

Investigating Electrical Charge with the Electroscope - 03-22-01

Name _____

Purpose: To investigate electrical charge using an electroscope.

Theory: Electrical charge can be transferred to the leaves of an electroscope by touching the knob with charged objects. This is called conduction. Since both leaves will have the same sign charge, they will repel. If the sign on a charged scope is determined, the sign of the charge on other materials may be found by bringing them near the knob of the scope. Objects with the same sign charge will cause further repulsion while objects of the opposite sign will cause the leaves move closer together.

Electroscopes can also be charged by induction. The charged object is not touched to the scope, but the scope is grounded while the object is near the knob. This appears to force opposite sign charge to move to ground. Induction gives the leaves the opposite sign charge as the object used to do the charging.

Materials: Electroscope, PVC pipe, Plexiglas rod, wool cloth, silk cloth, and wire.

Procedure:

NOTE: When the leaves on the scope move apart, we will say they repel. When they move together, we will say they converge. DO NOT say they attract. When the leaves are vertical we will say the leaves are discharged or collapsed.

PART A. Temporary charging by induction

NOTE: If at any time during these Part A experiments you hear a spark as you bring a rod near the scope, charge has jumped between the rod and the scope, probably ruining your results. You should ground the electroscope with your finger and repeat that experiment being careful not to bring the rod too close.

1. Discharge the scope by touching the knob with your finger. If the leaves do not collapse (your body may be slightly charged), touch a wire to the knob and the cover plate of an electrical outlet. (DON'T plug the wire into the outlet!) If the leaves still don't collapse, gently tap the electroscope or pick it up and gently tap it on the table. Sometimes the leaves get stuck on the support.
2. Rub the clear Plexiglas rod several times with the silk cloth to charge it. Slowly move it near the knob of the electroscope but no nearer than about 1 cm and hold it there. What do the leaves do? _____.
3. Slowly move the rod away from the knob. What do the leaves do? _____. Move it in and out several times and observe.
4. Discharge the scope as shown in step 1.
5. Repeat steps 1 to 3 for the PVC pipe. (First charge the PVC by rubbing it with the wool cloth.)
6. Do you see any differences? _____. (Your answer should be 'no'.) If not, check with me before you proceed.

PART B. Permanent charging by conduction

6. Discharge the scope.
7. Now charge the clear rod with the silk and touch it to the knob and slide it back and forth several times to allow good transfer of charge. Then take the rod far away. What do the leaves do? _____.
8. Charge the clear rod again and bring it close to the knob. What do the leaves do? _____.
9. Repeat steps 1 and 2 for the PVC pipe. (Make sure you first charge the PVC with the wool.)
10. Do you see any differences? _____. (Your answer should be 'no'.) If not, check with me before you proceed.

PART C. Determining whether the two rods have the same charge.

11. Discharge the scope.
12. Charge the scope by conduction with the clear rod.

13. Charge the PVC pipe and slowly bring it near the knob and observe. What do the leaves do? _____.
14. Now charge the clear rod again and bring it near the knob and observe. What do the leaves do? _____.
If they repel farther, this means the clear rod has the same charge as the scope, as it should.
15. Repeat steps 11 to 14 but this time, start by charging the scope with the PVC pipe and bringing the clear rod nearby. What do the leaves do? _____. If they partially collapse, this means the rod has the opposite charge as the PVC. What do the leaves do when you bring the PVC pipe near the scope? If they repel farther, this means the PVC has the same charge as the scope, as it should.

PART D. Determining the sign of the charge

16. To find the sign of the charge, we need a standard to compare it to. We will use the electrophorus as our standard. When the plastic sheet on the electrophorus is rubbed with the wool, it becomes negatively charged. When the metal plate is set on the electrophorus and grounded by touching it briefly with a finger, the metal plate is charged positively by induction. (Can you see how that works?)
17. Remove the metal plate from the electrophorus by using its insulating handle. Set it on the table. Charge the plastic sheet of the electrophorus by rubbing it with the wool. This will charge the plastic negatively.
18. Using the insulating handle, put the plate back on the plastic sheet. Touch the metal plate with a finger and take the finger away. The metal plate is now charged positively due to induction.
19. Take the metal plate to your electroscope. Discharge the electroscope.
20. Touch the metal plate onto the scope. You may see and hear a spark if you observe closely. The leaves should repel because they are charged positively due to conduction.
21. Now charge the clear Plexiglas rod and bring it near, but not touching, the knob on the scope. If the leaves repel farther, the rod is charge positively. If the leaves collapse, the rod is charged negatively. What is the charge on the clear Plexiglas rod? _____.
22. Next charge the PVC pipe and bring it near the knob on the scope. Based upon the action of the leaves and what you have learned, what is the charge on the PVC pipe? _____.

PART E. Permanent charging by induction

21. Discharge the scope.
22. Charge the clear rod and move it toward the knob from the side until the leaves have repelled noticeably. (The bottoms should be at least 2 cm apart.) Hold the rod there without it touching the electroscope. (Do not bring the rod in from the top. It should come in from the side, parallel to the tabletop.)
23. Touch the knob with your finger on the side opposite the side the rod is on.
24. Now remove your finger from the knob.
25. Then remove the rod and put it some distance away on the table.
26. If you did this correctly, the leaves of the scope should be repelling.
27. Charge the PVC pipe (what charge does it acquire? _____). Bring the negatively charged PVC pipe near the knob on the scope. Based upon the action of the leaves, what is the charge on the scope?
_____.
28. When an electroscope is charged permanently by induction, it always picks up the _____ (same or opposite) charge as the object used.