THINKING AND ACTING LIKE A SCIENTIST

TEACHER'S GUIDE

Light the Bulb

How can a bulb, battery, and wire(s) be connected to light the bulb?

GRADE 4

Physical Science

VAN ANDEL EDUCATION INSTITUTE
VAEI.ORG

INQUIRY-BASED SCIENCE

Physical

Light the Bulb

Grade Level/ Content	4/Physical Science
Lesson Summary	In this lesson, students will discover how to connect a battery to a light bulb using wires in order to make it light.
Estimated Time	2, 45-minute class periods
Materials	D Cell battery, small 1.5 volt bulb, 8-10" pieces of wire (at least 2), Play-Doh (for holding bulb in place, Investigation Plan , Observation Form Assessment
Secondary Resources	• Discovery Kids: Electrical Circuits • Explain That Stuff: Electricity • BBC Bitesize: Electrical Circuits
NGSS Connection	**4-PS3-2** Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.
Learning Objectives	• Students will describe the transfer of energy by electric currents producing light. • Students will collect data describing the presence of electric currents flowing through wires linking one form of energy (battery) to another (light). • Students will provide evidence of how energy can be transferred from electric current to light.
Cross-Curricular Project Connections	Show Time!, Intruder Alert!

How can a bulb, battery, and wire(s) be connected to light the bulb?

Electricity—we depend on it every minute of every day. And yet to many of us, electricity seems a mysterious force. Before Ben Franklin did his kite flying experiment, electricity was thought to be a type of fire. In 1847, the year Thomas Edison was born, most people considered electricity to be some sort of dangerous fad. By the time Edison died in 1931, entire cities were powered by electricity.

Although it has been used as an energy source for more than 100 years, many people don't understand the basic principles of electricity. In this lesson, students begin to develop an understanding of electrical currents through a hands-on investigation as they figure out how a bulb, battery, and wire(s) can be connected to light the bulb.

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

Strip one-half inch of plastic insulation off the ends of each wire segment. Each group of 4 students will need the following:

- D Cell battery
- Small 1.5 volt bulb
- 2 8-10" pieces of insulated wire (with ends stripped)
- 1 tablespoon of Play-Doh (for securing the battery and propping up the bulb as needed)
- Investigation Plan
- Observation Form
- Assessment

Part 2

INVESTIGATION FACILITATION

Question

Introduce the investigation question.

Q: How can a bulb, battery, and wire(s) be connected to light the bulb?

CURIOSITY

Bring in objects that turn on in different ways, *(i.e., a flashlight with a sliding on button, a light with a switch, a bell that rings when turned on, a flashlight or clock that is wound before it will work, etc.).*

Encourage students to ask questions about how the item begins to work. Then, introduce the investigation question.

Personal Knowledge

Students capture what they already know about electricity.

- Find out what students already know about electricity, batteries, and light bulbs.
- Create a class list. (List may include: electricity flows through circuits, electricity can generate light, electricity can generate heat, batteries have positive and negative ends, Thomas Edison invented the light bulb, etc.)

DISCOURSE

Conduct a Pass the Paper with students working in groups of 2, 3, or 4. Each student in the group writes a different word at the top of a piece of paper. Words include electricity, bulb, wire, and battery. Students write something they know about the word and then pass the paper to their right. Each student now has one of the other words to write about. They continue to write and pass the paper until the time is up.

RISK-TAKING

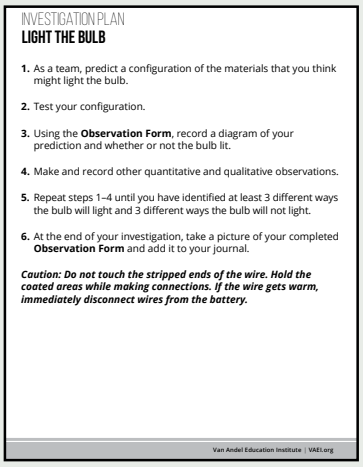
Add all ideas, even misconceptions, to the class list. If something is questionable, place a question next to it and explain that we should revisit it later. Telling students their personal knowledge is incorrect does not cause them to change it. Instead, confront misconceptions at the appropriate time in the investigation. Often this will be during data analysis and explanation.

