PhyzLab: Charge It II

an investigation of static electricity using an electroscope

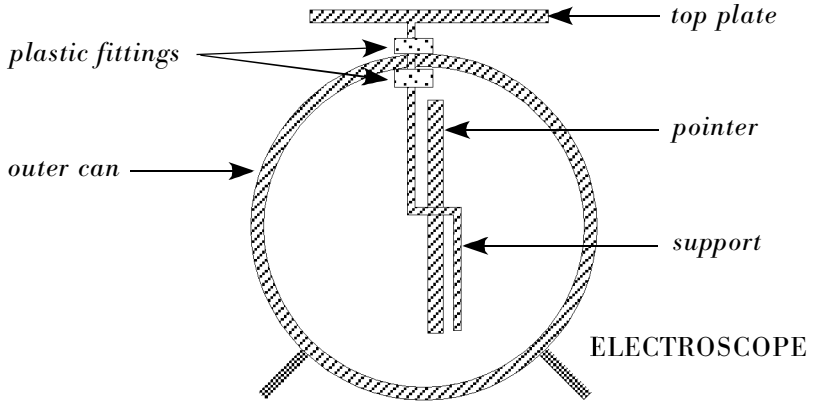
PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

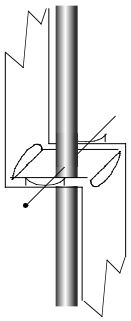
To gain a basic understanding of electric charge. You will investigate charge detection and charge typing with the aid of an electroscope, practice charging by conduction and induction, and you will investigate the difference between conductors and insulators.

• Apparatus •

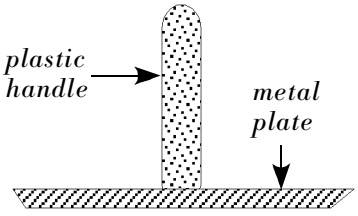
___ 1 electroscope with straw pointer: **examine the illustration to ensure proper configuration**
___ 1 electrophorus [pronounced eh · lek · TRAH · fer · us, **not** uh · LEK · tro · FOR · us]
___ 2 strips of acetate (transparent plastic)
___ 2 strips of vinyl (opaque plastic) [pronounced VIE · nul, **not** VIN · ul or vuh ·NIL]
___ 1 small square of silk or cotton (light colored cloth)
___ 1 small square of wool (dark cloth)
___ 1 PVC tube
___ 1 metal tube
___ access to blow dryer for drying any/all materials when they don't appear to be functioning properly



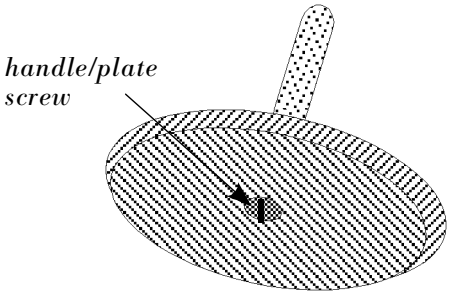
ELECTROSCOPE

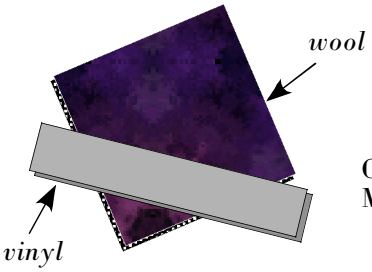


Be sure the pointer's pivot pin is resting properly in its "cradle," and the support structure is aligned properly. Do not tighten or loosen the top plate. If you have questions, ask the teacher!

