Physics 513 Name
Electroscope Lab Date

Electroscope Lab

Objective: To observe the behavior of charged objects and explore the uses of the electroscope

Materials: 2 green/black strips, 1 clear strip, paper towel, 2 pith balls, ring stand, electroscope, proof plate with base (shared among groups), string

Introductory notes: When a green/black strip is rubbed with paper towel, it becomes negatively charged. In the lab, I will refer to it as the black strip. When a clear strip is rubbed with paper towel, it becomes charged positive. The paper towels get oily pretty quickly so get new paper towels often. Throw them out when done with them.

Procedure

1) Using the string, suspend the black strip from the ring stand. Rather than tie the string to the strip, tape it on. Rub the hanging strip with the paper towel. Rub the other black strip with the paper and bring it **near** the end of the suspended rod.
   a) Record your observations.

   The two strips repel

   b) Why does this occur?

   The strips repel because they have like charges. Like charges repel.

2) Rub the clear strip with the paper. Bring the clear strip **near** the suspended black strip. (You might have to recharge the black strip first.)
   a) Record your observations.

   The two strips attract

   b) Why does this occur?

   The two strips attract because they have opposite charges. Opposite charges attract.

3) Remove the suspended strip and hang a single pith ball from the ring stand. Do not tie it on, tape it onto the stand. Bring a charged black strip **near** the pith ball.
   a) Record your initial observations when you bring the strip near.

   The pith ball is attracted to the strip

b) Allow the pith ball to touch the strip. Then bring the strip near to the pith ball again. Record your observations.

The pith ball is repelled from the strip

c) Explain both sets of observations.

When the pith ball is neutral, the charged strip causes the pith ball to become polarized. The negatively charged strip repels the electrons in the pith ball, causing the electrons to move to the far side of the pith ball, leaving the near side positive. The positive side is then attracted to the negatively changed strip. When the ball and strip touch, electrons are transferred from the strip to the pith ball, making both negative. Two negative objects repel.

4) Take the watch glass (the curved glass plate) and place it on your table so the curvy side is up. Balance a meterstick horizontally on the watch glass.
   a) Bring a charged black strip close to one side of the ruler. Describe what occurs.

   The ruler is attracted to the strip

   b) Bring a charged clear strip close to one side of the ruler. Describe what occurs.

   The ruler is attracted to the strip.

   c) What can you conclude about the meterstick? Explain why.

   Since the ruler is attracted to BOTH a positively charged object and a negatively charged object, the ruler must be neutral

5) Bring a charged black strip **close** to the top of the electroscope without touching the plate of the electroscope
   a) Describe what happens as the strip approaches the plate

   As the strip approaches the plate, the rod/needle in the electroscope is deflected from vertical

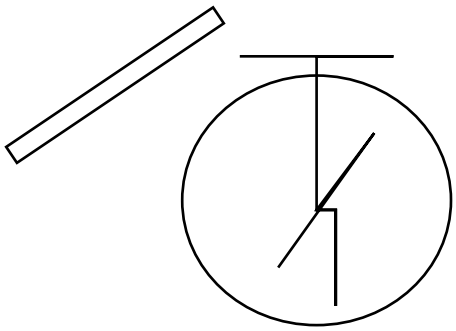
   b) Describe what happens as the strip is moved away from the plate

   As the strip is moved away from the plate, the rod/needle in the electroscope moves back toward vertical

   c) What is happening on the electroscope during this process?

   The negative black strip repels electrons from the plate into the zig-zag and the rod/needle. When both are negative, they repel each other, and the rod deflects

d) On the scope picture below, show the charge distribution when the black strip is brought near without touching Rod is negative, top of escope is positive, bottom of escope negative



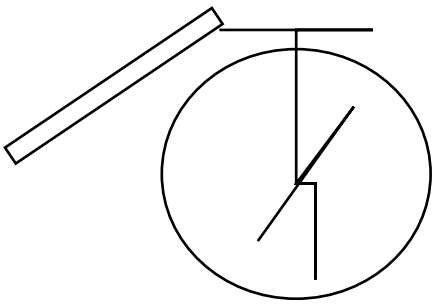
e) Bring a charged clear strip **close** to the top. Which of the strips has a greater charge? Cite an observation that supports your point.

When brought the same distance from the plate, the strip that causes more deflection has more change. Causing more deflection means there is more movement of charges in the scope, which means a greater force from the strip, which means a greater charge on the strip.

6) **Touch** the black strip to the top of the electroscope. Sometimes to make this work, you will have to leave the black strip on top of the scope.
   a) Record your observations of what happens to the scope. How is this different from what happened in the previous question?

The needle/rod will deflect. The difference is that now electrons are being transferred from the negative rod to the initially neutral electroscope, leaving the scope with a net negative charge

   b) On the scope picture below, show the charge distribution when the black strip touches the scope Strip is negative, scope has a net negative charge which is evenly distributed



c) Touch the plate of the electroscope with your finger. Describe what happens and why it occurs. Make sure to talk about charge transfer.

The rod/needle goes back to vertical. The excess electrons in the scope, which repel each other, are now given a path (through you and to the ground) to move farther away from each other, so they do. This returns the electroscope to neutral, so the rod/needle no longer deflects.

