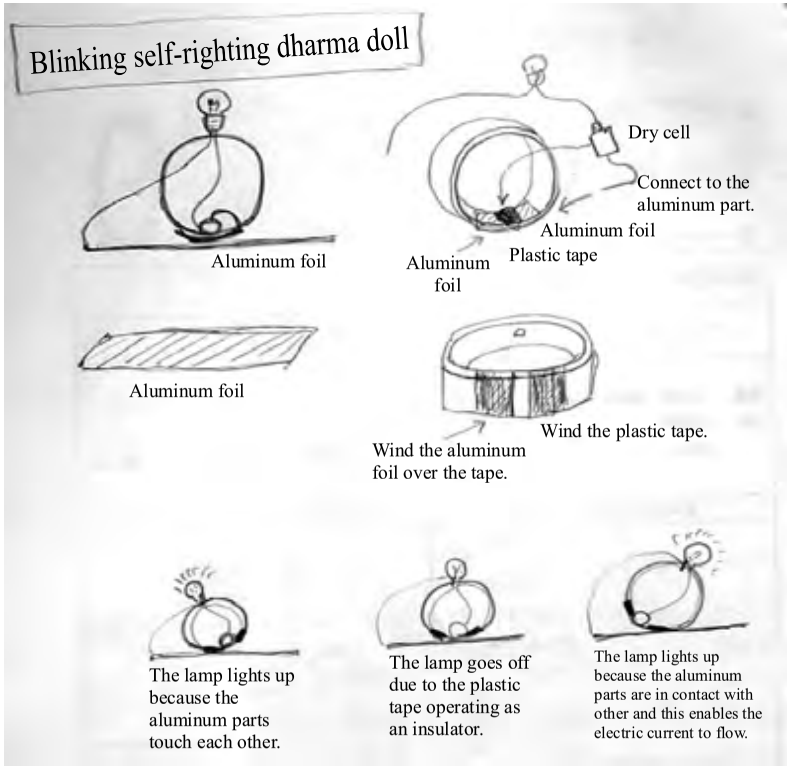
After teaching “making electric circuit” in the lesson “Electricity,” the teacher prepares Islands A, B, C, and D in the gym where the pupils can have an experience in explaining. They solve problems on an island basis.

Namely, after solving a problem on one island with a good understanding and successful fabrication, a pupil goes to the next island. For example, Islands A, B, C, and D present problems related to a "blinking self-righting dharma doll," an "illuminating mask," "lighting a miniature bulb using a windmill," and an "electric signboard," respectively. The children are required to apply the principles correctly. The teacher works as an evaluator. If any member has no idea, the group takes time for a discussion. The purpose of this learning method is to raise the pupils' ability to think, make decisions, and express themselves by finding out through a group that repeatedly applies and takes advantage of scientific principles. It is also called the island-hopping explanation and demonstration learning method.

"Blinking self-righting dharma doll"

Move a self-righting dharma doll to observe that the lamp blinks. Next, have a discussion about the mechanism of the doll. Finally, read the manual and fabricate the doll.

Manual





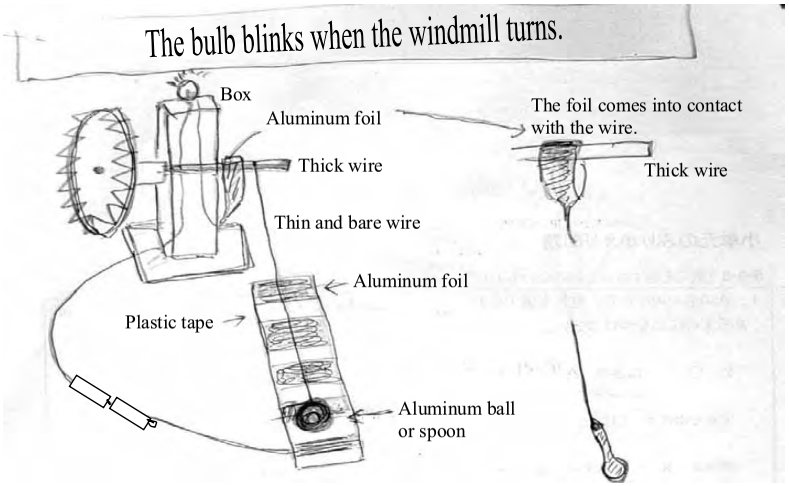



"Illuminating mask"

Folding the hands lights the eyes, nose, and mouth. The hands form a switch. Colored cellophane is put over the eyes, nose, and mouth. Operate the hands to light the miniature bulbs. Imagine the circuit without looking at the back of the mask and design it group by group. After all the members reach agreement, look at the back to confirm the circuit and start fabrication.

