ScienceCube

Static Electricity and Electrostatic Induction

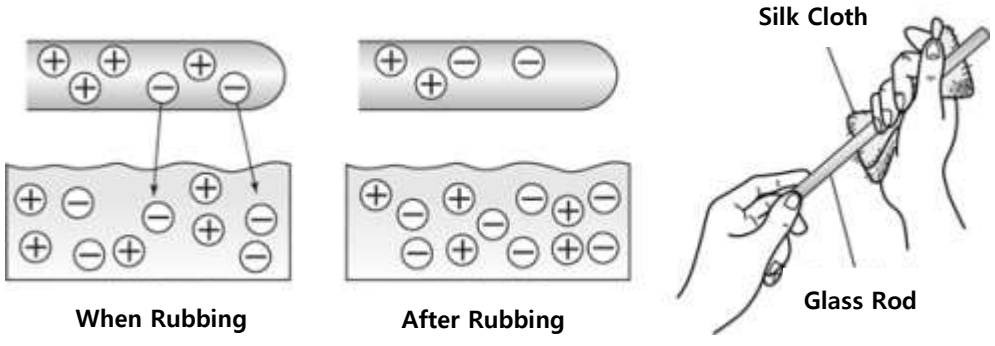
---

1. **Explain how different types of frictional electricity are generated when two different materials are rubbed together.**
2. **Explain the phenomena of electrostatic induction and dielectric polarization in conductors and insulators.**

Fundamental Concept

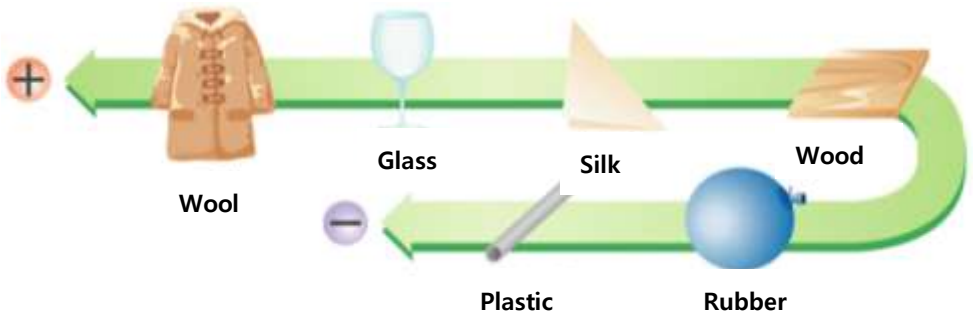
1. **Frictional Electricity**

When objects are rubbed together, the atoms on the surfaces of the materials become excited, causing some of the outermost electrons to move from one object to the other. The object that gains electrons becomes negatively charged, and the object that loses electrons becomes positively charged. This electricity generated by rubbing objects is called frictional electricity.



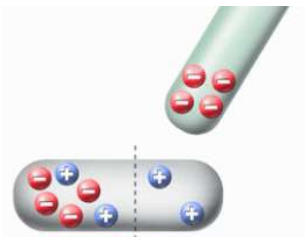
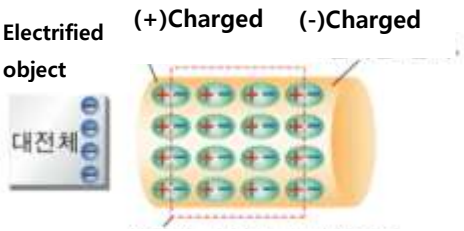
2. **Triboelectric Series**

When objects are rubbed together, they acquire positive or negative charges in a specific order, known as the triboelectric series. The order is as follows:



3. **Electrostatic Induction**

When a charged object is brought near a neutral object, the charges in the neutral object rearrange so that the charges opposite to those of the charged object are attracted to the side closest to it, and the like charges are repelled to the far side. This phenomenon is known as electrostatic induction

