UNIT SE

LESSON 1: Exploring Static Electric Effects

Purpose and Materials Needed

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 drier, or the 'shock' you receive when you walk across a carpet and then touch something. In this unit, you will develop another model to explain these effects associated with static electricity. To start, in this lesson you will observe some static electric effects and look for some patterns on which to base your initial model.

What are some properties of interactions involving electrified objects?

For these investigations your team will need:

- Roll of sticky tape
- Pen or permanent marker
- A support, such as a ruler or long pencil
- An envelope containing several items

Predictions, Observations and Making Sense

Part 1: What kinds of materials can be involved in static electric effects?

In the previous unit you found that only certain materials could 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 do you think?

CQ 1-1: What kinds of materials do you think can be involved in static electric effects?

A. All materials, both metals (copper, aluminum, iron, brass, etc.) and non-metals (plastic, wood, glass, etc.)
B. Only metals, but not non-metals
C. Only non-metals, but not metals
D. Only certain metals, not all metals
E. Only certain metals and non-metals, but not all of them

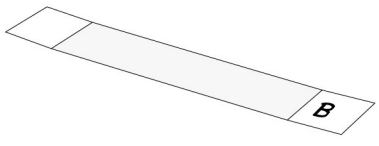
To find out, you will perform some experiments with electrified and non-electrified objects. You are no doubt aware that some objects can be electrified by rubbing them, but for these experiments you will use a different technique to electrify two pieces of sticky tape.

To begin, open the small envelope in your kit and lay out all the items (listed in Table I on the next page) on a desktop. Add two additional items that you will be testing.

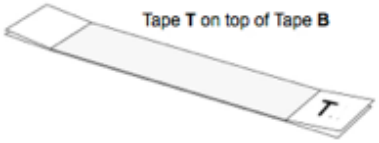
Read through the following steps first, and then go through them quickly, but carefully. Static electricity effects sometimes wear off quickly, so if you don't observe any types of interactions you might consider re-electrifying the tapes. If you don't have the materials, watch the movie **USE L1 Mov1**.

Prepare two pieces of sticky tape, each about 4 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).

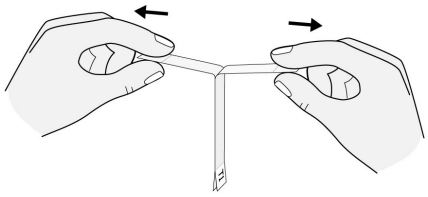


Now place a second piece of tape directly on top of the first, again sticky side down. Label this piece T (for Top).



Rub you 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.)

One member of your group should slowly 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. Keep your two hands far apart so the tapes do not touch. [Ripping the tapes apart should electrify each of them.]

To find out how the various materials in your envelope interact with the electrified tapes, ***other members of your group should slowly bring each item close to each of the two tapes in turn. Do this quickly.*** As soon as any reaction from the tape is observed, pull the object away again. Try not to let the tape touch any of the objects. Without the materials you should watch the movie **[USE L1 Mov2].**

For each item, record in the table 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	Paper clip		Finger
T-tape									
B-tape									

What do your observations show about what types of materials can interact with electrified objects?

You can discard the two tapes. Your instructor will review the observations in the Table and your conclusions to ensure that everyone agrees.

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 today think of it, we still use his terminology. Thus, from now on we will refer to electrified objects as being 'charged' with static electricity.

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

In Part 1 you saw what happens when uncharged objects are brought near charged objects. 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.

CQ 1-2: If different ends/faces of two electrically charged objects were brought close together, what do you think would happen?

A. It would be like two magnets. If they attracted each other when two of the ends/faces were close to each other, they would then repel if one of the ends/faces were turned around.
B. It would not be like two magnets. If two ends/faces attracted or repelled each other, they would do the same thing if one of the ends/faces were turned around.
C. They would not react to each other.

Two different experiments will help you check your thinking.

