LESSON PLAN

How Solar Panels Work

Grade Level:
7-8

Subjects:
Science

Length:
2-3 Class Periods

How Solar Panels Work

INTRODUCTION

In this lesson, students will learn that sunlight is the underlying component of energy use. Students will examine atoms as the basic building blocks of matter, including electrons, protons, and neutrons, and explore how these building blocks are used with the element silicon (Si) to produce energy. Students will perform two interactive activities to further their understanding of this concept. Finally, students will investigate careers in solar energy and report on the growing solar industry.

LESSON OVERVIEW

Grade Level & Subject: Grades 7 – 8: Science

Length: 2 – 3 class periods

Objectives:

After completing this lesson, students will be able to:

- Identify the basic building blocks of matter
- Understand how electrons, one such building block of matter, are required for solar energy production
- Demonstrate a basic understanding of how sunlight is converted into electricity, with a particular focus on the role of silicon
- Recognize multiple career pathways in solar energy

National Standards Addressed:

This lesson addresses the following National Science Education Standards from the National Academies of Science:[1]

- **Content Standard: NS.5-8.5 SCIENCE AND TECHNOLOGY**
  In grades 5-8, students should develop:
  - Abilities of technological design
  - Understanding about science and technology
- **Content Standard: NS.5-8.7 HISTORY AND NATURE OF SCIENCE**
  In grades 5-8, students should develop an understanding of:
  - Science as a human endeavor
  - Nature of science
  - History of science

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[1] National Science Education standards are from the National Academies of Science, 2011: http://www.nas.edu. National Science Education standards can also be found at http://www.education-world.com/standards.

- **Content Standard: NS.5-8.6 PERSONAL AND SOCIAL PERSPECTIVES**
  In grades 5-8, students should develop an understanding of:
  - Populations, resources, and environments
  - Risks and benefits
  - Science and technology in society

This lesson addresses the following National Standards for Arts Education from the Consortium of National Arts Education Associations:[2]

- **Content Standard: NA-VA.5-8.5 REFLECTING UPON AND ASSESSING THE CHARACTERISITICS AND MERITS OF THEIR WORK AND THE WORK OF OTHERS**
  Achievement Standard:
  - Students compare multiple purposes for creating works of art
- **Content Standard: NA-VA.5-8.6 MAKING CONNECTIONS BETWEEN VISUAL ARTS AND OTHER DISCIPLINES**
  Achievement Standard:
  - Students describe ways in which the principles and subject matter of other disciplines taught in the school are interrelated with the visual arts

21st Century Skills:

This lesson addresses the following 21st Century Skills from the Partnership for 21st Century Skills by asking students to:[3]

- Focus on 21st century skills, content knowledge, and expertise.
- Build understanding across and among core subjects as well as 21st century interdisciplinary themes.
- Communicate interactively: teaming, collaboration, individual responsibility, social responsibility, and interactive communication.
- Engage with real-world data, tools, and experts they will encounter in college, on the job, and in life. Students learn best when actively engaged in solving meaningful problems.
- Investigate and analyze environmental issues, and make accurate conclusions about effective solutions.
- Use entrepreneurial skills to explore career options.

Key Questions:

- Can students demonstrate comprehension of the basic building blocks of matter?
- Can students understand that electrons and silicon play a major role in producing solar energy?
- Can students state several career opportunities related to solar energy production?

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[2] National Art Education standards are from the National Art Education Association, 2011: http://www.arteducators.org. National Art Education standards can also be found at: http://www.education-world.com/standards.

[3] "P21 Framework Definitions." Partnership for 21st Century Skills, 2011. http://www.21stcenturyskills.org/documents/P21_Framework_Definitions.pdf.

Materials Needed:

- **Reproducible #1 – The Importance of the P-N Junction**
- **Reproducible #2 – Photon Scramble Comprehension**
- **Reproducible #3 – Solar Careers Investigation: List of Careers**
- **Reproducible #4 – Solar Career Investigation**
- 8 blue "electrons" for each student.
- 8 red "protons" for each student
- 8 yellow "neutrons" for each student
- Toothpicks
- 6-10 ping pong balls
- 2 small-medium-sized bowls or buckets
- Multiple pairs of dice

Assessment:

Students will be assessed through the following activities:

- Participation in class discussion
- Ability to successfully create models of atoms
- Participation in the game and class discussion
- Completion of a career pathway report

