SOLAR SCIENCE STATION LAB

High School Lesson Plan

LESSON OVERVIEW:

The focus of this activity is utilizing the Solar Science Station as a tool for science discovery. The Station can be used in a variety of contexts to highlight the content that is most important to your course of study. It could easily be used to explore electricity, solar photovoltaics, or the steps of the scientific method. At the high school level, there are multiple avenues to take. First, students could be asked to design their own investigation of variables. Second, students could analyze the cumulative impacts of multiple variables. Or third, if you feel that your class is not at this level yet, feel free to use the middle school level lesson plan. It could still provide an engaging and rewarding experience for them. Additionally, this could be done in small groups with multiple Solar Science Stations or as a whole class activity with one Station.

LEARNING OUTCOMES:

Learners will be able to explain the processes of solar photovoltaics.
Learners will be able to apply the scientific method.
Learners will be able record and synthesize data.
Learners will be able to apply their knowledge of circuit function.

TIME:

At least 3 45-minute periods. More time may be needed for building background knowledge regarding circuits, scientific method or solar photovoltaics.

MATERIALS:

- Science stations
- Sunny location
- A protractor
- Pen / pencil
- Timer
- Graph paper

STANDARDS

NEXT GENERATION SCIENCE STANDARDS

CROSSCUTTING CONCEPTS EMPHASIZED

1. Patterns
2. Cause and Effect: Mechanism and Explanation
3. Scale, Proportion, and Quantity
4. Systems and System Models
5. Energy and Matter: Flows, Cycles and Conservation
6. Structure and Function
7. Stability and Change

SCIENTIFIC AND ENGINEERING PRACTICES

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

HS-PS3 Energy

Students who demonstrate understanding can:

HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.
HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).
HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.

HS-ETS1 Engineering Design

Students who demonstrate understanding can:

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.
HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

COMMON CORE MATH

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
4. Model with mathematics.

COMMON CORE READING

College and Career Readiness Anchor Standards for Reading (6-12)

7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words.
8. Delineate and evaluate the argument and specific claims in a text, including the validity of the reasoning as well as the relevance and sufficiency of the evidence.

WRITING

College and Career Readiness Anchor Standards for Writing (6-12)

1. Write arguments to support claims in an analysis of substantive topics or texts, using valid reasoning and relevant and sufficient evidence.
2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content.
3. Write narratives to develop real or imagined experiences or events using effective technique, well-chosen details, and well-structured event sequences.
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.
10. Write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

SOCIAL STUDIES – Texas Science, Technology, and Society standards

High School (various grades)

The student understands the impact of science, technology, and the free enterprise system on the economic development of the United States.
The student understands the influence of scientific discoveries, technological innovations, and the free enterprise system on the standard of living in the United States.
The student understands how major scientific and mathematical discoveries and technological innovations have affected societies from 1750 to the present.
The student understands how current technology affects human interaction.
The student understands the impact of advances in science and technology on government and society.

PROCESS:

1. Depending on your class' previous experiences, you may want to engage them with a background video or reading on one of the following: circuits, scientific

method solar photovoltaics or the scientific method. You can find age-appropriate readings to build background knowledge at BrownDogGadgets.com.

2. If your students are self-directed enough, you may want to use a blank copy of the Science Station High School Student Page and encourage students to design their own scientific investigation based on which variables they would like to test. It can be an interesting formative assessment of their inquiry skills even if they do not actually pursue the investigation.

3. Start with presenting one of the Research Question to the class:

> Which variable (angle, direction, hour or season) most impacts the voltage produced by the science station?

While the process of collecting data to compare seasons may feel daunting, it is an interesting exercise for students to pursue a long-term, reoccurring data collection process. Particularly in the study of climate and climate change, the realization of researchers' patience may be a crucial learning outcome.

Probably more likely is testing angle, direction and hour of day. By having half of the groups in any given class testing the optimal angle, half of the groups testing the optimal direction to face, and collecting data over the course of a day, it would be possible to combine all of that data into a theoretical peak angle, direction and hour of the day.

4. Help build some background knowledge via a video such as this one from TedEd: http://ed.ted.com/lessons/why-aren-t-we-only-using-solar-power-alexandros-george-charalambides. Use information from the video to answer the question in the BACKGROUND KNOWLEDGE section of the student page: "How does a solar panel work?" Then have students "Draw a sketch of a solar panel", including its main structural components.

5. Remind or instruct students about what a hypothesis is. Their hypothesis should be making a prediction in order to answer the research question.
The Independent Variable is what we are changing; the Dependent Variable is what we are measuring as an outcome. The comfort level for you and your students may dictate the terms that you use. Regardless, discuss the hypothesis as a class. *If the panel angle changes, then voltage will stay the same.* is a great example of a potential hypothesis. You may either have students write their own hypotheses and then share out or write a hypothesis together as a class. Either way, write it as an If..., then... statement.

6. Read through the Materials list with students. You may want to delete the list from their page and have the students write in the materials: Solar Science Stations, a sunny location, a protractor, pen/pencil, and a timer.

7. Read through the procedure either individually, in small groups, or as a class.

8. Distribute the Solar Science Stations and have students look at how their diagram matches the real physical Stations.

9. Assign the roles of a timekeeper, a voltage reader for each station, a writer, and recorder for everyone else.

10. Assign a unique angle or direction for each individual Station. Have students use the protractor and the angle markings on the side to set the angles.

11. Find a sunny place to set up your stations, keeping them covered from sunlight. You will want a place that can accommodate all of your groups of students.

12. Project or otherwise display the data table on the front white board so your various student groups can all share the data.

13. Have all of the student groups record the voltage as baseline data at 0 minutes.

14. The timer should start the stopwatch, letting everyone know when it has been 2 minutes. At 2 minutes, have the readers look at the voltage on their solar station. The writer should then write the amount on the front board. Make sure to get the data in the right combination of time and angle! The recorders, everyone else, should be carefully recording the data for all of the groups' angles.

15. Continue until minute 12. You may extend or shorten the time based on your time available. You would then want to alter the data tables as well.

16. Once all of the data is collected, your students may need a few minutes to make sure that everyone has their data collected. Ask students to look at their data. This may be a great opportunity for a think/group/share with these questions:

a. Which group has the highest voltage at minute 6?
b. Which group has the highest voltage at minute 12?
c. Did it change or was it always the highest?
d. Why do you think that this particular panel angle had the highest voltage?

17. Next, graph the data.

18. Explain to the students that the Independent Variable will be placed on the horizontal (x) axis. The Dependent Variable will be placed on the vertical (y) axis.

19. Once the data points are placed on the graph, students can connect them and see the change over time.

20. Students can move on to writing the Conclusion section. Once students finish, a discussion about their hypotheses and results should help highlight the class' process. Listen especially closely to the students' answers to the last Discussion section questions:

What are some possible improvements we could make to the lab?
What is something slightly different that could be tested next time?

Their input can be really enlightening regarding making improvements for future labs and the next time this topic is taught.

21. If you are requiring students to complete a formal lab report, then that would be the last stage of the Solar Science Station.