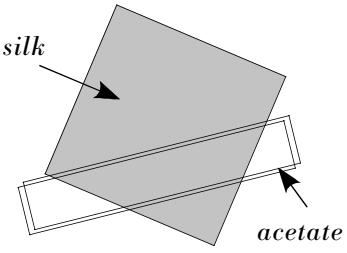


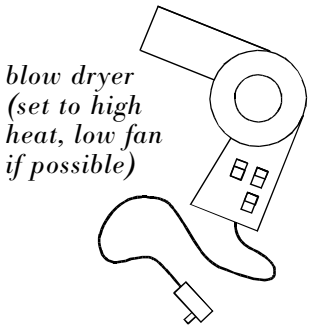
ELECTROPHORUS





CHARGING MATERIALS

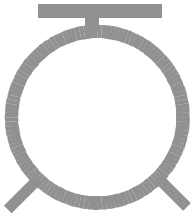




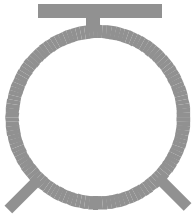
1. CHARGE DETECTION

Using the electroscope to determine whether or not an object is charged

a. Rub the **vinyl** strip with the **wool**. Carefully place the vinyl strip on the top plate of the electroscope. Illustrate the results below.



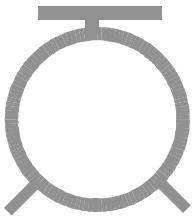
i. Electroscope with nothing nearby.



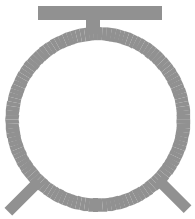
ii. Electroscope with charged vinyl on top.

NOTE: On electroscope diagrams, the electroscope structure has been drawn for you; you must draw in any objects that are being brought nearby and you must draw the pointer position.

b. Remove the vinyl strip. If the pointer remains deflected after you remove the vinyl, touch the top plate with your finger. Lightly rub the **acetate** strip with the **silk** or **cotton**. Place the acetate strip on the top plate of the electroscope.



i. Electroscope with nothing nearby.



ii. Electroscope with acetate on top.

Based on your observation, the acetate strip is (circle one)

CHARGED

NEUTRAL

c. Remove the acetate strip. If the pointer remains deflected after you remove the acetate, touch the top plate with your finger. Try other objects.

i. Rub a piece of metal with wool. The metal is then	CHARGED	NEUTRAL.
ii. Rub a piece of metal with silk/cotton. The metal is then	CHARGED	NEUTRAL.
iii. Rub a piece of PVC tube with wool. The PVC is then	CHARGED	NEUTRAL.
iv. Something else: _____	CHARGED	NEUTRAL.

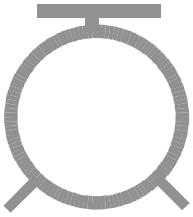
d. How can the electroscope help you to determine whether or not an object is charged?

e. Can insulators (such as vinyl or acetate) become charged? (Is the answer below consistent with the answer you gave in the Pre-Lab?) Explain.

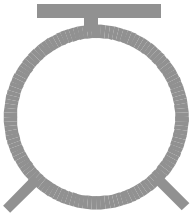
2. CHARGE TYPING

"Vinyl electricity" and "acetate electricity "—is there a difference?

a. Place a charged **vinyl** strip on the top plate of the electroscope. (The pointer should show a **small** deflection. If the deflection is too big, remove the vinyl, "wipe it off" with your hand, and try again.) Bring another charged **vinyl** strip close to the top plate. Illustrate and describe the results below.



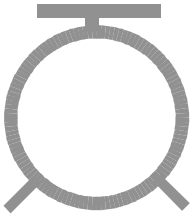
i. Electroscope with one charged strip of vinyl on top.



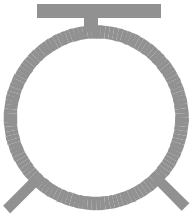
ii. A second charged strip of vinyl is brought nearby.

Describe what is happening.

b. Leave the charged **vinyl** strip on the top plate of the electroscope. Bring a charged **acetate** strip close to the top plate. Illustrate and describe the results below.



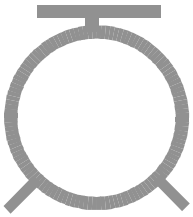
i. Electroscope with one charged strip of vinyl on top.