Feature	Conductor	Insulator
Free Electrons	Many free electrons within the conductor	No free electrons, bound to molecules or atoms
Force	Electrical force acting on conductor's charges	Electrical force acting on molecules or atoms
Approach of Charged Object	Free electrons move, opposite charge induced near the charged object, like charge induced far.  (-)Charged (+)Charged	Molecules polarize, opposite charge induced near, like charge induced far  Electrified object (+)Charged (-)Charged 대전체 **The positive and negative charges inside an insulator balance each other out.**

Removal of Charged Object	Free electrons return to original state	Returns to pre-polarization state
Examples	High conductivity materials	Bending of water stream when charged object is near, paper clinging to charged object

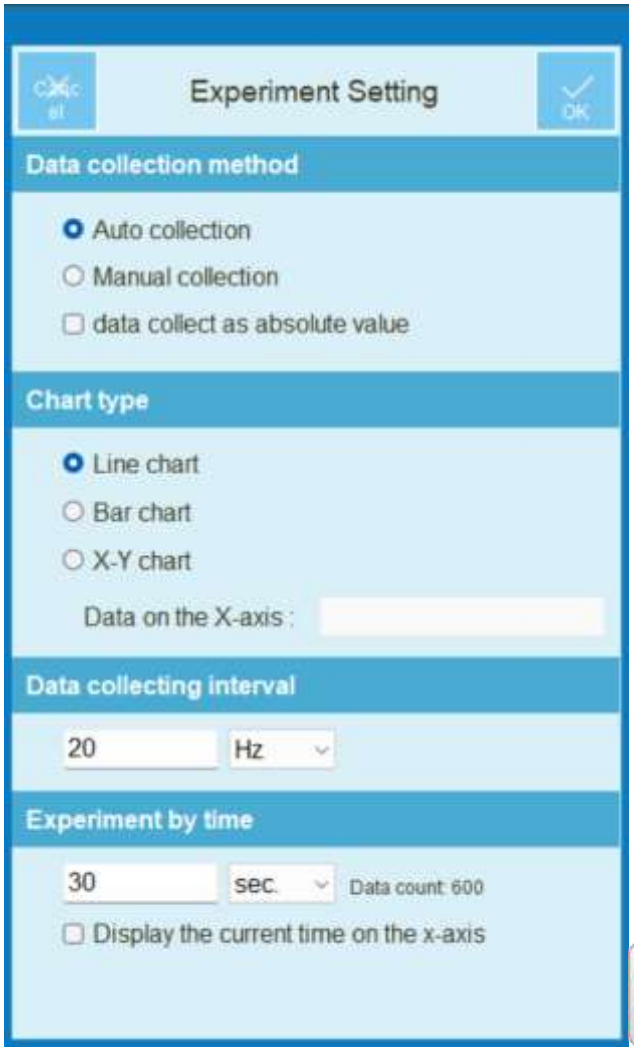
Experiment

Materials Needed

Interface, Science# program, electroscope sensor, plastic rod, metal rods (2), glass rod, stand, wool cloth, beaker, vinyl, rubber balloon, thick cotton thread, wooden rod

Interface Setup

1.  Run Science#.
2. Connect the electroscope sensor to the interface.
3. Click  to set up the experiment environment as shown below, or click  for automatic setup.



 Automatic Setup

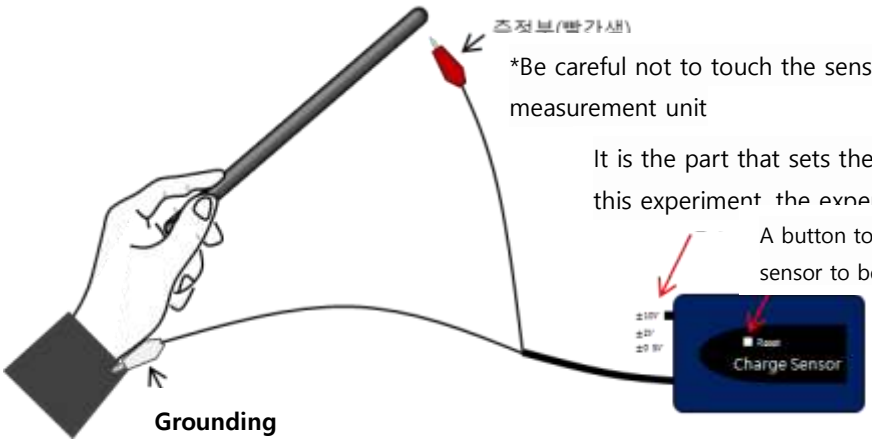
Data Collection

Click  to start data collection.

