ACTIVITY 1: Exploring Static Electric Effects

Purpose

In the previous unit you explored some magnetic effects and then went on to develop a model that explains these effects in terms of tiny entities within magnetic materials. You are also likely familiar with some other phenomena, usually associated with ***static electricity***, like the 'static cling' by which clothes stick together when you remove them from a dryer, or the 'shock' you receive when you walk across a carpet and then touch a metal door handle.

In this unit you will develop another model to explain some effects associated with static electricity. To start, in this activity you will observe some static electric effects and look for some patterns on which to base your initial model[1].

What are some properties of interactions involving electrified objects?

Initial Ideas

In the previous unit you found that only certain materials interact with a magnet. Will it be only these same materials that interact with electrified objects, or will different materials show static electric effects?

What kinds of materials do you think can be involved in static electric effects; all materials (metals and non-metals), all metals but not non-metals, or only certain specific materials?

[1] Because static electric effects are sometimes difficult to observe in humid conditions, your instructor may direct you to watch movies of some, or all, of these experiments on the *Next Gen PET Student Resources* website.

In the previous unit you also found that two particular magnetized objects could both attract and repel each other, depending on which parts of them (poles) are brought near to each other. Do you think the same is true of electrified objects?

If you were to bring two electrified objects close together, how do you think they would react to each other? Would your answer depend on which parts of the electrified objects were close to each other?

Participate in a whole class discussion about the answers to these questions. Make a note of any ideas that are different from those of your group.

Collecting and Interpreting Evidence

Your group will need:

- Roll of sticky tape
- Pen, or other permanent marker
- Support stand from which to hang tape. (This could be a meter stick projecting beyond the edge of a table.)
- Various materials to test
- Balloon

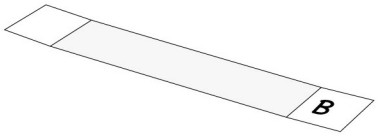
Exploration #1: What types of objects show static electric effects?

STEP 1. You are no doubt aware that some objects can be electrified by rubbing them, but for these experiments you will use a different technique to electrify two pieces of sticky tape.

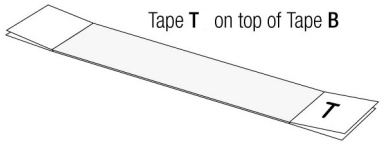
<u>Read through the following steps first, and then go through them quickly, but carefully</u>. Static electricity effects sometimes wear off quickly, so if you don't observe any types of interactions you might consider re-electrifying the tapes. (If your instructor has directed you to watch a movie instead of trying this yourself, you should watch USE-A1 – Movie 1.)

Prepare two pieces of sticky tape, each about 5 inches long. Fold over about $^1/_2$ inch of both ends of both pieces of sticky tape. These ends will serve as 'handles' that will allow you to work with the tape without touching the sticky surfaces.

Place one of the pieces of tape on the desk in front of you, sticky side down. Using a pen, or other permanent marker, label one of the handles on this piece B (for Bottom).

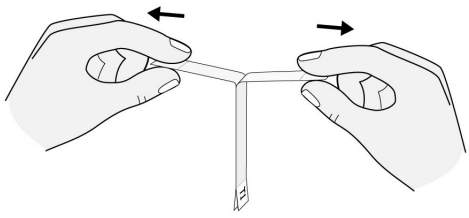


Now place a second piece of tape directly on top of the first, again sticky side down. Label this piece T (for Top).

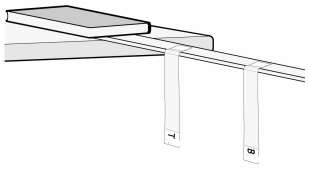


Press your finger over the two pieces to make sure they are firmly stuck together. (The bottom piece will also be stuck to the table, but that is not important.)

Now **<u>slowly</u>** peel both pieces of tape, still stuck together, from the table, (If the two pieces of tape become separated press them firmly together again.) Holding a handle on each piece of tape in each hand, **quickly** rip them apart.



After separating the tapes, keep them far enough from each other so they don't touch again. Attach them to the support stand so they hang straight down below it, (or have one of your group hold one tape in each hand.)