LESSON BACKGROUND

Relevant Vocabulary:

- **Alternating Current (AC):** An electric current that reverses its direction at regularly recurring intervals.[4]
- **Atom:** The basic unit of a chemical element.[5]
- **Direct Current (DC):** An electric current flowing in one direction only and substantially constant in value.[6]
- **Electron:** A stable subatomic particle with a charge of negative electricity found in all atoms. Acts as the primary carrier of electricity in solids.[7]
- **Neutron:** A subatomic particle of about the same mass as a proton but without an electric charge. Present in all atomic nuclei except those of ordinary hydrogen.[8]

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[4] *Alternating Current*. Merriam Webster Online Dictionary. Retrieved May 23, 2011 from http://www.merriam-webster.com/dictionary/alternating%20current.
[5] *Atom Entry*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1223605#m_en_us1223605.
[6] *Direct Current (DC) Entry*. Merriam Webster Online Dictionary. Retrieved May 23, 2011 from http://www.merriam-webster.com/dictionary/direct%20current.
[7] *Electron Entry*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1243541#m_en_us1243541.

- **P – N Junction:** The area where electricity is first generated in a semiconductor, such as a solar cell. More specifically, it is the boundary between p-type and n-type materials in a semiconductor device and functions as a rectifier, or conversion space, for electrical generation.[9]
- **Photon:** The basic unit of light. A photon carries energy but has zero rest mass.[10]
- **Proton:** A stable subatomic particle occurring in all atomic nuclei with a positive electric charge equal in magnitude to that of an electron, but of opposite sign.[11]
- **Solar Panel:** A panel designed to absorb the sun's rays as a source of energy for generating heat or electricity.[12]

Background Information:

Ask students how electricity is moved or delivered. They will likely answer through wires.

While an electrical current is indeed an electric charge carried by electrons (negatively charged particles) through a medium (such as a wire), there are other methods for moving electricity, such as lightning jumping through the air. Encourage students to take this information a step further. By investigating the role of light and its relationship to the atomic structure of certain elements, students can begin to understand the basic functionality of solar-based electricity.

A solar panel is comprised of smaller photovoltaic cells. The word photovoltaic comes from a combination of the ancient Greek "phos," meaning light, and "volt," named for Alessandro Volta, an Italian physicist known for his pioneering work in electricity. Silicon, an element on the Periodic Table, is the typical semiconductor material in a photovoltaic cell. A semiconductor has properties of an electric conductor (such as a metal) at high temperatures, while it takes on the lower conductivity properties of an insulator at low temperatures. Silicon is the element most commonly used as a semiconductor and is typically employed in electronic circuitry.

A typical silicon atom has 14 electrons (negatively charged particles) arranged in three different shells. The outer shell is half full with four electrons. However, as atoms try to fill their electron shells to find stability, a typical silicon atom will usually share electrons with four other silicon atoms, thereby filling the electron field and creating a crystalline silicon molecule.

The creation of electricity from sunlight involves the reaction that atoms undergo when exposed to energy – in this case photons from the sun. When enough energy is absorbed by a silicon molecule, it eventually dislodges an electron. This electron is then free to float – along with its negative charge – until it finds another place to land. More literally however, the electron is urgently seeking a free

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[8] *Neutron Entry*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1271168#m_en_us1271168.
[9] *P-N Junction*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1278974#m_en_us1278974.
[10] *Photon Entry*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1277719#m_en_us1277719.
[11] *Proton Entry*. "Oxford University Press Online Dictionary." Retrieved May 26, 2011 from http://oxforddictionaries.com/view/entry/m_en_us1281338#m_en_us1281338.
[12] *Solar Panel Entry*. "Oxford University Press Online Dictionary." Retrieved May 31, 2011 from http://oxforddictionaries.com/definition/solar+panel?region=us.

place to land. It can be useful to think of them not so much as floating, but frenetically, *electrically* seeking a new home.

Yet, as the creation of electricity is dependent upon the movement (electrical current) of electrons, the stability of silicon molecules is not conducive to this action. The release of electrons by the application of energy is more easily done if the molecules are instable, meaning the electron shells are not completely filled. That is why impure, or "doped," silicon is used in the production of photovoltaic cells. This impure silicon is created through the addition of both boron and phosphorus to the silicon molecule. This forms unstable electron shells, which require far less energy to dislodge an electron – thereby creating an effective electrical current. Two slices of the doped silicon are placed together to create "sandwich," with the boron-doped and phosphorous-doped silicon constituting either side. This is done because the joining of these two types of silicon essentially creates an imbalance in their charges. In a photovoltaic cell, this imbalance results in an electric field, like a battery or a magnet, and it has a positive and negative terminal. The field forces electrons freed by photons (sunlight) to move only in one direction while searching for places to bind. The movement of electrons through this space creates a current which, when connected to an external load, creates electricity.