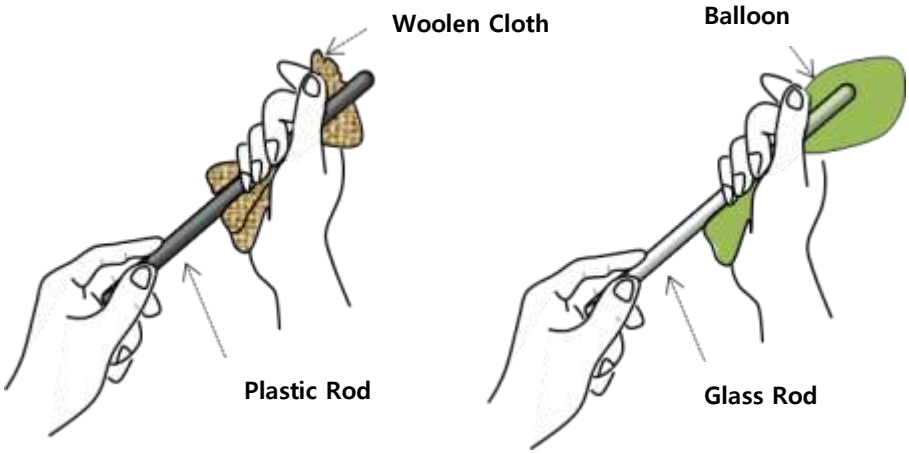
[Experiment 1] Types of Frictional Electricity

1. Ground the electroscope sensor by connecting the grounding part (white) to the sleeve.
2. Set the Range to ±2V using the button on the left of the electroscope sensor.
3. Click the Reset button to discharge the internal electricity of the sensor to neutral.

Measuring Part (Red)



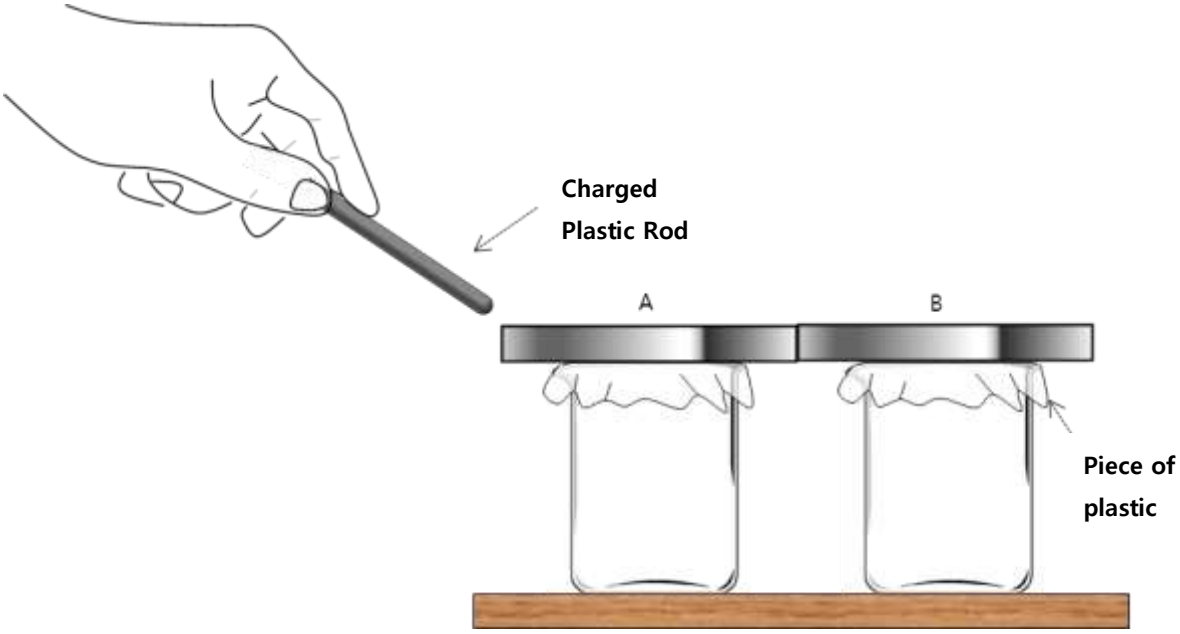
4. Rub the plastic rod with a wool cloth, and the glass rod with a rubber balloon to generate static electricity.