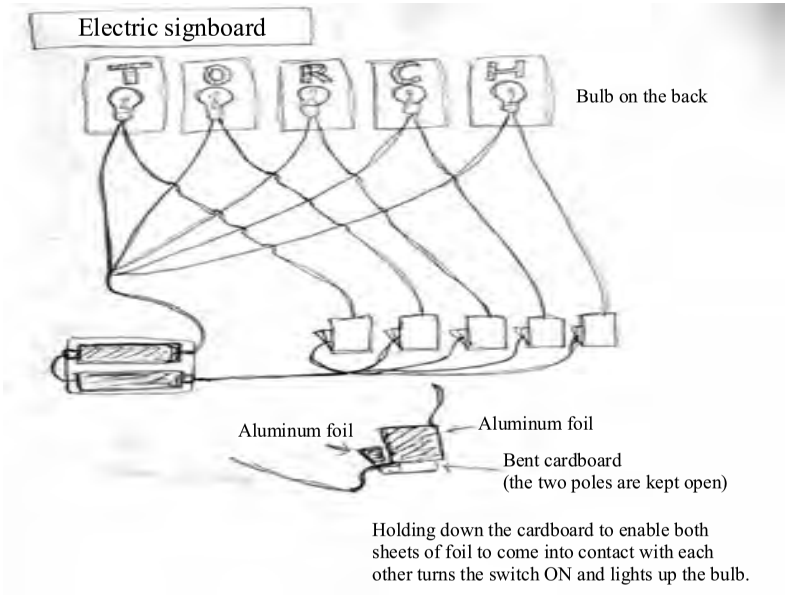

"Lighting a miniature bulb using a windmill"

Blow on the windmill to turn it round. When the windmill rotates, the miniature bulb blinks. The higher the rotation speed, the higher the frequency of blinking. The materials forming the switch are in a box and only the thin wires are extending out from holes in the box. First, discuss the mechanism of the switch in a group to propose various ideas. Next, open the box to observe the mechanism. Finally, make the switch and check that it works.




"Electric signboard"

The signboard consists of five pieces of paper, each having the red letter T, O, R, C, or H, and five miniature bulbs, each positioned behind a letter. Different lamps are connected to different switches. Push one hand-made switch to light the corresponding letter. Press all the switches to illuminate all the letters. The circuit is placed in a box, so no one can see it. Design the circuit. After all the members agree on one design, open the box to observe the circuit. Finally, start fabrication.








**7. Workshop method**

After understanding the scientific views and concepts resulting from a certain phenomenon, all the class members conduct different experiments as a way of applying the knowledge at different tables. For example, if 32 pupils attend this class, they are divided into four groups of eight. The learning manual is put on each table and it describes the purpose and method of the experiment. Each group conducts an experiment and answers the questions given at the end of the manual. All the members have a discussion about how to conduct the experiment and to present the information as well as answers to the questions. They play the role of a teacher or a pupil. After completing the four experiments, the four members are pupil teachers, while the others are visiting pupils. This means that the class is divided into two: one is an instructing group and the other is a learning group. After conducting the experiment A, B, or C, the visiting pupils move to table B, C, or D, respectively, to learn new knowledge. They describe the test results. The pupil teachers put questions and the visiting pupils answer them. After one cycle is complete, both sets of pupils exchange with the others and continue with the class. The purpose of this method is to raise the pupils' ability to think, make decisions, and express themselves, and to improve their competence to apply knowledge and skills through mutual learning and teaching.

Accordingly, teaching other classmates not only deepens their understanding and skills, but also raises their awareness of voluntary and independent learning. It is necessary to provide sufficient time to play joyfully.

**Examples**

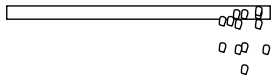
The pupils have learned that lightning is discharged static electricity and the measures to be taken to prevent harm or injury from it.

In this lesson, they conduct a pleasurable experiment in static electricity. It is recommended to teach static electricity in the dry season rather than in the wet season. Dirty objects are troublesome, so it is necessary to clean them with alcohol for good results. A guide for each experiment is put on each table.

