

Electroscope, Flask Form

P6-1156



ASSEMBLY:

1. Remove the stopper and post from the flask.
2. Carefully remove the aluminum leaves from the package. (Note: aluminum leaf can be quite fragile.) Pierce a hole (just large enough to accommodate the hook) near the end of each of the leaves. Flatten the leaves as much as possible.
3. Suspend the two leaves from the hook so that they hang loosely from the lowest point.
4. Replace the stopper in the flask.

BASIC OPERATION (CHARGING BY CONDUCTION):

1. Create a static charge (e.g. by rubbing wool or fur on a rubber rod). Transfer the charge to the top ball by contact.
2. The charge will spread evenly through the ball, post, hook, and metal leaves.
3. The leaves, carrying like charge, will repel each other.
4. Larger charges will cause greater repulsion in the leaves.

EXPERIMENTS:

1. Determining like and opposite charges. Create a charge using one set of objects (e.g. wool and rubber) and transfer the charge to the electroscope. Create a charge using a second set of objects (e.g. silk and glass) and transfer the charge to the electroscope. If the charges are alike, the leaves will repel further. If the two charges are opposite, the leaves will repel less (or not at all). Note: it is not possible to identify a charge specifically as positive or negative without a reference charge for comparison.
2. Charging by Induction. Charge an object and hold it near the ball without touching. The leaves will repel even though the electroscope is still neutral. Suppose the external object carries a negative charge (excess electrons). When held near the electroscope, free electrons in the metal are repelled from the charged object near the ball. They move down the post into the leaves, causing the leaves to carry an overall negative charge. (The ball has a positive charge.).

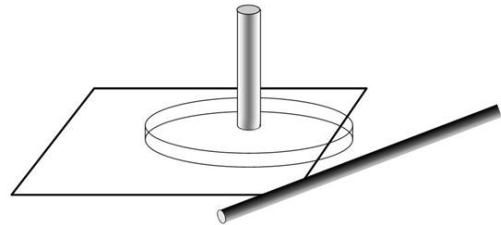
ADDITIONAL ACTIVITIES FOR THE GENERATION OF STATIC ELECTRICITY:

Activity One: The Electrophorus

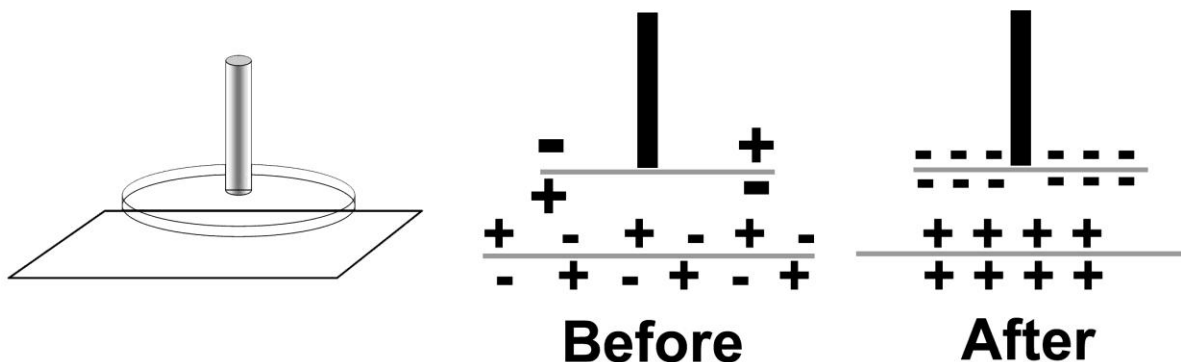
Note: In the following activity the polyethylene rod or some other type of plastic rod or strip is used to produce the initial charge. It may be instructive to have the students try many materials to see if there is any difference in the amount of charge that each material will create. You will also need a flat acrylic plate, flat metal plate, acrylic sheet, various cloth materials and a neon bulb.

The electrophorus, which means “electric carrier”, is a very simple and easy to make electrostatic generator. It is just a flat acrylic plate that is rubbed with a cloth or other material by hand. This builds up static in the plate, which can then be transferred to a flat metal plate that has an insulated handle. Different materials rubbed on the acrylic plate will have different effects.

