Phys1112: Electric Charge and Force

Objectives:

- To become familiar with basic electric phenomena.
- To learn the charge model and apply it to conductors and insulators.
- To understand polarization and the attraction between neutral and charged objects.

Materials: Plastic rod, glass rod, piece of wool and silk, scotch tape, soda can, aluminum foil, Styrofoam board, neon bulb, two aluminum pie pans, alligator clips, and electroscope.

Part 1: Electrical Interactions of Sticky Tape

1. Obtain a piece of sticky tape, about 15 - 20 cm in length. For ease in handling, make "handles" by folding each end of tape to form portions that are not sticky. Press the tape firmly onto a smooth, unpainted surface, for example, onto a textbook or onto the table. Then quickly peel the tape off the surface and hang it from a support.

   Describe the behavior of the tape as you bring objects, such as a finger or a pen, towards it.

2. Make another piece of tape as described above. Bring the second tape toward the first tape with the non-sticky sides facing each other. Describe your observations. It is important, that during this experiment you keep your hands and other objects away from the tapes.

   Explain why this precaution is necessary. Describe how the distance between the tapes affects the interaction between them?
3. Press two pieces of tape onto the surface and write a B (for bottom) on them. Then press another tape on top of each B tape and label it T (for top). Pull each pair of tapes off the surface as a unit. After they are off the surface, separate the T and B tapes. Hang one of the T tapes and one of the B tapes from a support.

Describe the interaction between the following pairs of tape when they are brought near one another.

**Two T tapes**

**Two B tapes**

**One T and one B tape**

### Part 2: Interactions of More Charged and Uncharged Objects

When performing the following experiments, extend the rubbed objects away from your body so that your body does not influence your observations made with hanging tapes. Also, in humid conditions the electric charge on the pieces of tape can “leak off” causing them to become discharged. You may have to recharge or replace your T- and B-strips from time to time.

Create T and B tapes 15 to 20 cm long. Complete the following investigations and record your observations.

4. Bring a few charged objects toward the tapes one at a time and record the observations below.

<table>
<thead>
<tr>
<th>Material</th>
<th>T type tape</th>
<th>B type tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charged area of plastic rod, rubbed with wool</td>
<td>Attracted /Repelled/Nothing</td>
<td></td>
</tr>
<tr>
<td>Charged area of glass rod rubbed with silk</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
5. You have probably heard that “like charges repel” and “unlike charges attract.” Use this fact to explain how you can determine if any particular object is charged T type or B type.

6. List only objects or types of materials that are CLEARLY T-type or B-type. Paste tapes to the edge of the table to do the experiment. Make sure that you keep a good distance between the tapes.

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<table>
<thead>
<tr>
<th>Material</th>
<th>T type tape</th>
<th>B type tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Glass rubbed with silk</td>
<td>Glass is</td>
<td>Silk is</td>
</tr>
<tr>
<td>Glass rubbed with wool</td>
<td>Glass is</td>
<td>Wool is</td>
</tr>
<tr>
<td>Plastic rubbed with silk</td>
<td>Plastic is</td>
<td>Silk is</td>
</tr>
<tr>
<td>Plastic rubbed with wool</td>
<td>Plastic is</td>
<td>Wool is</td>
</tr>
</tbody>
</table>
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7. Now re-charge the T and B tapes or use new ones. Bring a few uncharged objects toward the tapes. And record the observations below.

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<table>
<thead>
<tr>
<th>Material</th>
<th>T type tape</th>
<th>B type tape</th>
</tr>
</thead>
<tbody>
<tr>
<td>Your finger</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncharged area of plastic rod</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Uncharged area of glass rod paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aluminum foil</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Any coins</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
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8. What can you conclude from your observations in Question #7? You may base your conclusions on what you learned in the class or from the textbook?

9. Charge the plastic rod with wool. Put an empty soda can on the table (horizontal) as shown in the figure below. Bring the charged portion of the rod parallel to the empty soda can. Do not touch the soda can with the rod.

Observe the rolling motion of the soda can. Repeat observation with glass rod charged with silk.

Explain your observations by drawing a model for the relative charge distribution on the rod and on the soda can for both cases. Name your charges as T or B based on your identifications in #6.
10. What is the net charge of the soda can in each case? Explain the reason for your answer.

11. Can you have a net electric force on an object with no net charge? Use your observations of the motion of the soda can to support your answer.

Part 3: Charging Metals by Contact

From now on use the following information to identify charges on the plastic rod and glass rod.

- Plastic rod rubbed with wool is negatively charged. (plastic negative)
- Glass rod rubbed with silk is positively charged. (glass positive)

Now go back to #6 and identify T and B in terms of + and –

12. Get an electroscope similar to the one drawn below. When the metal leaves have excess charge they repel as shown, when there is no excess charge on leaves they hang vertically down.

First touch the metal sphere once with your finger. Then bring the charged plastic rod rubbed with wool toward the metal sphere of the electroscope and observe the behavior of the leaves. Do not touch the metal sphere with the plastic rod.

Record what you observe when you bring the plastic rod near.

What is your model of what is going on that can explain this observation?
13. Draw + and – charges on the diagram to represent the distribution of charge on the rod and the electroscope when the rod is brought close to the electroscope.

14. Describe what you observe when you take the charged rod away from the electroscope. Explain what you think is causing that behavior.

15. Now repeat #12 but instead use the charged glass rod rubbed with silk. Describe what you see. Compare what you see in this case to what you observed in Question #12 for the rubbed silk.

Use + and – symbols to draw the distribution of charges on the electroscope. Draw your conclusion for what the charge distribution and explain why you observe what you observe.
16. Recharge the plastic rod, then touch the metal sphere with the charged portion of the plastic rod and take the rod away. Describe how the leaves look like after you complete the task.

Do you think that the electroscope now has a net charge? __________________________
Explain why or why not.

Use + and – symbols to draw the distribution of charges on the electroscope.

17. One of your class mates says that the angle between the leaves is an indication of the amount of charge present in the electroscope. That is larger angle means more charges etc. Do you agree? If yes why? If not why not?

18. Use the plastic rod to investigate this claim and decide if the angle of the leaves on the electroscope indicates how much charge is on them. Describe your observations and conclusions.

19. Charging of a conductor by touching with a charged material is called charging by contact. Now touch the metal sphere again with your finger. Explain what happens when you touch the metal sphere with the finger.
Part 4: Can Moving Charges Light the Bulb?

The last activity will require two aluminum pie pans, two short wires (with alligator clips), and a neon bulb. Assemble these objects as shown in the figure below.

20. In a darkened room, vigorously rub a Styrofoam board with a cloth to charge it. Now wave the foam board in various ways above one of the pie pans while carefully observing the bulb. What did you notice?

21. What, if any, correlation do you detect between the behavior of the bulb and the motion of the board?

22. Using the observations and ideas developed up to now, how do you explain what is happening in this activity?