SNC1D/1P The Characteristics of Electricity/Electrical Applications

Teacher Demo/Student Activity: Conductor vs. Insulator

Topics	Timing
static electricity transfer of charge induction	preparation: 3 min demonstration: 5 min

Specific Expectations

SNC1D

A1.1 formulate scientific questions about observed relationships, ideas, problems, and/or issues, make predictions, and/or formulate hypotheses to focus inquiries or research

A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty

A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions

A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language and a variety of formats (e.g., data tables, laboratory reports, presentations, debates, simulations, models)

E2.1 use appropriate terminology related to electricity, including, but not limited to: *ammeter, amperes, battery, current, fuse, kilowatt hours, load, ohms, potential difference, resistance, switch, voltmeter,* and *volts* [C]

E2.2 conduct investigations into the transfer of static electric charges by friction, contact, and induction, and produce labelled diagrams to explain the results [PR, AI, C]

E3.2 explain the characteristics of conductors and insulators and how materials allow static charge to build up or be discharged

SNC1P

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E2.1 use appropriate terminology related to static and current electricity, including, but not limited to: *ammeter, ampere, battery, conductivity, current, energy consumption, fuse, kilowatt hours, load, ohm, potential difference, resistance, switch, voltmeter,* and *volts* [C]

E3.1 compare conductors and insulators, and explain how materials allow static charge to build up or be discharged

E3.2 explain the law of electric charges with reference to common electrostatic phenomena (e.g., charging by contact or by induction)

Introduction

In this demo, a polyethylene strip is charged by rubbing with wool. The strip is then used to test what happens to the flow of charge when the strip is placed in contact with a conductor (iron nail) and the materials are then moved towards a neutral object. An extension to the demo enables students to test what happens when an insulator (eraser) is used in place of the conductor (iron nail).

Materials

modelling clay
glass Petri dish
iron nail or steel scoopula
polyethylene strip
wool (sheep's fleece)
pith ball electroscope

Safety Considerations

- Safety goggles should be worn

Procedure

Wear appropriate PPE: safety goggles.

1. Put a small ball of modeling clay in the centre of an overturned Petri dish. Mount the nail on the Petri dish by pressing it into the clay (Fig. 1.)

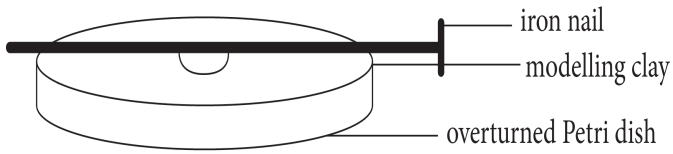

Fig. 1 Set-up of iron nail conductor on overturned Petri dish

2. Position the iron nail and Petri dish about 20 cm from the pith ball electroscope, with one end of the nail pointing toward the electroscope.
3. Charge the polyethylene strip by rubbing it with wool.
4. **Predict**
   Ask students to predict what will happen when the polyethylene strip is placed in contact with one end of the iron nail and the nail is moved near the neutral pith ball electroscope.
5. **Explain**
   Ask students to justify their predictions based on their knowledge of static electricity, charging by contact, and movement of electric charges.

6. **Observe**
   Touch the charged strip to the nail. Slowly move both the polyethylene strip and the nail, maintaining contact between them, toward the pith ball until they are about 5 cm from the hanging ball.
7. Move strip and nail in and out from pith ball to demonstrate charge separation by induction as ball moves toward the nail. Alternatively move the pith ball.
8. Allow nail to come in contact with pith ball.
9. **Explain**
   Ask the students to review their predictions and see if they match what they have observed. Can they suggest a model for why the pith ball is initially attracted to and then repelled from the nail to help explain their observations? What happened to the electrical charges that allowed the nail to charge the pith ball by contact?

Disposal

Store all equipment for future use.

What happens?

When the charged strip and the iron nail are moved nearer to the neutral pith ball, the ball moves toward the nail. After the ball touches the nail, it moves away again.

How does it work?

Rubbing the strip with sheep's fleece transfers electrons from the wool to the strip, giving in the strip a negative charge. Iron is a conductor of electricity, therefore some of the excess electrons in the polyethylene strip flow into the iron nail. Because the nail now has a negative charge, it induces a temporary electron shift in the pith ball, resulting in a temporary positive charge on the side of the pith ball next to the nail. As a result, the pith ball moves toward the nail. When the pith ball comes in contact with the negatively charged nail, some of the electrons in the strip transfer to the neutral pith ball via the nail, making the ball negatively charged. The pith ball is then repelled from the strip/nail combination and moves away.

Teaching Suggestions/Hints

1. This demo should be performed after "Charging by Contact."
2. A plastic Petri dish could be used but it is not as effective as well as glass since the plastic is more easily charged.
3. In Step 6 you will need to move the Petri dish along with the strip while maintaining contact between strip and nail. Alternatively move the pith ball toward the nail while keeping the strip in contact with the nail.
4. Discuss why it is the electrons that move. Relate this idea to the model of the atom.

Next Steps

Repeat the demo using a long eraser in place of the iron nail. The replacement insert for a pencil-style eraser (the kind that can be clicked to expose more of the eraser) is ideal. The eraser is made of a non-conducting material and will act as an insulator. When the procedure above is performed with the eraser instead of the iron nail, there will be no effect on the pith ball.

Additional Resources

none