Investigation Plan

Students perform trials and draw schematic diagrams to determine how to light their bulbs.

- Divide students into teams. Give each team a bag containing a D Cell battery, 2 wires, and a small bulb.
- As a class, determine how to draw and represent the battery, wire(s), and light bulb.
- Make sure all the parts of the bulb are clearly labeled (glass, wire or filament, metal bump, metal screw part, metal base, black belt).
- Distribute Student Investigation Plan.
- Challenge teams to use these materials to get the bulb to light.
- Have students observe and record a diagram, a prediction, and whether or not the bulb lit for each configuration they try.
- Encourage them to record additional qualitative data (dim, bright, heat, etc.).
- Continue until students have identified at least 3 ways the bulb will light and 3 ways the bulb will not light.
- Have students join with another team to compare and combine observations.

Sample Representation



INVESTIGATION PLAN

LIGHT THE BULB

1. As a team, predict a configuration of the materials that you think might light the bulb.
2. Test your configuration.
3. Using the **Observation Form**, record a diagram of your prediction and whether or not the bulb lit.
4. Make and record other quantitative and qualitative observations.
5. Repeat steps 1–4 until you have identified at least 3 different ways the bulb will light and 3 different ways the bulb will not light.
6. At the end of your investigation, take a picture of your completed **Observation Form** and add it to your journal.

Caution: Do not touch the stripped ends of the wire. Hold the coated areas while making connections. If the wire gets warm, immediately disconnect wires from the battery.

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Investigation Plan

Caution: Do not touch the stripped ends of the wire. Hold the coated areas while making connections. If the wire gets warm, immediately disconnect wires from the battery.

HABITS OF MIND

Ask students which of these habits of mind they think will help them most with the investigation:

- Curiosity
- Creative thinking
- Perseverance
- Self-direction
- Openness to new ideas
- Critical thinking
- Adaptability
- Integrity

They should review their choices when the investigation is over and determine if this was the habit of mind that helped them the most or if it was another.

INTEGRITY

Check the setups and encourage students to record their data correctly and ethically.

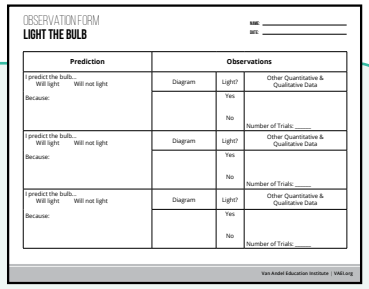
STUDENT CHOICE

Allow students to determine their own designs and ways to record and present their data.

Observation

Students document their observations.

Ask students to record their observations using the Observation Form.



OBSERVATION FORM

LIGHT THE BULB

Prediction	Observations		
I predict the bulb... Will light / Will not light Because:	Diagram	Light? Yes / No	Other Quantitative & Qualitative Data Number of Trials:
I predict the bulb... Will light / Will not light Because:	Diagram	Light? Yes / No	Other Quantitative & Qualitative Data Number of Trials:
I predict the bulb... Will light / Will not light Because:	Diagram	Light? Yes / No	Other Quantitative & Qualitative Data Number of Trials:

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Observation Form

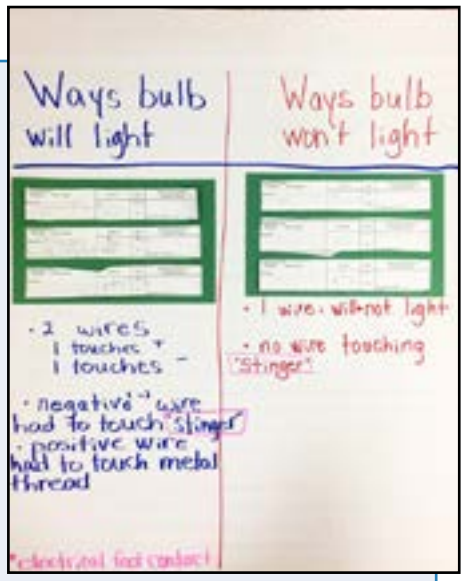
Part 3

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 cut up their data sheets into strips for each trial so they are easier to organize and move around.
- Have students **interpret** what the identified patterns or trends mean.
- Ensure they have enough data that it can be used as evidence to support a claim.



