

ELECTROSCOPE

OBJECTIVE:

You will understand the principle of the electroscope and will construct one and use it to detect the presence of and investigate the behavior of static electric charges.

INTRODUCTION:

By the late sixteenth century William Gilbert, physician to both Elizabeth I and James I of England, was “electrifying” objects and showing that they were attracted to some objects and repelled from others. During the seventeenth and early eighteenth centuries various electrical charge-generating devices were being developed, culminating in 1745 in the Leyden jar, a container that can store considerable amounts of electric charge generated by a friction device (see 8.01).

At about this time, devices for measuring the presence of an electric charge—called electroscopes—were also being developed. They not only detected charges, but also the relative amount and the nature (whether positive or negative) of the charge. Many of these used pieces of linen thread. In 1787 the gold-leaf electroscope—a more sensitive and reliable instrument—was developed by English scientist Abraham Bennett. It has been in common use since then, and it is essentially similar to the device described here.

Today, the electroscope is used in schools and colleges to demonstrate the existence and behavior of static electric charges.

TIME NEEDED:

1 hour

MATERIALS:

12-oz. or 16-oz. jar with plastic lid
(e.g., empty peanut butter jar)
6 in. of 2mm-diameter copper wire
pliers
bunsen burner
glue
9-in. or 12-in. glass rod

polyethylene rod
3 in. x 1/4 in. strip of thin metal foil from a
chocolate bar wrapper
sheet of aluminum foil, about 12 in. x 12 in.
transparent tape
clean, dry cloth

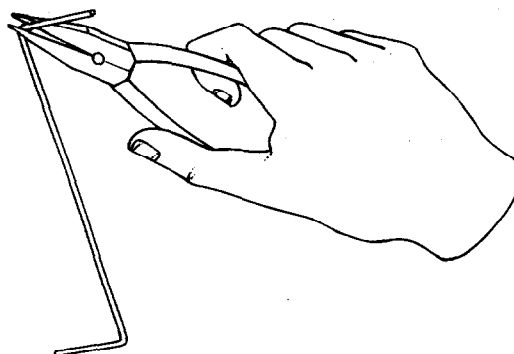
Safety Precautions

Adult supervision required. Please read and copy the safety precautions at the beginning of this book. Be careful when heating the wire in the bunsen flame.

PROCEDURE:

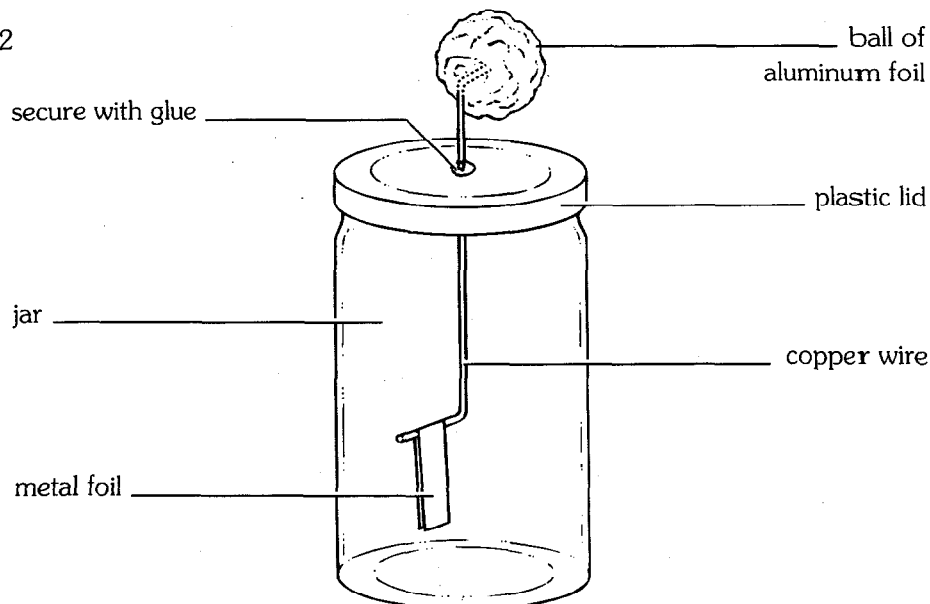
1. Holding one end of the metal wire with the pliers, heat the other end in a bunsen flame and use the wire to melt a hole in the center of the plastic lid of the jar.
2. When the wire has cooled, use the pliers to bend a 1/2-in. L-shaped hook at either end of the wire (see figure 1).

Figure 1



3. Insert the wire through the lid of the jar so that the wire projects halfway into the jar. Glue the wire securely into the lid.
4. Squeeze the aluminum foil into a ball and mount this on the top hook of the wire.
5. Carefully fold the strip of metal foil in half, unscrew the lid of the jar, and place the foil over the bottom hook of the wire (see figure 2). Ensure that the ends of the foil hang side by side. If they do not, press them together gently.
6. Finally, lower the assembly into the jar, and thread and tighten the lid. The electroscope is now ready to detect static charges.

Figure 2



7. Rub a polyethylene rod with the cloth and then bring the rod close to, but not touching, the ball of foil on top of the electroscope. Note what happens to the folded strip of foil when you do this. Remove the polyethylene rod and note what happens.
8. Rub the polyethylene rod again with the cloth. Touch the ball of foil on top of the electroscope with the rod. Note again what happens to the foil.
9. Now rub a glass rod with the cloth. Bring the rod close to, but not touching, the ball of foil on top of the electroscope. Closely observe the folded strip of foil.
10. Now rub the polyethylene rod once more, and bring it close to, but not touching, the ball of foil on top of the electroscope. Once again, observe the foil strip.