Place an acrylic sheet on a flat surface and rub it briskly with the polyethylene rod. Do not touch the sheet with your hand. It is easiest if the sheet is placed at the edge of a desk or table, and the rod is held so that the handle is over the edge. When a charge has been built up on the sheet, place the electrophorus on the sheet with the handle in the air. Some of the electrons on the charge sheet will move to the neutral electrophorus, giving it a charge. If there is sufficient charge and you bring the electrophorus away from the sheet and touch it with your finger you should feel or hear a small spark as the charge jumps the gap from the electrophorus to your finger.



Recharge the sheet and use it to charge the electrophorus. This time touch a small neon bulb to the electrophorus. If the charge is sufficient you should see the bulb glow as the charge is transferred.

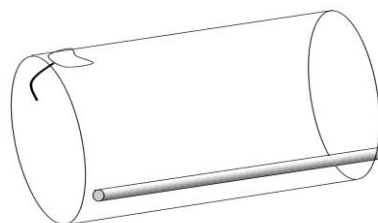


Activity Two: The Electroscope

The electroscope is a device used for detecting a difference in electrical potential of an object. The word scope means “to see” and an electroscope is designed to allow you to see the presence or absence of an electrical charge.

Note: This activity requires various friction rods of different materials, including solid glass, nylon, acrylic, polystyrene, PVC and polyethylene. You will also need an acetate cloth, polyethylene bag and a balloon.

To begin you will need some way to test the electrostatic charges. Usually for this you will use some sort of electroscope. You can use any type or make one using a drinking glass or a beaker and tape cotton thread to it as shown. This cotton thread will act as a simple electroscope. That is, it will be used to determine the presence of an electric charge.



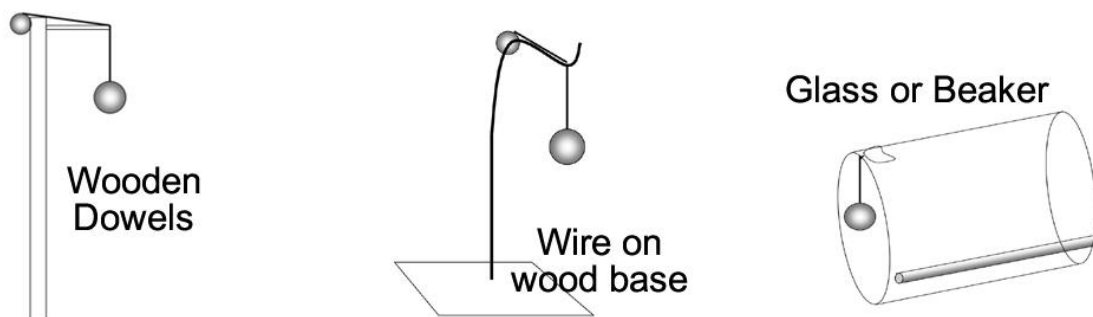
Before you test a rod, bring each up against a grounded item, such as a metal desk, radiator or water pipe. This will help discharge the items before testing them with a different material.

Now, take each of your friction rods and, one at a time, test each with acetate cloth and polyethylene bag by rubbing them on the rod. Bring the item being tested close to the thread and watch the thread’s movement. Note in the chart below what type of rod was used, what type of pad was used and, using a scale of 1 to 5 with 5 being the greatest attraction to the thread, what were the results.

ROD TYPE	ACETATE	POLYETHYLENE
	Attracted to the thread on a scale of 1 to 5	
Solid Glass		
Nylon		
Acrylic		
Polystyrene		
PVC		
Polyethylene		

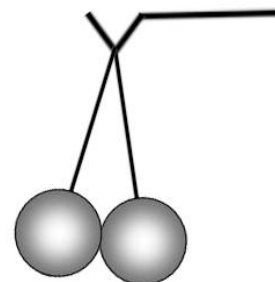
Activity Three: The Pith Ball Electroscope, Attraction and Repulsion

An electroscope works because of the nature of electrons. More simply because opposite charges attract and the same charges repel one another. If an object that is highly charged with negative charged atoms (electrons) is brought near to two aluminum painted cork balls (used to be made from pith) hanging side by side, the positive atoms on the balls will be attracted towards that object. This will cause them to swing in the direction of the object being tested. If the object touches



the balls, some of the electrons will be transferred to the balls. This makes both balls negatively charged which, in turn, caused the balls to repel one another. The more negative they are the more they will push each other away. This gives you a visual of the strength of the present charge.

