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Instructional Title: The Solar Shuffle
Subject Area: General Science, Chemistry, Environmental Science
Unit Duration: One 50-minute class period
Focus Grade Level: 11-12th grade
Grade Level Range: 4th -12th

After a discussion of how solar panels work, groups of students are challenged to represent the process of how a solar panel works through a physical demonstration of electrons moving through a circuit. This lesson is designed to get students up and moving and simultaneously help teach atom interactions.

MATERIALS & EQUIPMENT

- Access to PowerPoint and projector
- Props (plastic tablecloths, costumes, construction paper, etc.) are helpful in giving students motivation in performing the task

PREREQUISITE STUDENT KNOWLEDGE

It is helpful for students to have a basic understanding of how atoms are arranged in a lattice structure. However, if this is not the case, there are available modifications to help students learn this information.

LEARNING OBJECTIVE(S)

- Students will be able to physically demonstrate the way an electron moves through a circuit.
- Students will be able to circle a bond, an atom, and an electron in a picture.

VOCABULARY

Electron	A negatively charged subatomic particle
Atom	The smallest unit of an element: made of protons, neutrons, and electrons
Bond	An interaction between electrons that holds atoms together.
Circuit	A pathway for electrons to flow
Hole	A gap in the lattice structure left behind when an electron breaks out of a bond
P silicon	Silicon that has extra holes
N silicon	Silicon that has extra electrons
P-N Junction	The border between p silicon and n silicon

INSTRUCTIONS

Ask students to identify silicon on a periodic table. Talk about some of the characteristics of silicon--emphasize its ability to create covalent bonds and its semiconductor characteristics.

Show the How Do Solar Panels Work? by Richard Komp

Choose one option to support students in filling out the How Do Solar Panels Work? Worksheet (teacher copy provided here):

- Option 1: Lecture using the How Do Solar Panels Work? PowerPoint as students answer questions
- Option 2: Use Kahoot to review the introduction to how solar panels work. Follow up with the worksheet to ensure that the students have the information written down as they work.
- Option 3: Give the students a short lecture, using the worksheet to guide students.
- Option 4: Give the students the worksheet and ask them to do research to fill it out on their own. Much of the worksheet should be recall from the video, but they would need to do some research to complete all the questions. If you choose option 3, you can assign the research as homework.

Then:

- Ask students to create a kinesthetic demonstration of how a solar panel works. This demonstration will help students remember how a solar panel works in a circuit and relate their world to a microscopic scale. Their demonstrations could be a dance, a series of hand movements, or small skit.
- If appropriate, have students do the demonstration in class. However, some students may feel more comfortable recording it and sending it to you.

At any point, the teacher could give a short lecture on how solar panels work. The following structure might be useful for organizing this lecture:
https://docs.google.com/document/d/1ytHGpbrlXpmsGrCoxOgwGweAhFRMsXru_SsTn2_eThE/edit?usp=sharing

ASSESSMENT

Pre-Assessment

- Teachers can use the introductory discussion about silicon as an assessment of the knowledge that students already have about how solar panels work.

Formative Assessment

- The worksheet serves as a formative assessment in order to monitor progress as students work.

Summative Assessment

- The kinesthetic demonstration serves as a summative assessment. Students need to be able to explain how the steps of their demonstration explain how solar panels work. See the How Do Solar Panels Work? Rubric to evaluate student understanding.

EXTENDED EXPERIENCES

Instead of a kinesthetic demonstration, you could choose to have students write stories, create comics, or even write songs about how solar panels work.

An alternative assessment could be to have your students create board games that teach each other how solar energy works, and what role solar energy has in society. See The Board Game Project for a rubric and accompanying questions that will assist your students in their game creation. You will likely need 2-3 days for game creation if you use this as an assessment, and 5-6 days for game creation if you give your students less prerequisite knowledge and use it as a research project.

Next Generation Science Standard(s)

- *HS-ESS3-4. Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.*
- Constructing Explanations and Designing Solutions
- Systems and System Models

References

Komp, Richard. “How Do Solar Panels Work? - Richard Komp.” YouTube, TEDEducation, 5 Jan. 2016, www.youtube.com/watch?v=xKxrkht7CpY

How Do Solar Panels Work?

1. Sunlight is a type of _____ that comes to Earth in energy packages called _____. _____ appear to us as different colors because they have _____. _____ have more energy, while _____ have less energy. Draw a red photon and a blue photon.

2. Most solar panels are made of _____, which is a _____. A _____ carries energy better than an _____ like _____, but worse than a _____ like _____. _____ in solar panels is organized in a lattice. Draw a lattice of silicon below. Label the bonds on the lattice. Label the electrons in the bond.

3. When the electrons are not excited, each is joined with the hole in a bond. There are two types of silicon: __-type and __-type. __-type silicon has _____ in it, which means that it has extra _____ and is _____. __-type silicon has _____in it, which has extra _____and is _____. The process of adding boron or phosphorus is called_____. Draw how the p-type and n-type silicon are layered in the silicon.

4. When a photon from the sun transfers its energy to an electron (which is called "exciting" an electron), it _____.The high energy electron exits from the _____ silicon and flows through the _____ and the _____, and then leaves the panel and goes into the _____. Draw a solar cell and label the busbar and finger. In the circuit, the energetic electron powers appliances like _____. As it does this, it _____.

5. The _____ energy electron returns to the solar panel and joins together with a _____ to create a bond in the _____. Draw a circuit and show the electron travelling through the circuit from the N-type silicon through the circuit (put a light bulb in the circuit) to the P-type silicon.

Board Game Project

Category	Excellent	Average	Below Average
Content	All content shared is complete and accurate. Accompanying questions are completely and correctly filled out.	Most content shared is complete and accurate. Accompanying questions are mostly correctly filled out.	Content shared is not complete and accurate. Accompanying questions are not filled out.
Presentation	Presenters clearly and professionally present their games/activities to their audience. They have an understanding of the concepts and can explain how their activity relates to the power source.	Presenters are not clear as they present their games/activities to their audience, or they have an incomplete understanding of the concepts and cannot fully explain how their activity relates to the power source.	Presenters do not present, or present an activity or game completely unrelated to their topic.
Contribution	I worked to the best of my ability every day. My project is a reflection of my best effort.	I mostly worked to the best of my ability, but sometimes got distracted. If I had worked harder, my game would have been better.	I mostly did not work to the best of my ability. I spent a majority of my time off-task, and my final project is a reflection of that.
Sources	Sources are noted on any written documents provided. Sources are complete.	Sources are provided in a separate document but not cited within the project. They are partially complete.	Sources not provided, or are incomplete.

Renewable Energy Notes

1. How does solar energy work? (https://www.visualcapitalist.com/animation-how-solar-panels-work/ may be helpful)
2. What important information do people need to know in order to understand solar energy?
3. How much solar energy does Arizona use?
4. List three positive aspects about solar energy.
5. List three challenges or negative aspects about solar energy.
6. Identify three stakeholders who would be interested in more solar energy being installed.
7. How would an increased use of solar energy affect global warming and climate change?

Game Creation

1. What kind of game will you make? Wikipedia has a list of board games that may give you ideas. Consider if you want your game to be a board game, physical game, or otherwise.
2. Write an introduction for your game. What is the main idea of your game? What is the main theme?
3. Write an objective for your game. Explain to your players how they will win the game.
4. Write out instructions for your game. How do people take turns? How many people can play? How do people "progress" in the game? Can you sabotage other players?
5. How will this game teach players about solar energy?

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