Resources:

- **Solar** – *Department of Energy*
  http://www.energy.gov/energysources/solar.htm
- **Solar Energy Basics** – *National Renewable Energy Laboratory*
  http://www.nrel.gov/learning/re_solar.html
- **Solar Energy Research and Development** – *Department of Energy*
  http://www.energy.gov/hubs
- **Chemistry and Solar Energy Research** – *Brookhaven National Laboratory*
  http://www.bnl.gov/chemistry/research_programs.asp
- **Solar Photochemistry Research Conference** – *Department of Energy*
  http://science.energy.gov/~/media/bes/csgb/pdf/docs/solar_photochemistry_2010.pdf
- **Semiconductors in Photovoltaic Cells** – *Department of Energy*
  http://www.eere.energy.gov/basics/renewable_energy/semiconductors.html
- **Careers in Solar Power** – *Bureau of Labor Statistics*
  http://www.bls.gov/green/solar_power
- **How do Photovoltaics Work?** – *NASA*
  http://science.nasa.gov/science-news/science-at-nasa/2002/solarcells

LESSON STEPS

Warm-up: *Lights, Camera, Solar Power!*

1. Begin this lesson by discussing with your class the role of light in their lives.
   a. What is light?
      Collect different ideas from students (such as light bulbs or flashlights) before explaining that light is essentially energy.

   b. What is solar energy?
      Solar energy is the sun's rays (solar radiation) that reach the earth. This energy can be converted into other forms of energy, such as heat and electricity.
   c. What is a solar panel?
      A solar panel is a device designed to absorb the sun's rays as a source of energy for generating heat or electricity.
   d. Why is solar energy used?
      Answers will vary, but may include reducing energy costs, eliminating pollution, etc.

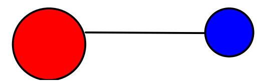
Teacher Preparation

1. For the first activity, distribute toothpicks, 8 protons, 8 electrons and 8 neutrons to each student. Protons and neutrons can be roughly the same size, while electrons should be smaller. The protons, electrons, and neutrons can be represented by different materials - gumdrops, clay, Styrofoam balls, etc. Each particle should be represented by different colors. For the activity below, electrons are **blue**, protons are **red**, and neutrons are yellow; however, any color may be substituted. The particle material should be soft enough to stick toothpicks into. Participate in this activity with the class, or prepare a model beforehand. This will give them a visual reference against which to check their own work.

Activity One: *Atomic Structure*

1. Ask students a few questions to get them thinking about the nature of atoms.
   a. What is an atom?
      An atom is the basic unit of a chemical element.
   b. What is an element?
      An element is a uniform collection of atoms that accounts for all the matter in the universe. The characteristics of an element are determined by the way its atoms are arranged. For instance, gold and silver are elements. Their characteristics are different because their atoms are structured differently.
   c. What is an atom made of?
      Atoms are made of three basic particles: protons, neutrons, and electrons. Electrons carry a negative electrical charge, protons carry a positive charge, and neutrons have no charge.
   d. Explain to students that different combinations of electrons, protons, and neutrons make the different kinds of atoms or matter in our world. Today, they will be making models of several kinds of atoms in order to better understand atomic structure.
2. Hand out materials to students. Ask each student to pick up a piece of the **blue** particle material. Explain that the **blue** particle material is an electron, a subatomic particle with a **negative** electric charge. Where atoms are the building blocks of elements, subatomic particles, such as electrons, are the building blocks of atoms.
3. Now ask students to pick up a piece of the **red** particle materials. Explain that the **red** particle material represents a proton. A proton is a subatomic particle with a **positive** electric charge.
4. Lastly, ask students to pick up a piece of the yellow particle material. Explain that the yellow particle material represents a neutron. Neutrons carry no charge.

