THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Center of Attraction

How can I affect the strength of a static charge?

GRADES 6–8

Physical Science

VAN ANDEL EDUCATION INSTITUTE
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INQUIRY-BASED SCIENCE

Physical

Center of Attraction

Grade Level/Content	6–8/Physical Science
Lesson Summary	Students use ordinary materials to create a static charge, test the strength of their charge, and modify their experimental design to improve the strength of the static charge.
Estimated Time	2, 45-minute class periods
Materials	small plastic or metal objects (such as a pen casing, plastic cup, metal end of a pencil, plastic bag, etc.), material with which to rub the plastic or metal objects (such as paper towel, fabric, rug, wool scarf, leather belt, etc.), facial tissues, Investigation Plan, Observation Form, journal
Secondary Resources	PBS Learning Media "Testing for Static Electricity" (4:19) PhET Online Simulation "John Travoltage" PhET Online Simulation "Balloons and Static Electricity" Bill Nye (YouTube) "Static Electricity" (38:11) Steve Spangler Science "Floating Static Bands" (1:55)
NGSS Connection	**MS-PS2-5** Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.
Learning Objectives	• Students will plan and carry out an investigation to generate a static electric charge from ordinary objects. • Students will change one variable in their system to affect the strength of the static charge. • Students will collect data to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

How can I affect the strength of a static charge?

Electricity is a flow of electric charge. In order to start this flow, a system must be in a complete circuit, and the circuit must include a power source, wires (or other conductor), and a load. Electricity can be used to create a field which attracts objects to each other. This force can also be generated without a complete circuit. This electrostatic field can be strengthened depending on the materials used and how the object is rubbed.

Static electricity also involves electric charge, but the charge flows in a different manner. Instead of flowing through a closed system or circuit, the electric charge is fixed in one location, causing the object to have a net charge. This static electric charge can be generated through friction. The negative electrons in one object attract the positive protons in another object, and the objects attract. Objects with like charges repel.

Investigation is based on the Van Andel Education Institute (VAEI) Instructional Model for Inquiry-Based Science. In all investigations:

Students don't know the "answer" they are supposed to get.

Students play a driving role in determining the process for learning.

Teachers and students construct meaning together by journaling.

Students are working as hard as the teacher.

Part 1

INVESTIGATION SETUP

Each group of two students will need the following:

- Small plastic or metal object (such as a pen casing, plastic cup, metal end of a pencil, plastic bag, etc.)
- Material with which to rub the plastic or metal object (such as paper towel, fabric, rug, wool scarf, leather belt, etc.)
- 1 facial tissue
- Investigation Plan
- Observation Form
- Journal (per student)

Note: This investigation is best completed on a day with low humidity.

Part 2

INVESTIGATION FACILITATION

Question

Introduce the investigation question.

How can I affect the strength of a static charge?

STUDENT ENGAGEMENT

Show students an inflated balloon and a magnet. Ask students to predict how these two objects are similar. Guide students to realize that both objects can attract other objects. Demonstrate this by rubbing the balloon on your hair to show that it will attract the hair. Hold the magnet up to your hair, and ask students to explain why the magnet does not attract hair. *(Hair does not contain material that reacts to a magnetic field.)* Then, hold the balloon and magnet beside a stack of paperclips. This time, the magnet attracts the clips, but the balloon does not. Encourage students to ask questions about the forces that are causing these attractions. Also ask students if they think the force that causes these attractions can be increased. If so, how? If not, why not? *(The magnetic force can be increased by increasing the size of the magnet and by bringing the magnet closer to the object. The electric force can be increased by increasing the amount of charge on the balloon or bringing the balloon closer.)* Then, introduce the investigation question.

Personal Knowledge

Students capture what they already know about static electricity.

- Have students share examples they have seen or experienced of static electricity.
- Examples of experiences students might share include a balloon rubbing on hair and sticking to a wall, hair standing up when someone puts on or takes off a sweater, getting a shock when rubbing feet along carpet and touching another object, puff rice cereal sticking to a plastic cereal bag, etc.
- Based on students' previous experiences with static electricity, discuss as a class how they might create a static charge. *(Most of the examples involve rubbing objects together.)*

DISCOURSE

Write these words on the board: *electricity* and *static electricity*. Have students talk with a partner about how they think these similar concepts compare. Have students write ideas in their science journals. Create a class Venn diagram to compare the terms. Incorporate ideas from the students to complete the diagram.