Sample Data Analysis

CRITICAL THINKING

Have students decide how to organize and represent the data. Guide them as needed in determining the most effective organization and representations. Ask questions such as, "Would that be clear to someone from another team?" and "Is there anything in your representation that might be confusing?"

Secondary Knowledge

Students use secondary sources to help understand patterns in sunrise and sunset times.

Use these resources (or your own) to develop students' understanding of electrical currents and circuits. After reviewing these resources, students should glean the concept of a circuit. They should also be aware of the source of the energy and when it is transferred to heat and light.

- Diagram of a bulb
- Discovery Kids: Electrical Circuits
- Explain That Stuff: Electricity
- BBC Bitesize: Electrical Circuits

Use these resources during or after the investigation as appropriate.

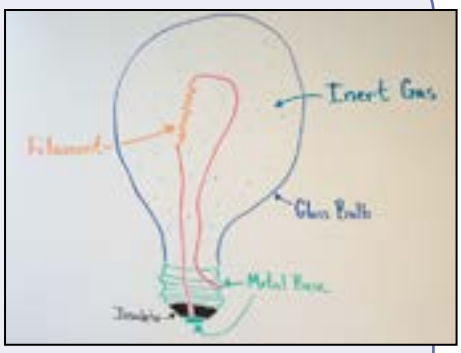


Diagram of a Bulb

PERSEVERANCE AND CURIOSITY

If students had success in lighting the bulb, use the secondary resources after the investigation to satisfy their curiosity about why sometimes the bulb lit and sometimes it didn't. If the students struggled with getting the bulb to light, use the secondary resources to encourage persistence as they learn about the parts of a light bulb and then return to their investigation plan. This demonstrates to students the nonlinear nature of the science process.

Explanation

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

- Have students use what they've discovered from the analyzed data to write an explanation that answers their investigation questions. Students may wish to use the Explanation prompt as a guide. Have them write their explanation in their journal.
- Have students develop a Claim to answer the question: How can a bulb, battery, and wire(s) be connected to light the bulb?
- 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

We claim that a bulb, battery, and wire can be connected to light a bulb if one wire is attached from the negative end of the battery to the metal screw part of the bulb (side of the base of the bulb) and the other wire is attached from the positive end of the battery to the metal bump on the bottom of the bulb.

Evidence

The evidence that supports our claim is shown in the drawing of the third setup we tried. The system is connected as we described in the claim. The bulb lit when we connected it this way.

The other systems that lit were connected in a similar way. The difference was, instead of one of the wires, either the bottom of the bulb or the side of the base was pressed directly against one of the ends of the battery.

Reasoning

Investigation: We did at least 2 trials for each of the investigation setups that lit. Three of our setups did light with a total of 2 trials. We followed the plan. We made sure our bulb worked, the battery was good, and the ends of the wire were clean. We were careful to connect our wires as shown in our diagram. We also took turns lighting the bulb for each setup to be sure the bulb would light. We carefully analyzed our data to determine what caused the bulb to light. We arranged our data to show which configurations caused the bulb to light and which didn't. This helped us discover that in order for the bulb to light, the wire had to be connected from the negative end of the battery to the metal screw part of the bulb.

Science: We learned from readings and class discussion that in order for a bulb to light, there must be a complete circuit. Electricity must flow from one end of the battery, through the bulb, and back to the battery. The wires must make a complete circle or circuit to light. This supports our claim.

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

HABITS OF MIND

Earlier, you asked students which habit of mind students felt they would need to utilize in this investigation. Revisit this idea by asking students which habits of mind were most useful after all. Ask students to explain their choices.

DISCOURSE

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

Evaluation

- Ask students how confident they are in their results.
- Ask what question they would like to pursue next.