5. Tell students that electrons are extremely small and very light. If an **electron** weighed the same as a dime, a **proton** would weigh about as much as a gallon of milk. **Neutrons** and **protons** weigh about the same.
6. Tell students that they are now going to make some atoms by piecing together the different particles. Make sure that students understand that stable atoms have as many electrons as protons, so that their electrical charges balance out. When atoms are out of balance and electrically charged, they will seek stability by gaining or losing electrons.
7. To illustrate this last point, ask students to make hydrogen. Hydrogen has **1 electron**, **1 proton**, and **0 neutrons**. Allow time for students to piece the materials together with a toothpick. Hydrogen is the lightest and most abundant chemical element and accounts for about 75% of chemical elemental mass found in the universe.[13]



Hydrogen Atom

8. Ask students to change their hydrogen atoms to nitrogen atoms. Allow students time to add **6 blue**, **6 red** and **7 yellow** pieces to their hydrogen. Nitrogen can be found in all living organisms. The human body is 3% nitrogen.
9. Ask students to change their nitrogen atoms to oxygen atoms. Allow students time to add **1 electron**, **1 proton**, and **1 neutron** to their nitrogen atoms to make oxygen. Oxygen is the third most abundant element in the universe by mass. Oxygen mixed with 2 hydrogen atoms makes water. All living organisms are made up of water. Humans are approximately two-thirds water.
10. Now that students have an understanding of atomic structure, ask them the following questions to reiterate important points:
    a. What kind of charge do electrons have?
    Negative.
    b. What is an imbalanced atom?
    One that has either too many or too few electrons, resulting in a negative or positive charge.
11. How do imbalanced atoms find stability?
    They seek to lose or gain electrons. (How exactly they do this is too advanced for this particular lesson. The important concept for students to grasp is that imbalanced atoms will shed electrons far more easily than stable atoms.)

Activity Two: *Photon Scramble*

To demonstrate how the movement of electrons at the p-n junction creates an electrical current, students will play a game, similar to musical chairs, which pits teams against each other to create their own electricity. This game will illustrate how electricity is created at the atomic level. To understand how electrons dislodged by the sun's rays create electricity, students will recreate the movement of electrons through the electric field to deposit electricity into an external load.

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[13] "Ask an Astrophysicist: Hydrogen in the Universe." National Aeronautics and Space Agency, 1997. Retrieved May 26, 2011 from http://imagine.gsfc.nasa.gov/docs/ask_astro/answers/971113i.html.

Learning Objective:

- This game will demonstrate how an electrical current is created in a solar panel.

Game Objective:

- To collect more "electricity orbs" than the other team.

Materials Needed per Team:

- 1 bowl or bucket
- Ping pong balls or other such equipment (10 or so)
- 1 die
- 1 desk on which to roll the die and store potential electricity orbs

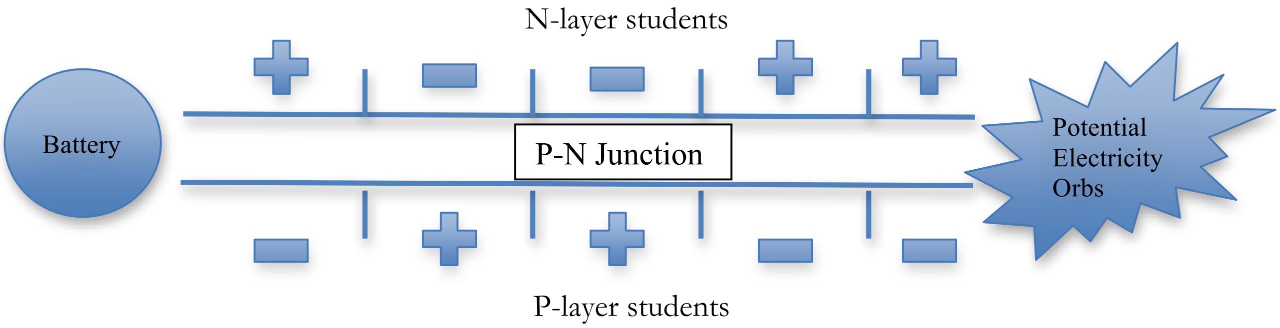
Players:

- P-type silicon team
- N-type silicon team
- Photons (one student at a time)

Setup:

1. Review **Reproducible # 1 – Importance of the P-N Junction** with students before starting this activity, then review the rules of the game.
2. Divide class into 2 or 3 teams with an odd number of students per team (preferably 9 or 11). Arrange each team up as a photovoltaic cell as illustrated below:
    a. Two parallel lines with an equal number of students facing each other. There should be an arm's width between each pair. One side represents the p-type silicon layer; the other side represents the n-type silicon layer. Silicon is the main component of photovoltaic cells.
    b. The remaining student starts as a photon and stands at one end of the lines holding the die.
3. The space between the students, (should be an arm's width) is the p-n junction. This is where the absorption of photon energy occurs.
4. Students should know that the "sandwich" made by the two types of silicon (doped with phosphorus and boron, respectively) is what creates the electric field that forces free electrons to travel in one direction. In this game, the electric field means that students may only move in a clockwise direction. Tell students that they all now represent either negatively charged electrons, or positively charged spaces, both created through the doping of silicon.
5. Place a bowl at the end of the line. The bowl represents a battery or electrical appliance (anything that draws power from the solar panel). At the other end of the line on top of a desk, place the electric orbs balls, which represent potential electricity.

Photo Illustration[14]:



Steps:

1. Before each turn, students facing each other will play "rock, paper, scissors" to determine who is a positively charged space and who is an electron with a negative charge (winner's choice). Students who choose to be electrons should grab an electricity orb from the desk. These students should hold the orbs up for all to see.
2. Next, the teacher will choose a photon absorption number. This number represents the changing environmental conditions (weather, angle of the sun, age of the solar panel, etc.) that are responsible for the rate at which photons make their way into the p-n junction. Students will need to equal this number through rolls of the die before the student representing a photon can be released. The photon absorption number should be changed periodically and posted on the board, which will require the photon to be alert.
    - Students should be made aware that not all photons are absorbed into the p-n junction. In fact, only about 20% ever make it to the electrons; some bounce off the glass coating of a solar panel and others aren't strong enough to dislodge an electron. For instance, if the teacher determines that a photon needs 18 points to be absorbed in the cell, they will have to roll accordingly before they move into the p-n junction.
3. The photon (student) for each team must now roll the die to reach the photon absorption number. The student must roll the die as many times as needed until the sum of the rolls matches the absorption number.
4. Once the photon (student) rolling the die reaches the target photon absorption number or above, the photon student can make his or her way into the middle of the p-n junction (between the parallel lines of students) to be "absorbed." Once in the p-n junction, the photon will quickly choose 3 electrons (students with electricity orbs) to dislodge. The photon will then take one of the electron's places.
    a. Please note that the photon taking an electron's place does not represent what actually happens in a photovoltaic cell. This motion has been added to the game to provide added musical chairs-type motivation for the electrons to move quickly.
5. When electrons are "dislodged," they aim to deposit their electricity orb in the bowl and fill an open space in the p-n junction before they are gone, similar to the game musical chairs. To do this they must step out of their line, away from the p-n junction, and make at least

[14] Image credit: Josh Volinsky. Earth Day Network.

one circuit around the group (passing their starting spot before settling into a new one), while remembering to deposit their electricity orb into the bowl. Remind the electrons that the electric field created by the p-n junction forces them to move in a clockwise direction.

- Explain to students that they have become electrically charged free electrons, dislodged by the energy of the photon, and are desperately seeking a new home. It is this movement that fosters the creation of electricity. Emphasize the correlation between physical movement and electricity. Namely, electricity is generated through the movement of electrons. Thus, the game seeks to emphasize that greater movement can generate greater amounts of electricity in a solar cell or panel.

6. Once all electricity orbs have been deposited into the bowl, there will be one free electron left without a home, that space having been occupied by the photon. At this point, that student becomes the new photon and should begin rolling the die to reach the new absorption number. Meanwhile, the students in the p-n junction should once again determine who will be the electrons. Make sure each of those students is holding an electricity orb.
7. After play has gone on for about 10 minutes, declare the game over and count number of balls in the bowl to determine a winning team. The team that has most efficiently reached the absorption numbers will end up with more electricity orbs in their battery bucket. This should reinforce the concept that better equipment and more favorable environmental conditions will lead to a better photon absorption rate.
8. Have students fill out **Reproducible #2 – Photon Scramble Comprehension** and lead a discussion based on the answers.