Continued

RISK-TAKING

Add all ideas, even misconceptions, to the class Venn diagram. If something is questionable, place a question mark next to it and explain that the class will revisit it later. Clarify misconceptions at the appropriate time in the investigation, perhaps during data analysis and explanation.

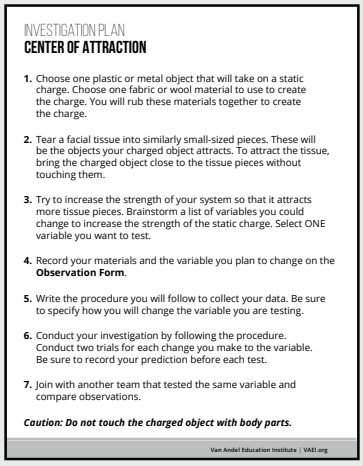
Investigation Plan

Students discover what kind of materials can be used to create a static charge and investigate how to change the strength of the charge.

Part 1

- Conduct a mini-investigation (**Messing About**) for students to develop the knowledge and skills required to perform the investigation.
- Place a variety of materials from these two columns (or similar materials) on a table for students to observe.

Group 1	Group 2
Plastic pen casing	Paper towel
Plastic cup	Fabric
Metal end of pencil	Wool rug
Plastic grocery bag	Wool scarf
Plastic brush or comb	Glass
Metal fork or spoon	Leather belt
Balloon	Silk



INVESTIGATION PLAN
CENTER OF ATTRACTION

1. Choose one plastic or metal object that will take on a static charge. Choose one fabric or wool material to use to create the charge. You will rub these materials together to create the charge.
2. Tear a facial tissue into similarly small-sized pieces. These will be the objects your charged object attracts. To attract the tissue, bring the charged object close to the tissue pieces without touching them.
3. Try to increase the strength of your system so that it attracts more tissue pieces. Brainstorm a list of variables you could change to increase the strength of the static charge. Select ONE variable you want to test.
4. Record your materials and the variable you plan to change on the **Observation Form**.
5. Write the procedure you will follow to collect your data. Be sure to specify how you will change the variable you are testing.
6. Conduct your investigation by following the procedure. Conduct two trials for each change you make to the variable. Be sure to record your prediction before each test.
7. Join with another team that tested the same variable and compare observations.

Caution: Do not touch the charged object with body parts.

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Investigation Plan

- Explain that some of these materials, when rubbed together, can create a static charge.
- Have students rub different materials together to determine which ones generate a charge. *(They will need to rub either a plastic or metal object, Group 1, with some sort of cloth or fabric-like material, Group 2, to generate a charge.)*
- Challenge the students to sort the materials into two groups (as seen above), where the materials from group 1 could be rubbed with the materials from group 2 to generate a charge.

Part 2

- Once students have an understanding of which materials can be used to create a static charge, divide the class into teams of two and have each team choose the materials they want to work with (one item from Group 1 and one item from Group 2).
- Explain that the objective is to determine the strength of the static charge from their system and try and strengthen the charge by changing one variable.
- Review the Investigation Plan and Observation Form with students.
- To test the strength of their system, students will use facial tissue that has been torn into similarly small-sized pieces. They should move the charged object toward the tissue pieces without touching them and record how many pieces their system picks up on the **Observation Form**.
- Discuss as a class how students might change their design to improve the strength of the static charge. Students may want to change: the number of rubs; the strength of rubs; the duration of rubs; the speed of rubs; the amount of space rubbed along the object; etc.
- Have students write the steps they will follow (procedure) and the variable they will change. Ask students to explain why they will change their selected variable.

Continued

- Remind students to be specific about the change they will make for each trial. For example, students who are testing how the number of rubs increases the force may start by rubbing the object six times, then increase two rubs for each trial. Students should conduct at least 2 trials for each change in their variable.
- Have students collect their materials and begin their investigation.