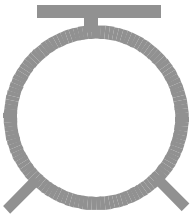
ii. A charged strip of acetate is brought nearby.

Describe what is happening.

c. Remove the **vinyl** strip and touch the top plate of the electroscope to discharge it. Place a charged **acetate** strip on the top plate of the electroscope. (Again, obtain a **small** deflection.) Bring another charged **acetate** strip close to the top plate. Illustrate and describe the results below.



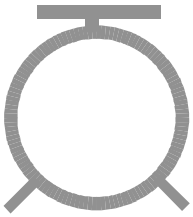
i. Electroscope with one charged acetate strip on top.



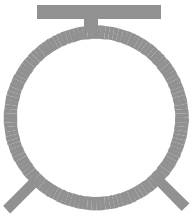
ii. A second charged acetate strip is brought nearby.

Describe what is happening.

d. Leave the charged **acetate** strip on the top plate of the electroscope. Bring a charged **vinyl** strip close to the top plate. Illustrate and describe the results below.



i. Electroscope with one charged acetate strip on top.



ii. A charged vinyl strip is brought nearby.

Describe what is happening.

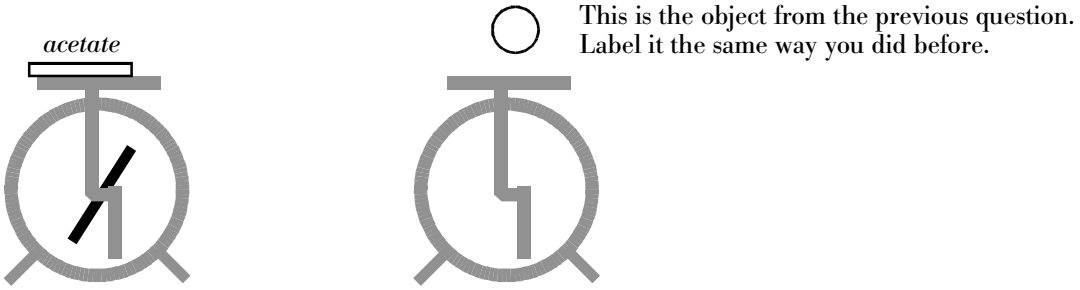
e. How would you explain the difference between what occurred in step a and what occurred in step b of this procedure (Charge Typing)?

*f. For arbitrary reasons, the charge on the **vinyl** is called **"negative."** What type of charge is on the **acetate**?*

g. What is the difference between steps a-b and steps c-d in the procedure?

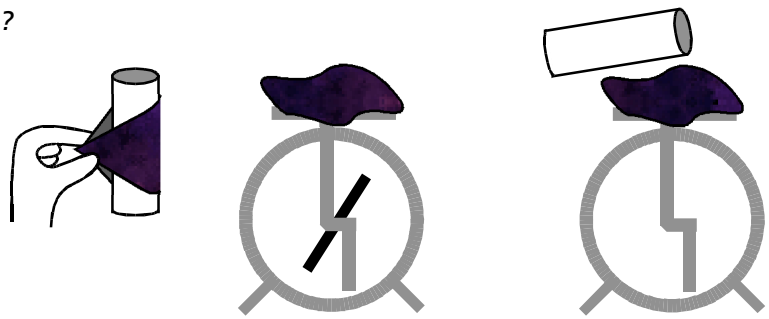
h. If the electroscope is charged by a piece of vinyl lying across its top plate and an unknown charged object brought nearby causes the needle to deflect even further, what type of charge does the mystery object have? (This is a "think-it-through" question, not a "do-it-then-answer" question.)

*i. What would happen if **that** object were brought near to an electroscope charged by a piece of acetate?*



j. Rub the PVC tube with the wool. Make a sling with the wool and hold only two corners of the wool as you vigorously rub the tube. Place the *wool* (without the tube) on the electroscope and observe the slight deflection of the pointer. With the wool in place, bring the tube near to the electroscope and observe the effect.