In the next two steps, the main goal is to discover the charge on an unknown, which will be called the proof plate. The proof plate is the plate you will be using and NOT the base that we will be rubbing with the fur. There will be a demonstration about how to charge the proof plate.

7) **Charging by conduction**. Charge the proof plate as was demonstrated in class. Touch the plate of the e-scope with the proof plate so that the scope is now charged.
   a) Bring the black strip near the top of the plate of the electroscope without touching the plate. What happens to the vane?

   DEFLECTS MORE or DEFLECTS LESS

   b) Now bring the clear strip near the top of the plate of the electroscope without touching the plate. What happens to the vane?

   DEFLECTS MORE or DEFLECTS LESS

   c) Based on the previous two steps, the e-scope now has a positive charge.

   d) Being that the scope was charged by CONDUCTION with the proof plate, what must be the sign of the charge on the proof plate that was used to charge the e-scope by conduction? Explain why.

   The proof plate must have been positive in order to give the electroscope a positive charge. The negative strip will push electrons from the top of the scope down, which caused less deflection. This means the bottom, with the strip near, has a smaller magnitude of charge. If adding electrons made the magnitude smaller, the charge must have been positive. Vice-versa for the positive strip.

8) **Charging by induction**. Bring the proof plate **near** the top of the scope. When the vane deflects, touch the plate of your e-scope with your finger. Remove your finger. Take away the proof plate. The vane should now be deflected as the scope has been charged by induction.

   a) Bring the black strip near the top of the plate without touching the plate. What happens to the vane?

DEFLECTS MORE or DEFLECTS LESS

b) Now bring the clear strip near the top of the plate without touching the plate. What happens to the vane?

DEFLECTS MORE or DEFLECTS LESS

c) Based on the previous two steps, the e-scope now has a negative charge.

d) Describe the flow of charges that caused this charge during this process of induction.

When the positive proof plate is brought near the top of the scope, it attracts electrons toward the top of the scope. When you touch the scope, electrons are drawn into the scope from the ground by this attraction. The scope now has a net negative change. When the finger is removed, no more charge can flow onto or off of the scope, so when the plate is taken away, the scope remains negatively charged.

e) Compare your answer to 7 c and 8 c

They are opposite

f) Remembering that you used the same object (the proof plate) to charge the e-scope first by conduction (in 7) and then by induction (in 8), why does your answer to 8e) make sense?

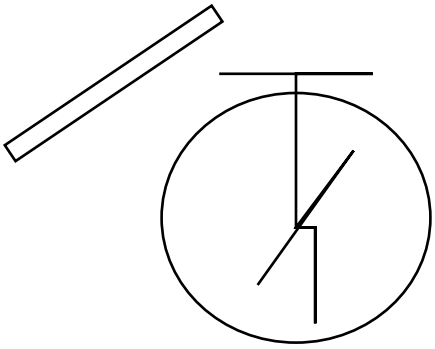
Charging by conduction means that the charging object shares its charges with the charged object, so they end up with the same sign charge. Charging by induction means that the charging object makes the charged object share charges with the ground, so the charging and charged object end up with opposite sign charges.

Conclusion Questions

1) On the scopes below, illustrate the charge distribution if a positively charge strip is

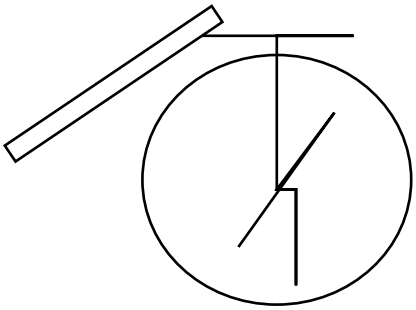
a) brought near the top of the scope

top of scope is negative, bottom is positive

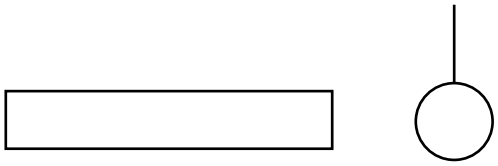


b) touched to the top of the scope

all of scope is positive, evenly distributed



2) A positively charged rod was brought **near** a neutral pith ball. Illustrate the resulting charge distribution below. Explain why this distribution occurs and what will subsequently occur.



Right side positive, left side negative, because the electrons in the pith ball are attracted to the positive strip, causing them to move to the left

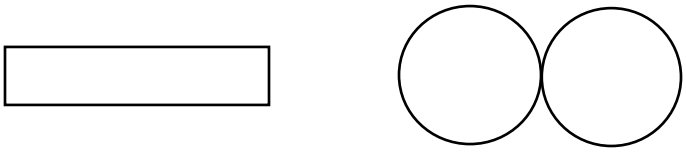
3) Why can't a metal rod be charged while you are holding it in your hand?

Unless there is induction! Cannot be charged by CONDUCTION because any excess charges that build up on the rod will cause an exchange of charges with the ground, causing the rod to remain neutral.

4) In the diagram below, a negative strip is brought near metal spheres A and B that are initially neutral and in contact. While the strip is held near, the two spheres are separated. Draw the charge distributions when the strip is held near and when the spheres are separated.

Initial

left side of left sphere positive, right side of right sphere negative



Final (after spheres separated and the strip is taken away)

Left sphere positive, evenly distributed. Right sphere negative, evenly distributed