Caution: Do not touch the charged object with body parts.

Remind students that the objective is to create a field between two objects, not themselves.

CRITICAL THINKING

Use the Fair Test checklist to help students think critically about the investigation plan. Help them understand that a good investigation plan must include a test that is repeatable, generates quality data, and minimizes error. The more critically students think about their investigation plan, the more confident they will be in their results.

PERSEVERANCE

The first challenge that students will face is figuring out how to determine if the materials are generating a charge. Encourage students to not give up and keep trying until they find a method that works consistently.

INTEGRITY

Check the list of procedures and encourage students to change only one variable in their system at a time.

Observation

Students record the number of tissue pieces their object attracts with each trial.

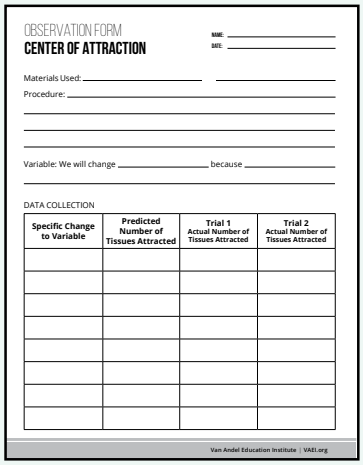
- Remind students to record data for each trial. They may complete up to eight trials.
- Have students join with another team that tested the same variable to compare observations.

INTEGRITY

Monitor students as they conduct their trials. Ensure that students only change one variable.

CRITICAL THINKING

Make sure students are recording their predictions before each trial. This encourages them to think critically throughout the investigation, evaluating what is happening in each trial.



OBSERVATION FORM

CENTER OF ATTRACTION

NAME: _____

DATE: _____

Materials Used: _____

Procedure: _____

Variable: We will change _____ because _____

DATA COLLECTION

Specific Change to Variable	Predicted Number of Tissues Attracted	Trial 1 Actual Number of Tissues Attracted	Trial 2 Actual Number of Tissues Attracted

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Observation Form

Part 3

INVESTIGATION ANALYSIS AND DEVELOPMENT OF CLAIM

Data Analysis

Students make sense of their data by organizing it and representing it visually.

Have students analyze their data. They may wish to use the Data Analysis prompt as a guide.

- Have students **evaluate** their data for trustworthiness.
- Then, have them analyze their data to find patterns and trends. They may **organize** the data and/or **represent** it visually to construct meaning.
    - You may want to have students graph their data to provide a visual representation. For example, students can chart their outcomes on a coordinate grid, labeling the variable along the *x* axis and the number of tissue pieces they attract with each trial along the *y* axis.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure that students have enough data that it can be used as evidence to support a claim.

STUDENT CHOICE

Encourage students to choose how they want to represent their data. You may want to show them a variety of chart types and infographics to spur their thinking.

Secondary Knowledge

Students use secondary sources to understand that fields exist between objects that exert forces on each other even though the objects are not in contact.

- Use these resources (or your own) to develop students' understanding of forces between objects that cause an attraction between them.
  PBS Learning Media: Testing for Static Electricity
  PhET Online Simulation: John Travoltage (move the foot to generate a charge, then move the finger to the door to see the strength of the charge.)
  PhET Online Simulation: Balloons and Static Electricity (rub balloon against sweater to see how the electrons react)
  Bill Nye: Static Electricity (38:11)
  Steve Spangler Science: Floating Static Bands (1:55)
- After reviewing these resources, students should understand the concept of forces (attraction) that exist as fields between objects. They should be able to provide evidence to support the idea that objects do not have to touch in order for the objects to attract each other.
- Discuss these questions to connect what students learned to their investigation:
    - How do you know a field exists between objects that causes them to attract?
    - Were you able to strengthen the force between objects?
    - How do you think your outcome would differ were you to change one additional variable?

CONSTRUCTION OF MEANING

Have students reflect on what they knew about static electricity before conducing the experiment and reviewing the science resources. Instruct students to write in their science journals and summarize new learning using a *3, 2, 1* model: list 3 things you learned about static electricity, 2 things you still want to know, and 1 way static electricity connects to something that interests you.

Explanation

Students write a claim and provide evidence and reasoning to support it.