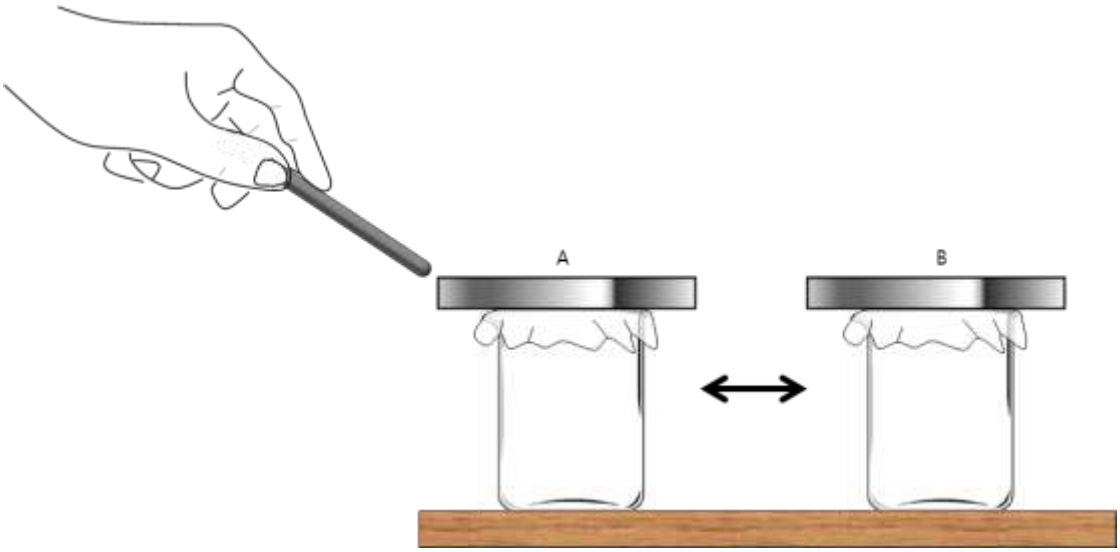
5. Approach the measuring part of the electroscope sensor to the object for about 1 second without touching it, and record the charge values. Ensure the sensor's measuring part does not touch the object.