What do you observe and what does it mean?



k. Describe a method by which you could determine the sign of a charged object. What would you do, and what would you conclude based on what you've seen?

i. Use your method to determine the charge on a charged electrophorus.

Charge on the electrophorus: _____
The electrophorus was charged using (check one)
___ the acetate base provided with the electrophorus ___ a plastic chair ___ other:

*ii. Ask the teacher to provide a charged "mystery **object**" to test. The mystery object may be bulky and impossible to set on the electroscope. Be prepared to test its charge quickly when it arrives.*

Object: _____ Charge: _____

Evidence:

l. Describe a method for determining the sign of a charged electroscope. That is, suppose an electroscope is already charged and you are "charged" with finding the sign of that charge. What would you do and what conclusion would you draw from which observations?

*m. Ask the teacher to place a "mystery **charge**" on your electroscope.*

Source (how charge was put on electroscope): _____

Charge: _____

Evidence:

3. (CONDUCTION JUNCTION, WHAT'S YOUR) INDUCTION?
Charging by induction

a. Discharge the electroscope by touching the top plate.

b. Set a charged vinyl strip on the top plate of the electroscope. Notice the deflection of the pointer.

What is the sign of the charge on vinyl?

c. Now briefly touch the pointer support post inside the can (but avoid touching the pointer itself). Leave the vinyl strip on the top plate.

What happens to the pointer and what does it mean in terms of the charge on the support post and pointer needle?

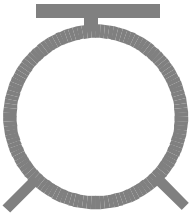
d. Without touching any part of the electroscope, move the vinyl strip away from the top plate.

What happens to the pointer and what does it mean?

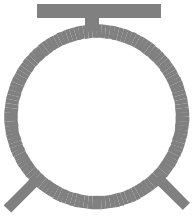
e. Test to determine the sign of the charge on the electroscope.

What is the sign of the charge left on the electroscope?

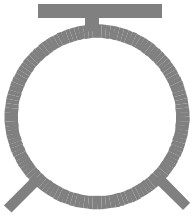
f. In the sequence of steps b-d above, you charged the electroscope. The name of the method employed is **induction**. Illustrate the sequence in the diagrams below.



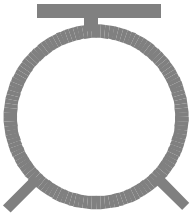
i. Uncharged electroscope with nothing nearby.



ii. Vinyl brought nearby.



iii. Bottom support is touched. Vinyl remains in place.



iv. Vinyl is removed.

*g. How does the **sign** of charge left on the newly charged object (electroscope) compare to the **sign** of charge on the object used to induce the charge (vinyl)?*

4. CONDUCTORS AND INSULATORS
What's the difference after all? Find out in this activity.

Can insulators (like vinyl or acetate) become charged? __Yes __No

Are all insulators always charged? __Yes __No

Can conductors (like aluminum) become charged? __Yes __No

Are all conductors always charged? __Yes __No

What is the difference between conductors and insulators? Don't answer—yet!
a. Observation. Charge a strip of vinyl or acetate (both insulators)—whichever charges better—and lay it on the top plate of the electroscope. Illustrate and describe what happens.

b. Prediction. What will happen if you remove the charged insulator from the electroscope? DON'T ACTUALLY DO IT.

c. Observation. Now remove the charged insulator from the electroscope. Illustrate and describe what ACTUALLY happens.

d. Observation. Charge your electrophorus (whose aluminum plate is a conductor) and lay it on the top plate of the electroscope. Illustrate and describe what happens.

e. Prediction. What will happen if you remove the electrophorus from the electroscope? DON'T ACTUALLY DO IT.

f. Observation. Now remove the electrophorus from the electroscope. Illustrate and describe what ACTUALLY happens.

g. Describe the difference in the behavior of insulators and conductors.