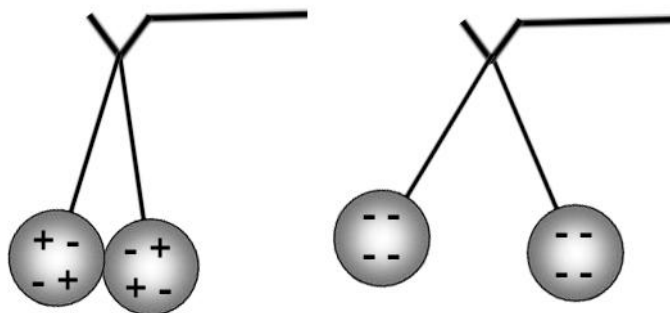
Take a cork ball set (or pith ball set) and suspend one ball by wrapping the other around an insulated hanger. This can be a hook on a wooden dowel, a piece of wire on an insulated base, or you can use a glass as in the previous electroscope (see illustration above). Charge the electrophorus and bring it near the ball. Since the ball is neutral, it has both a positive and a negative charge. As the electrophorus gets near, the negative charges on it attract the positives on the ball, and repel the negative charges. This causes the negative charges to move to the far side of the ball, and the positive charges to move to the near side. Since the opposite charges attract, the side of the ball nearest the electrophorus will be attracted to the electrophorus and the ball will swing that way. If the charge is strong enough and the two objects are near enough, the ball will actually touch the electrophorus. When this happens some of the negative charge on the electrophorus will be transferred to the ball and both will become negatively charged. As soon as this happens the like charges will repel each other and the ball will swing away from the electrophorus.



You may also use a PVC rod with the attached metal ball as a transfer apparatus. You will probably have even better results because the PVC rod acts as an insulator.

Next, take the cork balls (one on each end of a string) and suspend them from an insulated hanger so that they are free to move in any direction. Charge the transfer ball and move it near the balls. The balls should move away from the transfer ball, just as the cork ball did. Touch one of the balls with the transfer ball, and watch what happens. The ball that was touched will swing away from the transfer ball and will touch the other ball. Each time some of the negative charge is transferred, so that both balls end up with a negative charge. If you recharge the transfer ball, and touch one of the balls again, more charge will be transferred and the two balls repel each other more. Eventually, you

will find it impossible to bring the transfer call in of the balls, and to touch each other.



impossible to bring contact with either they will not be able

Activity Four: The Flask Electroscope

A very common type of electroscope and one that has been around for a long time is the **flask electroscope** (P6-1156). This item can be very sensitive and, because it is enclosed within a glass housing, it is not prone to being affected by air currents in the room.

Rather than using pith balls or cork balls for indicating the presence of charges, it uses very thin metal foil leaves. Another big difference is the way that the charge is induced on to these leaves. Rather than the object being tested coming in direct contact with the leaves, the charge is introduced to a metal post to which the leaves are attached. The charge is then transferred from the post to the leaves. The foil leaves then act in a similar manner to the cork balls.

Note: The following flask electroscope activities require two flask electroscopes, a rubber, plastic and glass rod, a piece of wool and silk cloth, as well as two metal disk terminals for using in place of the metal terminal ball found at the top of a standard flask electroscope. You will also need an acrylic sheet and a neon bulb.

First, set both flask electroscopes up with metal balls on the top of their post. Discharge the electroscope by touching the balls with your hand or against a metal disk or similar object. When the electroscopes are discharged both leaves should hang straight down.

Take a rubber or plastic rod and rub it with a piece of wool cloth or similar material. When the rod is rubbed with the material, electrons are rubbed off the cloth and onto the rod. When a rod is brought near the ball (but not touching) the electrons that are already present on the rod are forced toward the leaves. This is due to the repulsion of similar charges. When both leaves have an over abundance of electrons they repel one another causing them to separate from one another. When the rod is removed the leaves should return to their earlier state.

Now bring the rod back to the ball but this time actually touch the ball. This time you should find that the leaves remain diverged when you remove the rod. This is because some of the electrons from the rod transfer to the post, which remains on the rod and leaves after you take the rod away. The electroscope will remain in this state until it is discharged. This can happen by touching the ball to something else that will attract some of the excess electrons or by leaking through the air. The time it takes to leak and return back to a normal state depends on the amount of charge and the humidity of the environment.

Now remove the balls from the electroscopes and replace them with metal disks. With the plates touching, charge one as in the illustration. Both electroscopes should now show a charge. Discharge one of the electroscopes by touching it with your hand. You should see that both discharge showing how the charges can transfer from one to the other. Finally, charge one of the electroscopes and then bring the charged electroscope to the other and allow the plates to touch again. You will find that some of the charge will transfer to the second electroscope. The movement of the foil leaves in the second electroscope will indicate this.