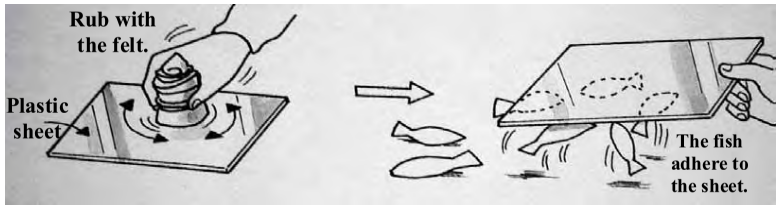
**Table A**

Rub the plastic ruler on your hair and confirm that it attracts fragments of paper.

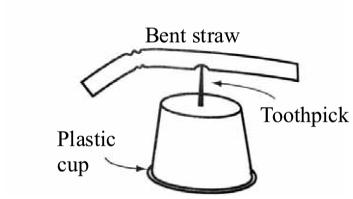
Charged ruler



Rub the plastic ruler or sheet with a roll of wool or felt. The fish jump.




Next, make a tool as shown in the figure below to conduct an experiment.




A clay cup can be used to substitute for the plastic cup.

Rub the straw with the tissue and place it on the toothpick. If your hand approaches the straw, it turns toward your hand.

Bring the objects listed below close to the straw in the following order: the paper, ballpoint pen, eraser, wood, glass, ceramic ware, handkerchief, vegetable, salt, and sugar. What happens?

The straw attracts all the objects—it turns toward them.

The straw rubbed with tissue has a negative charge. If any of the objects above approaches it, positive charges gather at the near end of the object. As a result, the straw and object attract each other.
Rubbing the straw with the eraser positively charges the straw. If any of the objects above approach it, a negative charge gathers at the closest end of the object. As a result, an attractive force turns the straw towards the object.

What happens if you rub another straw with tissue and bring it close to the tool? Did you expect and can you explain the resulting movement?

Both straws have negaitve charge, and as a result, the negative repellant force turns the straws away from each other.

What happens if you rub another straw with eraser and bring it close to the tool? Did you expect and can you





explain the resulting movement?

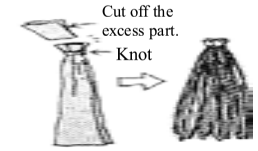
The first and second straws have negative and positive charges respectively, so the attractive force turns the first one towards the second one.

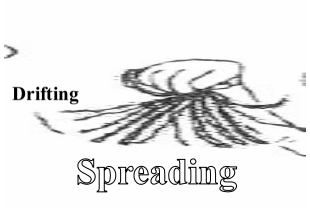
Experiment C includes a similar one.

**Table B**

Cut the plastic or polyethylene string to make a piece 15 to 25 cm long, make a knot at one end, and break it into as many thin threads as possible as shown in the accompanying figure. Hold the knot in one hand and the tissue in the other hand, and repeatedly rub the string with the tissue so that the tissue wraps around the string. You can use a comb instead of the tissue. The threads then spread out widely. What is this phenomenon? Did you expect it and can you explain it?

This occurs because all the threads have the same charge, so they repel each other. The repellant force generated by the negative charge makes the threads spread out.

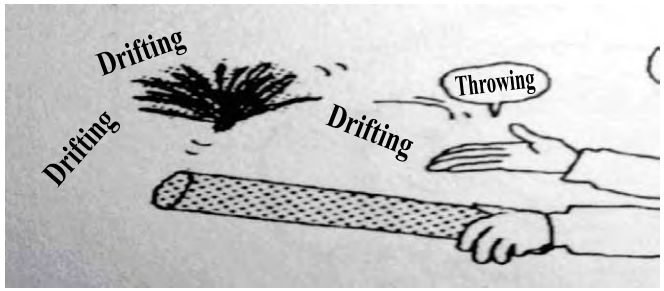



Rub the polyvinyl chloride pipe (or a long thin rubber balloon) with tissue.

Next, throw the charged string upwards in the air and position the charged pipe under it. The negative repellant force lifts the string, and then it drifts in the air.

The same phenomenon occurs when you rub a plastic bag, plastic balloon, or polyethylene bag using tissue, and throw it above a charged rubber balloon. Moreover, if you select two of these objects, connect a thread to each, and hold the threads to hang down and then make both approach each other, the two objects will repel one another.



