WS2
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# **Training for Educators**
# Electrostatics

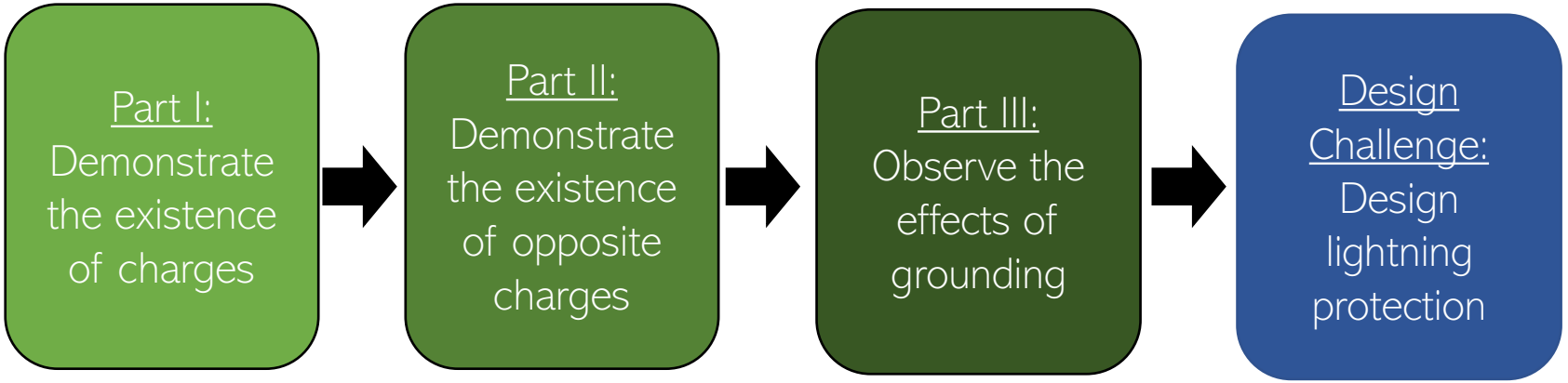
Secondary Level

Ages 12-18

# Mission of the lab

- This laboratory will teach students about electrostatics and how they may see electrostatics phenomena in their everyday lives, including in lightning strikes.
- The main takeaways are:
  - Objects can be positively charged (+), negatively charged (-), or uncharged (neutral).
  - Objects with the same charge repel each other; oppositely charged objects attract each other.
  - Charged and uncharged objects attract each other regardless of whether the charged object has a positive or negative charge.
  - Charges can easily move through metal; charges cannot easily move through plastic and other non-metal objects.

# Summary of experiments




There are 3 experiments in total.

# Supplies list

- Plastic (e.g., plastic pen, comb, straw, anything handheld and made of plastic)
- Paper
- Hair (e.g., on your student's head), wool, or fur
- Balloon
- Aluminum can (empty)
- Sticky tape
- Metal (e.g., fork, spoon, metal pen, keys, anything handheld and made of metal)
- Pen or pencil
- Scissors (optional)

# Safety considerations

Before the students begin the laboratory, please take into consideration the following safety concerns:

- Students should be aware that they may get shocked while doing these electrostatics experiments. The experiments should not pose any harm to them, but it is advised to not complete these experiments around anything especially flammable (e.g., gasoline fumes).
- Students can cut paper using scissors for experiments, or teachers can cut the paper for students beforehand. Scissors should always be handled with care. As an alternative, students can rip paper by hand since the exact size of paper is not important to lab.

# Setting up your space

- Gather your supplies and separate by experiment(s) on your table.
- These are our recommendations:
  - Each student should have a pencil or pen.

  <u>Groups of 2-4 students can be given the following supplies:</u>
    - 2 pieces of plastic
    - 1 piece of paper
    - 1 balloon
    - 1 empty aluminum can

  <u>The class can share the following supplies based on availability</u>
    - 1+ piece(s) of metal (or metal object)
    - Hair (on student's heads)
    - Wool or fur
    - Glass
    - Sticky tape roll
    - Scissors

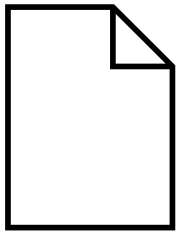
# Part Ia. Static attraction!

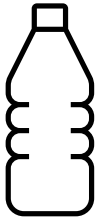
- Set-up:
  - Each group of 2-4 students gets ~1 piece of paper. The class can share pieces of wool/fur and glass. Students from each group can volunteer to offer their skin and/or hair.
- Procedure:
  - Students use a plastic instrument to rub against different surfaces (hair, skin, fabric, glass) and bring them close to the pieces of paper to see what happens.
- Results:
  - The plastic should attract the paper and slightly lift it off the table. The hair and skin should attract the paper the strongest, then glass, then fur, then wool.