First, watch a movie (**USE L1 Mov3**) of an experiment involving two plastic coffee stirrers. So that you can distinguish the ends, one end of each stirrer

will have a small piece of tape attached to it. One of the stirrers will be charged by rubbing it all over with wool, and then placed on a floating disk.

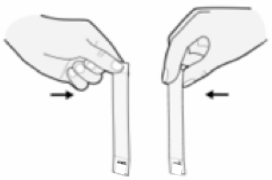
The second stirrer will be charged in the same manner, and then both ends of it will be brought close to both ends of the floating charged stirrer.

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

How does this behavior of two wool-rubbed stirrers compare to the behavior of two magnet-rubbed nails you saw in Unit M?

The next experiment you will perform yourself. (If you do not have the materials, then watch **USE L1 Mov4**.) Prepare a new pair of charged B and T tapes just as you did in Part 1. After ripping the B and T tapes apart, slowly bring them toward each other. As soon as you see any reaction, move them apart again. ***It is important not to let the tapes touch each other!*** (If they do, you should 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?



Turn one of the tapes around so its opposite side faces the other tape, and bring the two tapes together again.

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

In Unit M, you investigated what materials interact with a magnet and also whether magnetized objects are one-ended or two-ended.

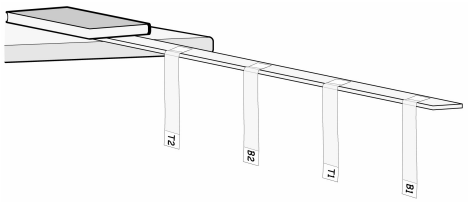
Based on your observations in this lesson, what can you conclude: are charged objects one-ended or two-ended?

When compared with the results of your investigations in Unit M, do observations in this lesson suggest that the static electric and magnetic interactions are the same or different? Explain your reasoning.

Part 3: How many types of charge are there?

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?



CQ 1-3: If the T1 and T2 tapes from two separate pairs of charged tapes were brought back toward each other, what do you think would happen?

A. They would attract each other.
B. They would repel each other.
C. They would not react to each other.

Either perform the following experiment with the materials or watch a movie **(USE L1 Mov5)** of the experiment. Prepare two pairs of B and T tapes so they are charged and label them B1, T1, B2, and T2. Then bring them toward each other in various combinations, as suggested in the following table.

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		

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?

Finally, we will check whether the ideas you have developed about charges using the pairs of tapes also apply to objects charged by rubbing them together.

Watch a movie (**USE L1 Mov6)** of an experiment 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.

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?

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

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

Next, watch a movie **(USE L1 Mov7)** that shows a rubber balloon being rubbed against a person's hair. Then the charged balloon is brought close to T and B tapes.

Describe how both tapes behave when the hair-rubbed balloon is brought near.

Do these results suggest that the hair-rubbed balloon has the same type of charge as the B tape, the T tape, or some different type of charge?

Summarizing Questions

S1. Use evidence from this lesson to answer the following question.

CQ 1-4: How many types of charge are there and how do they interact?

A. There is only one type of charge. All charged objects attract each other.
B. There is only one type of charge. All charged objects repel each other.
C. There are two types of charge. Like charges repel and unlike charges attract.
D. There are two types of charge. Like charges attract and unlike charges repel.

S2. Suppose you and your neighbors both rubbed a Styrofoam plate with an acrylic sheet and then brought the two plates together. What do you think would happen and why? What about if you brought your charged plate close to their charged acrylic sheet?

To get some feedback, watch the movie **USE L1 Mov8**, which shows what happens when the two Styrofoam plates are brought together.

 What actually happens?

S3. Answer the following question based on your current understanding of what happens when objects are charged by rubbing or peeling.

CQ 1-5: What happens when two objects are charged by rubbing or peeling?

A. Both objects have the same type of charge.
B. One object has only one type of charge. The other object has only the other type of charge.
C. Both objects have both types of charge, but there are different amounts of each type on each object.