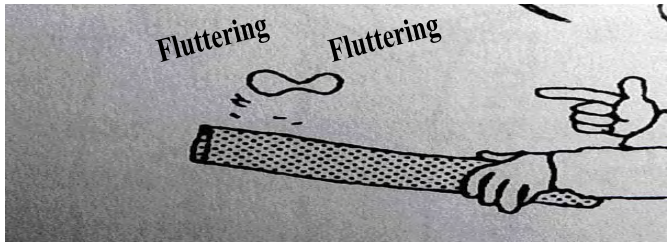




**Table C**

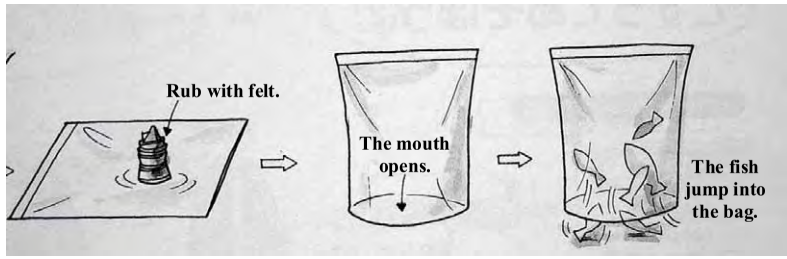
Place a polyvinyl chloride plate on the styrene foam blocks and rub it with a piece of woolen cloth.

Pass the charged plate over fragments of tissue. Some stand up or form a chain together because an attractive force is acting on them.

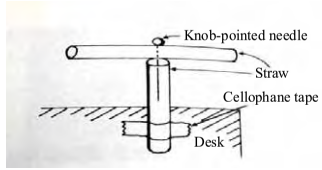
Rub the plastic bag with a roll of wool or felt. Hang the bag down to open the mouth. Bring the paper fish close to the open mouth. They jump into the bag. (This is an experiment that was conducted by Kiyoko Tsuda, a Japanese teacher.)








Next, make a tool as shown in the figure below and conduct an experiment.




Rub one straw with tissue, make the needle piece the center of the straw, and place them on the other straw. Bring your hand close to the first straw. It turns towards your hand.

Bring a pair of metal scissors, a knife, a clip, a piece of wire, or a nail close to the straw. Moreover, make water, a saline solution, or oil flow down near to the straw. What happens?

The straw attracts every object—the attractive force turns the former toward the latter.

The straw rubbed with tissue has a negative charge. Bringing any of the objects above close to the straw gathers a positive charge at the closest end of the object. Accordingly, both attract each other.

The straw rubbed with eraser has a positive charge. Bringing any of the objects above close to it gathers a negative charge at the closest end of the object. Therefore, the attractive force turns the straw toward the object.

Experiment A includes a similar one.

Charge the polyvinyl chloride or rubber balloon by strongly rubbing it with tissue. Bring the balloon close to a water stream that is flowing downward. What happens? As well as the straw and water attracting each other, the balloon attracts the water. As a result, the water stream bends.

Cut a sheet of paper into a long strip and glue one end to the other to make a ring. Place it on a smooth surface. Bring a charged object close to the ring. The ring rolls and approaches the object.




Rub the pantyhose with a roll of wool or felt. The pantyhose inflates due to the repellant force generated by frictional electricity. Why does it inflate? Bring the paper fish made in advance close to the pantyhose. The former adheres to the latter. Why does this phenomenon occur?

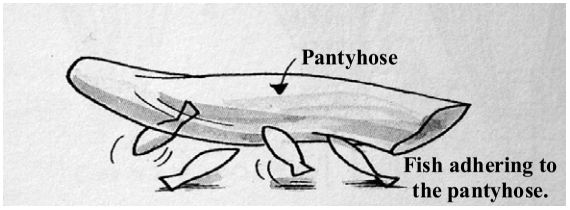



**Table D**

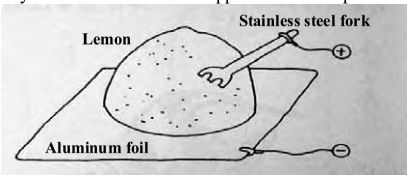
You have already learned about dry cells in this unit. Next, let's make a cell by hand.

**Fruit cell:** This cell consists of a fruit (lemon, grapefruit, kiwi fruit, strawberry, biwa (loquat), or watermelon), a copper sheet, and a piece of tinplate. Insert both plates into the fruit and connect two or three cells in series. Light the lamp and extract an electronic musical box from a Christmas card to connect to the cell. In addition, make an instrument as shown in the figure below to check that an electric current flows.

(ENERGY/7th Grade)

Make a coil and hang a needle in the center using a thread to connect them.
Magnetize the needle by rubbing it on a magnet in one direction beforehand.