ANALYSIS:

1. What happened in step 7, when you held the polyethylene rod close to the ball of foil? In terms of electrical charges, how do you explain what happened? (Hint: Like electrical charges repel, unlike charges attract.)
2. What happened in step 8, when you touched the foil ball with the polyethylene rod? Devise a theory/hypothesis to explain your observation.
3. Assume that the glass rod carries a charge opposite to that of the polyethylene rod. Explain why the glass rod has the observed effect on the electroscope in step 9.
4. Explain why the polyethylene rod has the observed effect on the electroscope in step 10.
5. A glass rod rubbed with a cloth carries an overall positive charge, while a polyethylene rod carries a negative charge. Using this information, explain how you would use an electroscope to detect whether other objects were positively or negatively charged.
6. Do some research. How did Michael Faraday use an electroscope to measure the size of a static charge?

OUR FINDINGS:

Click on above link to see what we found.

SPECIAL SAFETY NOTE TO INVESTIGATORS

Each invention includes any special safety precautions that are relevant to that particular project. These do not include all of the basic safety precautions that are necessary whenever you are working on a scientific investigation. For this reason, it is absolutely necessary that you read, copy, and remain mindful of the General Safety Precautions that follow this note.

Experimental science can be dangerous, and good laboratory procedure always includes carefully following basic safety rules. Things can happen very quickly when you are constructing or demonstrating a model invention. Things can spill, break, even catch fire. There will be no time after the fact to protect yourself. Always prepare for unexpected dangers by following basic safety guidelines the *entire* time you are carrying out the project, whether or not something seems dangerous to you at a given moment.

We have been quite sparing in prescribing safety precautions for the individual projects. We made this choice for one reason: We want you to take very seriously every safety precaution that is printed in this book. If you see it written here, you can be sure that it is here because it is absolutely critical to your safety.

One further note: The book assumes that you will read the safety precautions that follow, as well as those in the box within each project you are preparing to perform, and that you will *remember* them. Except in rare instances, these precautions will not be repeated in the procedure itself. It is up to you to use your good judgment and pay attention when performing potentially dangerous parts of the procedure. Just because the book does not say **BE CAREFUL WITH HOT LIQUIDS** or **DON'T CUT YOURSELF WITH THE KNIFE** does not mean that you should be careless when simmering water or stripping an electrical wire. It does mean that when you see a special note to be careful, it is extremely important that you pay attention to it.

If you ever have a question about whether a procedure or material is dangerous, wait to perform it until you find out for sure that it is safe.

GENERAL SAFETY PRECAUTIONS

Accidents caused by carelessness, haste, insufficient knowledge, or taking unnecessary risks can be avoided by practicing safety procedures and being alert while carrying out these projects. Be sure to check the individual projects in this book for additional safety regulations and adult supervision requirements. If you will be working in a lab, do not work alone.

PREPARING:

- Clear all surfaces before beginning projects
- Read the instructions before you start
- Know the hazards of the procedures and anticipate dangers

PROTECTING YOURSELF:

- Follow the directions step-by-step; do only one project at a time
- Locate exits, fire blanket and extinguisher, master gas and electricity shut-offs, eye wash, and first-aid kit
- Make sure there is adequate ventilation
- Do not horseplay
- Wear an apron and goggles
- Do not wear contact lenses, open shoes, loose clothing, or loose hair
- Keep floor and work space neat, clean, and dry
- Clean up spills immediately
- Never eat, drink, or smoke in laboratory or work space
- Do not eat or drink any substances tested unless expressly permitted to do so by a knowledgeable adult

USING EQUIPMENT WITH CARE:

- Set up apparatus far from the edge of the desk or bench
- Use knives and other sharp or pointed instruments with caution
- Pull plugs, not cords, when removing electrical plugs
- Clean glassware before and after use
- Check glassware for scratches, cracks, and sharp edges
- Clean up broken glassware immediately
- Do not touch metal conductors
- Use only low voltage and current materials such as lantern batteries
- Be careful when using stepstools, chairs, and ladders
- Never look directly at the sun with your observation devices

USING CHEMICALS:

- Never taste or inhale chemicals
- Label all bottles and apparatus containing chemicals
- Read labels carefully
- Avoid chemical contact with skin and eyes (wear goggles, apron, and gloves)
- Do not touch chemical solutions
- Wash hands before and after using solutions
- Wipe up spills thoroughly

HEATING SUBSTANCES:

- Use goggles, apron, and gloves when boiling water
- Keep your face away from test tubes and beakers
- Never leave apparatus unattended
- Use safety tongs and heat-resistant mittens
- Turn off hot plates, bunsen burners, and gas when you are done
- Keep flammable substances away from heat
- Have fire extinguisher on hand

FINISHING UP:

- Thoroughly clean your work area and glassware
- Be careful not to return chemicals or contaminated reagents to the wrong containers
- Don't dispose of materials in the sink unless instructed to do so
- Wash your hands
- Clean up all residue and put in proper containers for disposal
- Dispose of all chemicals according to all local, state, and federal laws

BE SAFETY CONSCIOUS AT ALL TIMES