Note: the method of charging an object by touching another charged object to it is called **conduction**. If you listen carefully, you can hear the snap of the spark associated with the charge transfer that takes place when a charged electrophorus is touched to the electroscope.

• Post-Lab Questions •

>>>RETURN LAB APPARATUS TO STORAGE AREA BEFORE ADDRESSING THESE QUESTIONS.<<<

DO NOT PROCEED WITH THE QUESTIONS BELOW UNTIL YOU HAVE FOLLOWED THE INSTRUCTIONS ABOVE.

1. IS IT A CONDUCTOR OR AN INSULATOR? YOU MAKE THE CALL

a. As object A approaches an electroscope, the pointer deflects. From this we may conclude that object A is a(n) CONDUCTOR INSULATOR NOT ENOUGH INFORMATION TO CONCLUDE

b. Object B causes the same behavior in the electroscope as object A. When object B is touched to the electroscope then removed, a charge remains on the electroscope. From this we may conclude that object B is a(n) CONDUCTOR INSULATOR NOT ENOUGH INFORMATION TO CONCLUDE

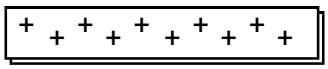
c. Object C is brought near to an uncharged electroscope, causing the pointer to deflect. The *electroscope* is then touched and object C is removed. A charge remains on the electroscope. From this we may conclude that object C is a(n) CONDUCTOR INSULATOR NOT ENOUGH INFORMATION TO CONCLUDE

d. While object D is touching an electroscope, the pointer is deflected. The *electroscope* is then touched and object D is removed. No charge remains on the electroscope. From this we may conclude that object D is a(n) CONDUCTOR INSULATOR NOT ENOUGH INFORMATION TO CONCLUDE

e. Object E is brought near to an uncharged electroscope, causing the pointer to deflect. *Object E* is then removed, touched, and returned to the electroscope. Again, it causes deflection. From this we may conclude that object E is a(n) CONDUCTOR INSULATOR NOT ENOUGH INFORMATION TO CONCLUDE

2. SHOWING CHARGE

Excess charge is shown graphically by small +'s or –'s drawn on the charged object. Which of the rectangular strips below shows charged vinyl and which shows charged acetate? (Label them.)



3. CHARGING THE ELECTROPHORUS

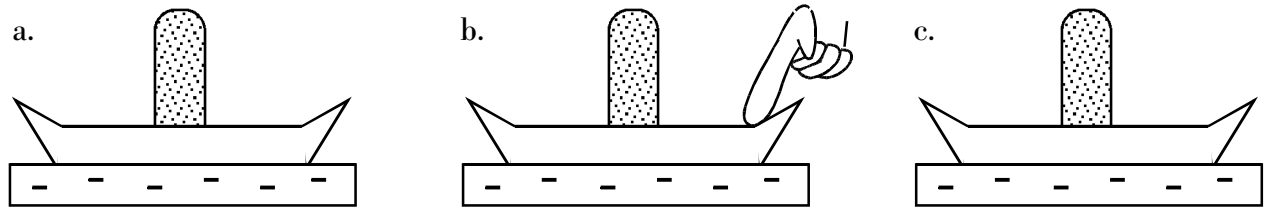
The electrophorus is charged by induction.

a. When the electrophorus is placed on a charged insulator, charge within the aluminum separates. (Charge in the aluminum that is opposite to that of the insulator is attracted to it; like charge is repelled.)

b. When the electrophorus is touched, the like charge escapes to you and to the earth; the opposite charge stays with the electrophorus.

c. The electrophorus is left with a charge opposite to that of the charged insulator.

Show the location of charge in this sequence on the diagrams below.



4. SOLVE THE PUZZLE

Suppose that charging an electrophorus gave it a positive charge. How could you use the charged electrophorus

a. to put a positive charge on an electroscope?

b. to put a negative charge on an electroscope?