The act of ripping the two tapes apart should have electrified both pieces. Later you will try to explain why this happens, but for now you will just look for how these electrified tapes interact with non-electrified objects, if at all.

STEP 2. To find out how the various materials in your envelope interact with the electrified tapes, you should slowly bring each one close to the bottom of each of the two tapes in turn. As soon as you see any reaction from the tape, pull the object away again. Try not to let the tape touch any of the objects.

For each item, record in the table below whether the tape is attracted (A) to it, repelled (R) from it, or there is no effect (O). Add two other items of your own choice to the table and test them. Finally, bring the tip of your finger close to each tape to see if there is any reaction.

Table I: Observations of Electrified Tapes near Objects (A, R or O)

	Wooden strip	Iron nail	Plastic pen/ruler	Aluminum foil strip	Copper wire	Nickel strip			Finger
T-tape									
B-tape									

Check your observations with at least two other groups and try to resolve any differences.

What do your observations seem to show about what types of materials can interact with electrified objects? Is this the same as, or different from, the types of materials that interact with magnets?

When Benjamin Franklin experimented with electrified objects, he imagined them as containing some type of electrical 'fluid' and so said they were 'charged' (as in 'charge [fill] your glasses for a toast') when describing them. While Franklin's use of 'charged' is probably different from the sense in which most people think of it today, we still use his terminology. Thus, from now on we will refer to electrified objects as being '**charged**' with static electricity.

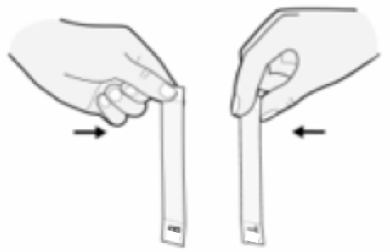
Exploration #2: How do electrically charged objects interact with each other?

STEP 1. You have now seen what happens when an uncharged object is brought near a charged object. But what would happen if two charged objects were brought near each other?

Do you think they would behave like two magnets (which attract or repel depending on which ends/faces are brought close) or would they behave in a different manner? Explain your thinking.

STEP 2. To check your thinking, prepare a new pair of charged B and T tapes, just as you did in Exploration #1. Now, slowly bring the **non-sticky** surfaces toward each other. (If not doing this yourself, watch ***USE-A1 - Movie 2***.) As soon as you see any reaction, move them apart again. ***It is important to try not to let the tapes touch each other!*** (If they do, you may have to go through the whole charging process again!)

What happens as the B and T tapes approach each other? Do they attract, repel, or is there no reaction?



Now turn **one** of the tapes upside-down, hold it by its other end and repeat.

Next, turn **one** of the tapes around so its sticky surface side faces the non-sticky side of the other tape, and bring them together again. Finally, bring both sticky sides together.

Do the results depend which ends/faces are tested, or does the same thing always happen?

Now go to the *Next Gen PET Student Resources* website and watch ***USE-A1 - Movie 3***, that shows an experiment involving two plastic coffee stirrers being tested in the same way that you tested nails in Unit M. To distinguish the ends, one end of each stirrer will have a small piece of tape attached to it.

One of the stirrers will be electrically charged by rubbing it all over with wool, and then placed on a floating disk.

The second stirrer will be charged in the same manner and then both ends of it will be brought close to both ends of the floating charged stirrer.

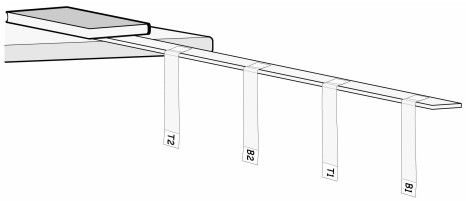
Does what happens depend on which ends of the stirrers are tested, or does the same thing always happen regardless of the ends used?

Do charged objects seem to be 'one-ended' (all parts of a charged object behave in the same way), 'two-ended' (the two ends or faces of a single charged object behave differently), or something else? How do your observations with both the charged tapes and the charged stirrers support your answer?