The takeaway is that objects can become statically charged. When brought close to neutral objects (paper) they attract!

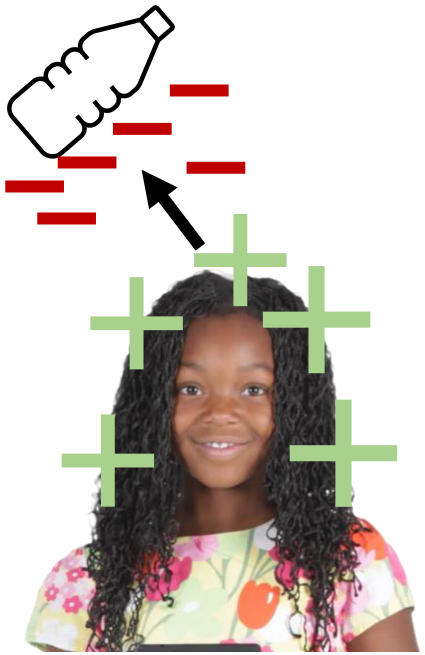
# Static attraction explained

1. Both are neutral to start

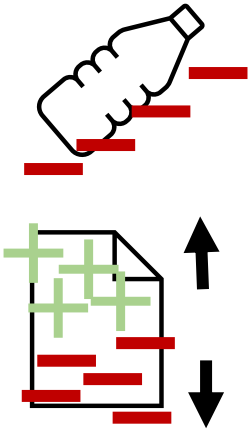




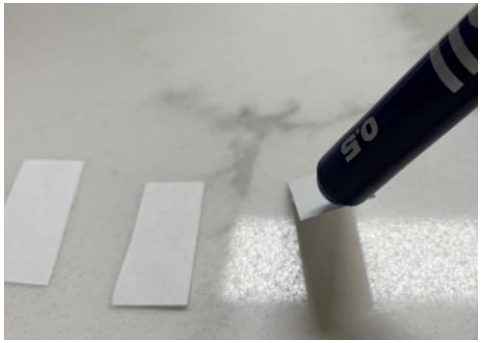
2. When we rub the plastic against our hair, electrons move from our hair to the plastic, making our hair positively charged and the plastic negatively charged.



3. When we bring the plastic close to the paper, we bring the positive charges close to the negatively charged plastic and push the negative charges away.



4. The opposite charges in the positive end of the paper and the negative plastic cause the plastic to attract the paper and lift it off the table.



Plastic pen lifting up paper after rubbing the plastic against hair.

Negative charge (electron)

Positive charge

# Part Ib. Racing Cars

- Set-up:
  - Each group (2-4 students) will need 1 balloon and an empty aluminum can. If you don't have aluminum cans, you can use another piece of metal that will roll across the floor.
- Procedure:
  - Students will blow up the balloon and statically charge it by rubbing it against a student's hair. Then they will use the balloon to guide the metal to roll across the room.
  - If you'd like, the students can race across the room to see which student can charge their balloon the best.
- Results
  - Students should be able to guide the metal using the static charge on the surface of the balloon

The takeaway is that students should have the conclusions from Part 1a reinforced with different materials: static charges exist and can make objects attract.