If you do not have either copper sheet nor a piece of tinplate, you can make a cell in the following way.

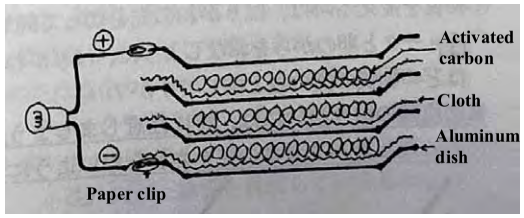



This cell can turn on an electronic music box or light up a light emitting diode (LED).

**Solution cell:** This cell consists of two different metals and a solution (saline, vinegar, or dilute hydrochloric acid) in which both metals are immersed. If lead wires are connected from both metals to the galvanometer shown above, the needle shakes. In addition, this cell can light a miniature bulb. Volta invented a cell that consisted of zinc, copper, and dilute sulfuric acid in 1800. Immersing the two metals in the solution enables an electric current to flow between them.

**Aluminum and stainless steel cell:** This cell consists of aluminum, stainless steel, and a saline solution. The aluminum part is made by cutting off the top of a juice can. The solution is made by dissolving 25 g of salt in 500 mL of water and mixing it with farm soil. Several aluminum cans are filled with the resulting solution, and a stainless steel spoon or a pencil lead of grade 2B is put into the center of each can. The stainless steel and aluminum parts work as the positive and negative terminals, respectively. This cell can turn on an electronic musical box or light up a miniature bulb. Connecting several cells in series can turn a propeller motor. There are other methods of making a cell: (1) Laying an aluminum sheet in a plastic container and filling it with a saline solution and (2) Wrapping a stainless steel spoon in a filter paper for use in a coffee maker and immersing them in a saline solution.

Next, let's make another kind of cell. Lay out a sheet of kitchen paper dampened with a saline solution on an aluminum dish, and spread pieces of activated carbon flat and uniformly over the paper. Make three to five cells and pile them up. The resulting cell can light up a miniature bulb and turn on a motor.




A small motor, LED, electronic musical box, miniature bulb, and wire are available from an educational materials shop.

Not only do all the members of each group have a discussion, affect each other, and support one another, but also the whole class forms a single entity in order to dynamically achieve a single learning goal. They become keen about learning and share a deep impression every time they attain a goal.

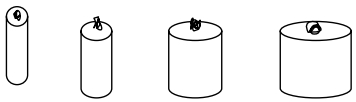
**8. Naive child question method**

Children have simple questions about electric phenomena, so it is important to answer them through experiments. All the members of each group pair off into couples. After completing an experiment, each pair shows and presents their results to the others.



**Experiment A**

"Dry cells are sized differently: D, C, AA, and AAA, so I think that the larger the cell, the brighter the bulb."



The experimental results show that every cell lights the bulb with the same intensity. Observing the cells finds that they are all labeled "1.5 V."

**Experiment B**

"I think that just like a hose connected to a faucet, bending a wire abruptly stops the electricity flowing through it."



The experimental results show that an electric current continues flowing to light the miniature bulb even if the wire is bent.

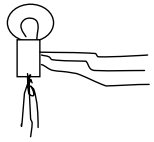
**Experiment C**

"I think that the longer the wire, the longer the time that it takes for electricity to reach the miniature bulb. Accordingly, pressing the switches simultaneously first lights the bulb with a short wire, and then the other with the long wire."

The experimental results show that both bulbs light up simultaneously. This is because electricity flows at an extremely high speed, but the bulb with the longer wire is slightly darker.

**Experiment D**

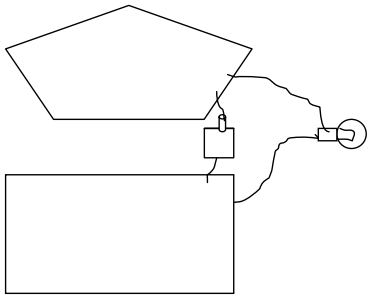
"I guess that connecting several pieces of wire or a thick wire between the dry cell and miniature bulb makes it brighter because more current flows along it."



The experimental results show that the brightness is hardly affected by the number or size of the wires—there is little difference.

**Experiment E**

"I think that putting a metal pan or a large sheet of aluminum foil on the positive and negative terminals makes the bulb darker since electricity is stored in them."



The experiment results show that the bulb illuminates with the almost same intensity regardless—there is little difference.