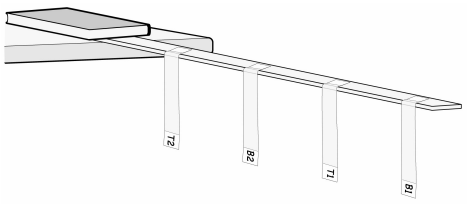
What do your observations imply about the electric charge on a charged object? Does such an object have only one type of charge all over it, or different types of charge in different places?

STEP 3. You have seen that during rubbing with wool, and the peeling apart of two tapes, objects involved become charged with static electricity. But is there only one type of charge, or are there more than one and if so, how many are there?

Suppose you prepared two pairs of charged tapes (call them T1/B1 and T2/B2) and brought tapes T1 and T2 together. What do you think would happen and why?



To check your thinking prepare two pairs of charged tapes, labeling them B1, T1, B2, and T2, and hang them from your support stand (or watch ***USE-A1 - Movie 4***). Alternatively, just have two group members hold the tapes in their hands.



Now bring the tapes toward each other in the various combinations corresponding to the cells in Table II below.

Remember to work quickly, but carefully. Electric charge effects sometimes wear off quickly, so if you don't observe any types of interactions you might consider re-charging the tapes. If you have difficulty making these observations a video of the experiments is available (USE-A1 – Movie 4).

Record the results of all the tests in Table II below. (Enter **A** for attract, **R** for repel, or **O** for no reaction.)

Table II: Observations with Charged Tapes

	B2	**T2**
B1		
T1		

Check your observations with at least two other groups and try to resolve any differences.

What do the results from these experiments with charged tapes suggest about the number of types of charge involved and how they interact with each other?

STEP 4: Now you will check whether the ideas you have developed about charges using the pairs of tapes also apply to objects charged by rubbing them together. Blow up the balloon. Rub one side vigorously against your hair. (It's best to use a member of your group who has long, straight and dry hair.) (Alternatively, watch ***USE-A1 - Movie 5***.)

After moving the balloon away from your hair, quickly bring the rubbed part of the balloon close to the rubbed part of your hair again. Does anything happen to your hair? If so, what? Why do you think this happens?

Prepare a **new** pair of charged B and T tapes and hang them from the support. Rub the balloon on your hair again and quickly bring the **rubbed part** of the balloon close to the B tape and then the T tape.

What happens to the B tape when the balloon is brought near? Is it attracted, repelled, or does nothing happen?

What happens to the T tape when the balloon is brought near? Is it attracted, repelled, or does nothing happen?

Do you think the rubbed part of the balloon has the same type of charge as the T tape, the B tape, or a different type than both? Why do you think so?

Finally, watch ***USE-A1 - Movie 6***, in which a Styrofoam™ plate and an acrylic sheet (a type of clear plastic) are rubbed together and each brought toward a pair of charged B and T tapes.

Describe how both tapes behave when the rubbed Styrofoam™ plate is brought near.

Describe how both tapes behave when the rubbed acrylic sheet is brought near.

Do these results suggest that the rubbed plate has the same type of charge as the B tape, the T tape, or some different type of charge? What about the rubbed acrylic sheet?

Summarizing Questions

Discuss the following questions with your group and note your answers. ***Be sure to support all of your answers with evidence from this activity.***

S1: How many types of electric charge are there and how do they interact with each other?

S2: When an object becomes charged (either by rubbing or peeling) is it one-ended (same type of charge all over), two-ended (two different types of charge at different locations), or something different?

S3: When two objects are charged, either by rubbing together or peeling apart, do they both have the same type of charge or does each have a different type of charge?

S4: Suppose you and your neighbors both rubbed a Styrofoam™ plate with an acrylic sheet and then brought the two Styrofoam™ plates together. What do you think would happen and why? How do you know?

S5: If you rub a balloon on your hair, it will pick up some small pieces of paper when held a short distance above them. Given all the evidence you have seen in this activity, what can you say about whether the paper is charged with the same or opposite type of charge to the balloon, or could it be uncharged?

S6: How are the interactions involving charged objects similar to those involving magnets? How are they different? Does this suggest that static electric interactions and magnetic interactions are really the same thing, or that they should be treated as two separate interactions?

 Participate in a class discussion.