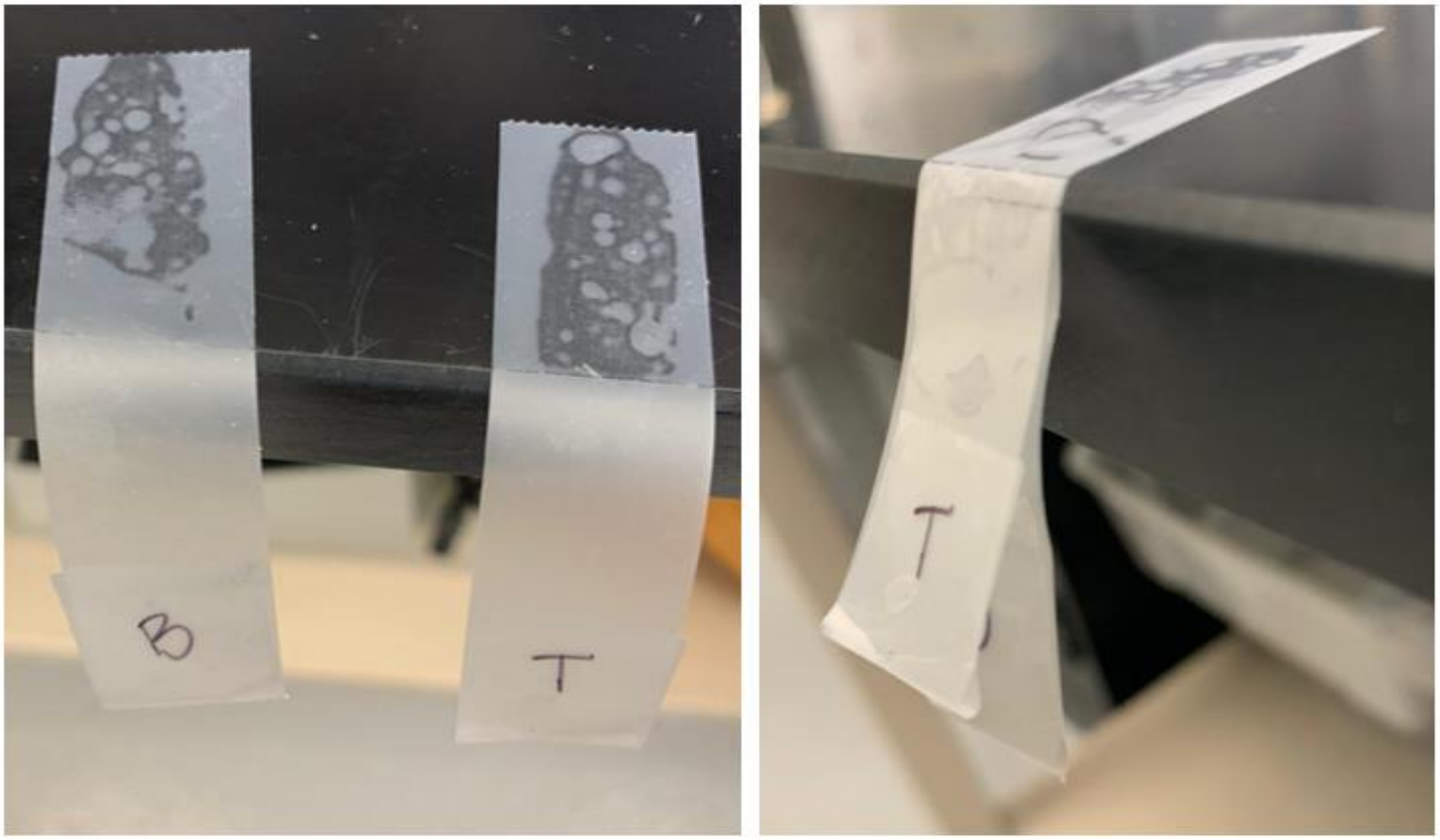
# Part II: Static repulsion

- Set-up:
  - Each group (2-4 students) will need 4 pieces of sticky tape about 10 cm long and a pen/ pencil.
- Procedure:
  - Students will pull apart pieces of tape quickly to give them opposite charges. They will do this twice to make two negative and two positive (labeled T for Top and B for bottom).
- Results
  - Students can see T+T repel, B+B repel, and T+B attract

    The takeaway is that like charges repel!

We can also see that opposite charges attract like we learned in Part I.

# Part II: Static repulsion setup




Experimental set-up for Part II before sticking tape together (left) and after (right).

# Part III: Grounding effects

- Set-up:
  - Each group (2-4 students) will need 2 pieces of plastic, ~1 piece of paper and something to rub the plastic against (hair, fur wool, glass, skin).
- Procedure:
  - Students will repeat the activity of Part I, but try to 'ground' the plastic by removing the charges from the plastic object.
- Results
  - Students should see that the metal removes the charges from the plastic, but other plastic will not work well to ground the plastic.

The takeaway is that charges can move through metal easily, but not through plastic.

# Design challenge

Students are asked to imagine a lightning safe space to protect them during a lightning storm. The instructor should encourage the students to think about what materials charges can move through easily and what they cannot move through easily based on Part III. Ideally, we would want metal on the outside and plastic, wood, or rubber on the inside.

- Questions to ask the students
  - What structures exist in our area that may be safe for lighting based on these findings?
  - What everyday materials could help protect you or your house from lightning?
  - What would you want to stay away from in a lightning storm to stay safe?

# Troubleshooting

- For Part Ia, if students have trouble lifting the paper without touching it, have them gently touch the surface of the piece of paper. Some surfaces make it more difficult to lift the paper off.
- For Part Ib, if you don't have a balloon, you can use another plastic object that can hold a lot of charge on the surface. Try experimenting with a plastic bag, bottle, or anything else you may think of!
- For Part II, make sure students fold over the tape before sticking them together. It will be very difficult to pull them apart if they skip this step.