[Experiment 2] Electrostatic Induction in Conductors

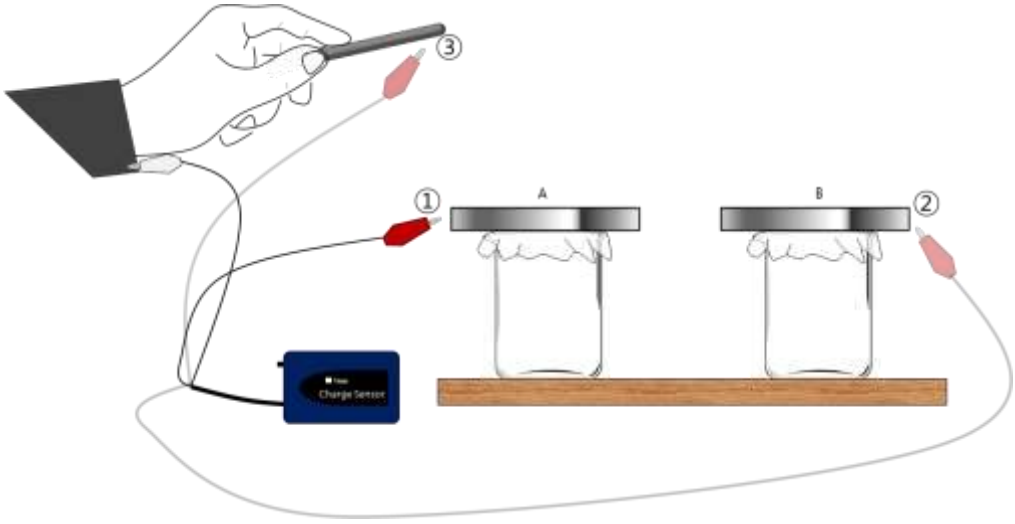
1. Place vinyl over two beakers.
2. Place two metal rods (A and B) on the beakers and make them touch each other.
3. Rub the plastic rod with a wool cloth, then bring the charged plastic rod close to the end of one metal rod without touching it.)



4. While keeping the charged plastic rod close, separate metal rods A and B as shown in the figure.



5. Measure the charge values of separated metal rods A and B and the charged plastic rod using the electroscope sensor.



Data Analysis

Recording Data

[Experiment 1] Types of Frictional Electricity

1. Record the type and magnitude of the charges on the wool cloth, plastic rod, rubber balloon, and glass rod after rubbing them as follows:

<When Rubbing Wool Cloth and Plastic Rod>

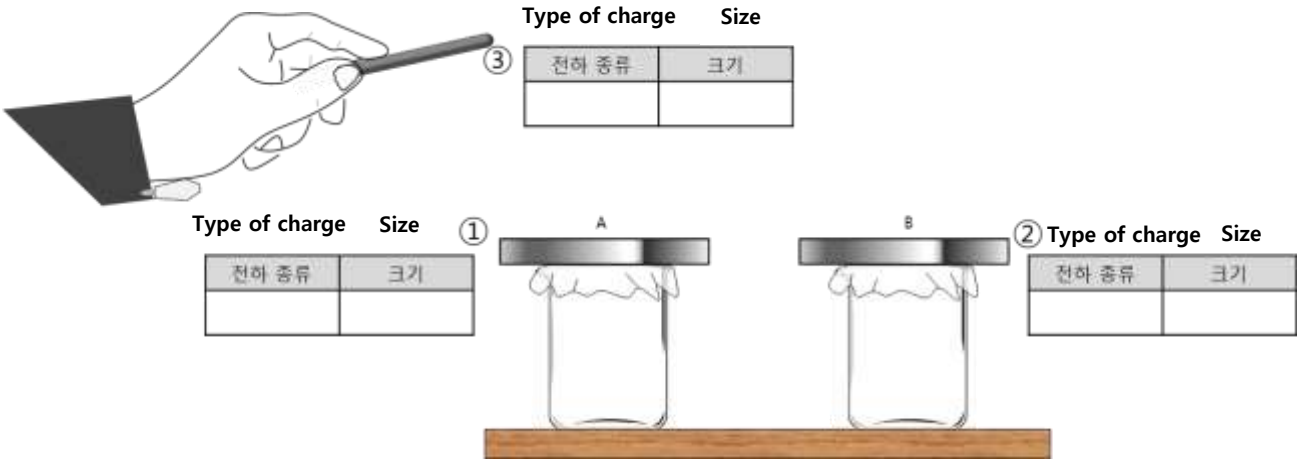
Wool Cloth's Charge		Plastic Rod's Charge	
Charge Type	Magnitude (nC)	Charge Type	Magnitude (nC)

<When Rubbing Rubber Balloon and Glass Rod>

Rubber Balloon's Charge		Glass Rod's Charge	
Charge Type	Magnitude (nC)	Charge Type	Magnitude (nC)