Part 4

INVESTIGATION ASSESSMENT AND EXTENSION

Application

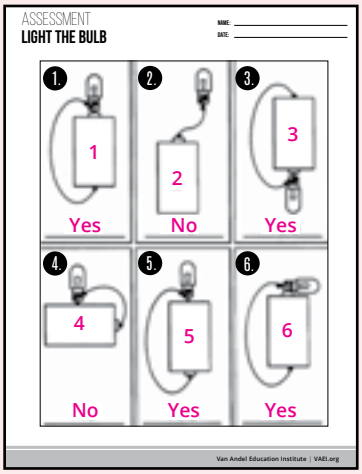
Students demonstrate understanding by identifying complete circuits and by applying their learning in multiple contexts.

- Have students apply their learning by answering the question: *What other examples can you think of where energy is being transferred? (from a battery to a moving toy; from a battery to a talking or singing doll; from a car battery to the starter; from a room outlet through a two-prong plug in running any home appliance.)*
- Now that students understand the elements of an electric circuit, they can use this knowledge to design and build simple circuits themselves. Explore several circuit projects for beginners here: *http://circuitdigest.com/electronic-circuits*
- In this video segment, students use electric circuits to create door alarms out of a variety of materials: *http://wgvu.pbslearningmedia.org/resource/phy03.sci.phys.mfw.zalarm/designing-electric-circuits-door-alarm/*

Assessment

To assess understanding, give students the circuit diagram Assessment and have them identify and explain which should and should not light. Also, evaluate their explanation on how well they:

- describe the transfer of energy by electric currents producing light.
- describe the presence of electric currents flowing through wires linking one form of energy (battery) to another (light).
- provide evidence of how energy can be transferred from electric current to light.



Assessment

CRITICAL THINKING

Diagrams that the students haven't tested may be presented to the students, forcing them to apply their learning about circuits to these new diagrams. They should be able to determine if there is a complete circuit through their learning and critical thinking abilities.

Take This Lesson Across the Curriculum

Show Time!

The Academy Awards honor the year's greatest achievements on the silver screen. But your classroom has achievements to celebrate as well. In this project, you and your students will produce your own awards show!

Reading/Language Arts	Math	Science	Social Studies
Make Your Case Write opinion pieces supporting your choices for this year's winners. CCSS.ELA-LITERACY.W.4.1	**Count the Votes** When the votes are in, use your understanding of number sense to compare the numbers and determine the winners. CCSS.MATH.CONTENT.4.NBT.A.2	**Light the Bulb** We need lights to produce the show, so let's understand how electrical circuits work to ensure the lights don't go out on our big night. NGSS: 4-PS3-2	**Do Your Part** We want the awards to be fair and just, so let's make sure the voting public has the necessary information to vote knowledgeably. NCSS: D2.Civ.2.3-5

Intruder Alert!

Sometimes you just need some alone time. In this project, students will contrast the themes of abandonment and privacy as they learn the math and science skills needed to design and build an alarm system for their bedroom door. They'll then take their design to the marketplace to see if there are any buyers!

Reading/Language Arts	Math	Science	Social Studies
All Alone Use the novel, *The Secret Garden*, to discuss themes of isolation and abandonment. Compare that with a natural desire for privacy. CCSS.ELA-LITERACY.RL.4.2	**It's in the Angle** Use your understanding of angles to design and install your alarm system on your bedroom door. CCSS.MATH.CONTENT.4.G.A.1	**Light the Bulb** Understand how electrical circuits work so you can design an alert system to light up when someone tries to open your bedroom door. NGSS: 4-PS3-2	**Do Your Part** Is there a market for your alert system? Articulate the benefits of your system and determine what classmates would be willing to pay for it. NCSS: D2.Eco.1.3-5

For additional lessons or to customize this lesson, go to www.nexgeninquiry.org.

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DATE: _____

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		Yes No	Number of Trials: _____
I predict the bulb... Will light Will not light Because:	Diagram	Light?	Other Quantitative & Qualitative Data
		Yes No	Number of Trials: _____
I predict the bulb... Will light Will not light Because:	Diagram	Light?	Other Quantitative & Qualitative Data
		Yes No	Number of Trials: _____

ASSESSMENT

LIGHT THE BULB

NAME: _____

DATE: _____