- Have students use what they've discovered from their analyzed data to write an explanation that answers the investigation question. Students may wish to use the Explanation prompt as a guide.
- Have students develop a **Claim** to answer the question: How can I affect the strength of a static charge?
- Then, have them add **Evidence** (the analyzed data) to support their claim.
- Finally, have them add **Reasoning** to their claim. Reasoning should include the information obtained from this investigation as well as science principles they have learned.

Claim

I can increase the strength of a static charge by increasing the number of times I rub a plastic pen with a wool scarf together quickly.

Evidence

When I rubbed the plastic pen and wool scarf together 5 times, I generated a static charge that picked up 3 tissue pieces. When I rubbed the plastic pen and wool scarf together 10 times, I generated a static charge that picked up 7 tissue pieces.

Reasoning

Investigation

We created a fair test by only changing one variable. We also conducted 2 trials for every change. We were careful not to touch the tissue papers with the charged object. Our data showed that the number of tissue papers we picked up increased the more times we rubbed the plastic pen and wool scarf together.

Science

We learned from our readings and videos that when you rub the plastic pen with wool scarf, the pen becomes negatively charged. When it is brought close to the tissue pieces, they become positively charged, and the pen attracts them. Because they are so light, they move to the pen.

- Once the explanation is written, have students share their work using a Present and Defend.

DISCOURSE

Have students conduct a Present and Defend to develop presentation skills as well as audience participation. The class analyzes the information presented and asks clarifying questions, challenges and/or supports the arguments made, and even presents alternative explanations as appropriate. Each team defends its explanation with evidence and reasoning. If teams are doing the same investigation plan, choose 1 or 2 to present.

Evaluation

Students reflect on the investigation.

- Ask students if they were satisfied with their materials selection having heard how everyone else's system performed. Would they change their materials if offered the chance?
- Ask students if they think they could generate a stronger force with larger objects. What other changes might students make to maximize the strength of the charge?

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

Students demonstrate understanding of a field existing between objects that exerts forces on each other even though the objects are not in contact.

- Have students apply their learning by answering the question: How do you know that fields exist between objects? *(Objects can have an electric charge which attracts them to other objects.)*
- Now that students understand the concept of fields exerting forces between objects, students can apply this knowledge to learn uses for it. Have students work in teams. Assign each team one application of static electric charges to research. Have students create a diagram explaining how the real-life application of static electricity works and present it to the class. *Examples include: photocopiers, laser printers, ink jet printers, dust collectors in smokestacks, defibrillators, paint sprayers, and crop dusters.*

Assessment

To assess understanding, pose this situation to students. Have students respond to the task on a half-sheet of notebook paper (to use as an exit card for the lesson). Instruct students to draw a diagram labeling the force field in the system.

Situation: Mrs. Olsen is dusting her house. She has a static duster. She charges the duster by rubbing it against a plastic grocery bag. Then, she starts dusting her house.

Task: Explain why using a static duster will help Mrs. Olsen remove more dust particles from surfaces compared to a regular, uncharged cloth.

By using a static duster, Mrs. Olsen can attract dust particles that the duster may not come into contact with. For example, when she places the duster behind the television set, she may not reach the entire surface of the table it is resting on. The charged duster will attract dust particles from the entire table, even though the duster does not touch them. This is because there is a field between the charged duster and the dust. This field causes the duster and dust to exert a force on each other, and the duster attracts the dust without touching it. (Diagram should show and label charged duster a few centimeters away from dust particles, the force between them, and the dust particles being attracted to the charged duster.)

OR

Evaluate students based on how they:

- planned and carried out an investigation to generate a static electric charge from ordinary objects.
- changed one variable in their system to increase the strength of the static charge.
- collected data to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

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OBSERVATION FORM
CENTER OF ATTRACTION

NAME: _____

DATE: _____

Materials Used: _____ _____

Procedure: _____

_____

_____

_____

Variable: We will change _____ because _____

_____

DATA COLLECTION

Specific Change to Variable	Predicted Number of Tissues Attracted	Trial 1 Actual Number of Tissues Attracted	Trial 2 Actual Number of Tissues Attracted