[Experiment 2] Electrostatic Induction in Conductors

2. Record the type and magnitude of the charges on the plastic rod and wool cloth, and the metal rods after electrostatic induction



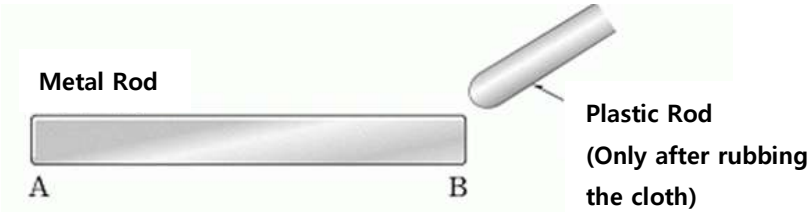
Data Application

[Experiment 1] Types of Frictional Electricity

1. Determine whether the plastic rod rubbed with the wool cloth and the glass rod rubbed with the rubber balloon are charged with the same type of electricity or different types, and explain why

[Experiment 2] Electrostatic Induction in Conductors

2. The following diagram shows an experiment where a plastic rod rubbed with a wool cloth is brought close to an uncharged metal rod. Select the correct statements from the following:



① The plastic rod is positively charged.

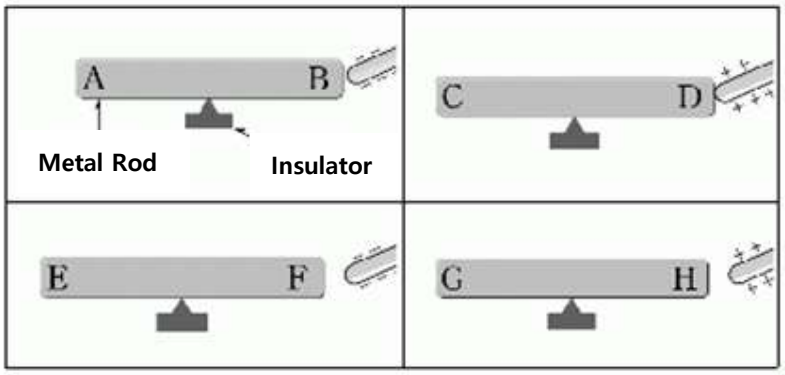
② The ends of the metal rod, A and B, become charged due to the movement of atomic nuclei.

③ A becomes negatively charged, and B becomes positively charged.

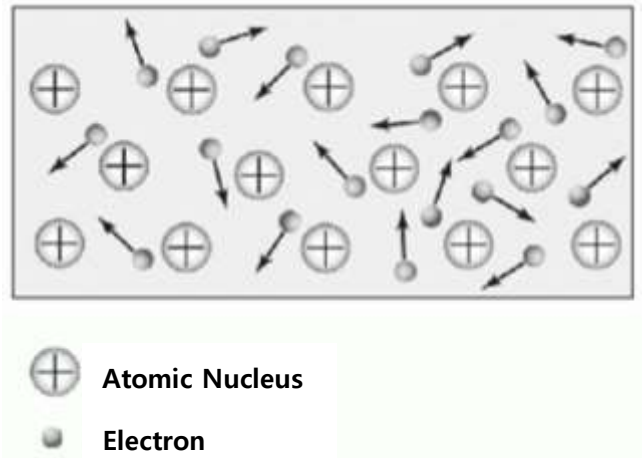
④ The charging state of A and B remains even if the plastic rod is removed.

⑤ The metal rod is not charged at all.

3. When conducting the following experiment, identify the locations (A~H) on the metal rod that become negatively charged and write them down.



4. The following diagram shows a model of atomic nuclei and electrons in a conductor. Select all the correct explanations from the options:



① Current is flowing.

② No current is flowing.

③ Electrons are stationary when no current is flowing.

④ The movement direction of atomic nuclei is opposite to the direction of the current.

Extension Activity

1. Slightly turn on the faucet to create a thin stream of water. Bring a plastic rod rubbed with a wool cloth and another plastic rod rubbed with a silk cloth close to the water stream. Explain the changes observed.