By using a glass rod rubbed with silk, you can generate an excess of positive charge on the rod. You will find that the electroscope will respond in the same way.

Next, take the electroscope and discharge it (to remove any residual charge) by touching it with your finger. The leaves should be hanging nearly straight down with only a small angle between them. Charge the electrophorus on the sheet, and bring it CLOSE to the electroscope. Do not touch the terminal! The leaves of the electroscope should move far away from each other slightly. The stronger the charge on the electrophorus the more they should repel each other. As you move the electrophorus away from the electroscope the leaves should return to a neutral state. Why does this happen? The high charge on the electrophorus (negative) repelled some positive charges on the terminal of the electroscope. The only place these positive charges could go was to the leaves of the electroscope. Since the two leaves then had the same charge, and since like charges repel each other, the leaves moved away from each other. When the electrophorus was removed, the positive charges could go back, returning the electroscope to a neutral state.

Again charge the electrophorus. This time touch the plate to the terminal of the electroscope. The leaves should move apart. However, this time the charge is due to an actual transfer of electrons, so it remains even when the electrophorus is removed. If this is repeated several times it is possible to build up a relatively strong charge on the electroscope, so that the leaves are standing well apart from each other. To return the electroscope to the uncharged state, touch the terminal with your finger. Charge it again, but this time discharge it by touching it with a neon bulb. If the charge was strong enough the bulb should light up briefly.

Charge an acrylic sheet again using the polyethylene rod. Take the transfer ball and rub it over the sheet, then touch it to the terminal of the electroscope. Repeat this several times, building a stronger charge on the electroscope. Note that each time you rub the ball over the sheet you are collecting more electrons, which are transferred to the electroscope. This is the mechanical transfer of static charge. This cannot be done with current electricity.

Activity Five: Point Discharge and a Flask Electroscope

Note: This activity requires one flask electroscope and a discharge point.

To begin, discharge one of the flask electroscopes. Charge the transfer ball and move it near the electroscope. The leaves should deflect, showing an induced charge. Keeping the ball away from the electroscope, touch it with the back of the point. Now move the ball near the electroscope. This time the leaves should not move much, if at all. Obviously, the charge has been transferred to the point. Move it near the electroscope. Again the leaves will not move, showing that the point has no charge. Where did the charge go?

Try one more thing. Charge the transfer ball and hold it near the electroscope. Now aim the sharp point at the disk of the electroscope and touch the transfer ball to the other end of the point. This time the charge should move to the electroscope, and some should remain even after the transfer ball and point are removed. Apparently the charge on a point is rapidly transferred to the air, and if

the electroscope is near enough the charge will go there. This is the principle behind lightning rods. The idea is not so much to attract lightning to a particular point as to remove as much charge as possible from the building the lightning rod is attached to.

Activity Six: Induced Charge and Flask Electroscopes

Note: This activity requires two flask electroscopes and two metal disk terminals.

To begin, remove the ball terminals from the electroscopes and replace them with disk terminals. Place the two electroscopes so that the disks are touching. Be certain that the two electroscopes are discharged. Charge the transfer ball and bring it close to the far side of one of the electroscopes. Note that both will show a charge. Being careful not to touch either of the disks, slide the two electroscopes apart. Move the transfer ball away. Both the electroscopes should now show a charge. Recharge the transfer ball and touch the terminal of one of the electroscopes. If that electroscope was negatively charged the leaves should move farther apart. If, on the other hand, it was positively charged, the leaves should move together, showing that the positive charge has been neutralized. Why are the two charged when there was no contact with the transfer ball, and why are they oppositely charged?

When the two were touching, they acted as one object. Therefore, when the transfer ball was moved near one edge, the negative charges on the combined plates were repelled from the transfer ball and moved to the far edge of the far electroscope. The positive charges were attracted to the transfer ball, and they moved to the near side of the near electroscope. While they were in this state the connection between them was broken, and when the transfer ball was removed it was impossible for the charges to move back to their original position. This resulted in an excess of positive charges on one electroscope, and an excess of negative on the other. Both, however, were charged so that the foil leaves were repelled.

RELATED PRODUCTS:

Electrostatics Demo Kit (P6-1600). Rubber and glass rods, fur, and silk flannel, and bubble wrap for creating positive and negative charges

Hand Crank Van de Graaff Generator (P6-3400)

Coated Pith Balls (P6-1650)