Activity Three: *Solar Career Investigation*

1. Use information from the Background Information and Resources sections of this lesson plan to start a discussion with students about the burgeoning solar industry. Lead students through a 5-minute discussion of the various economic and environmental benefits of solar energy and the opportunities for this growing 21st century industry to expand.
   a. How does solar energy help the economy?
   Answers will vary, but solar energy can create jobs, reduce energy costs, etc.
   b. How does solar energy help the environment?
   Answers will vary, but solar energy can reduce our reliance on fossil fuels and reduce various forms of air pollution.
   c. What careers can you name that are currently related to the solar industry?
   Electrician, architect, scientist, etc.
9. Hand out **Reproducible #3– Solar Career Investigation: List of Careers** and **Reproducible #4 – Solar Career Investigation** to continue the examination of the careers in this field.
10. Ask students to choose one career that interests them and they would like to research further.
11. Tell students that they may use the Internet, library materials, or other available resources to individually complete **Reproducible #4 – Solar Career Investigation**.
12. If students do not have enough time to complete this activity in class, allow them to finish the worksheet as homework to turn in the following day.

Extension Activity: *Exploring the Future of Solar Power*

Explain to students that there has been large-scale growth in the solar industry in the last few years in terms of equipment produced, installations completed, and the amount of solar energy generated. The next generation of solar research and development is likely to expand the solar market in several ways. For this extension activity, ask students to research third-generation solar cells and write an essay about the innovations in this quickly progressing field. Students should examine how third-generation solar power differs from previous efforts. Divide the following areas of research among the students:

- Thin film technologies such as CIGS (copper indium gallium selenide-related cell development)
- Cadmium telluride and amorphous silicon
- Silicon nanotechnology
- Organic photovoltaics
- Thermophotonics and use of the infrared spectrum

Students should write a report and then present their findings to the class, focusing on the chances for broader development in their research area in the years to come.

CONCLUSION

Students should leave this lesson understanding that protons, neutrons, and electrons constitute the basic building blocks of matter (atoms) and that silicon plays a major role in harnessing energy from sunlight. Students should also be familiar with a variety of career opportunities available now and in the near future in solar energy production and dissemination.

LESSON PLAN CREDITS

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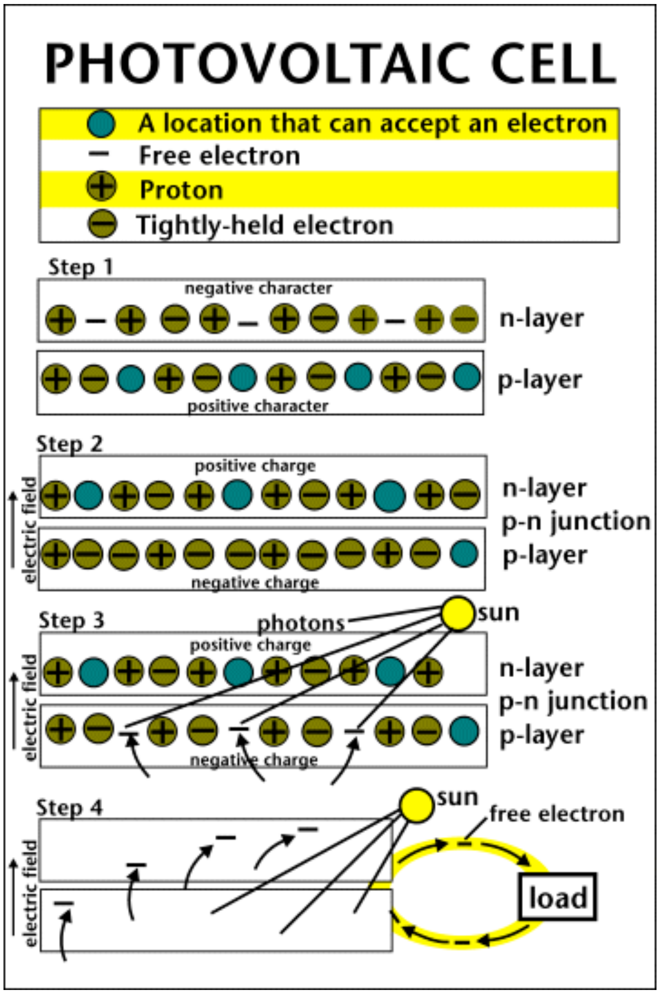
The Importance of the P-N Junction



The P-N junction makes solar energy possible by creating an environment in which the maximum amount of electrons are freed by the sun's energy and forced to travel through an electric field to create usable electricity. [15]

Electricity from sunlight is created when atoms are exposed to energy from the sun, called a photon. Photons are absorbed by atoms just as you would imagine heat from the sun being absorbed by a rock. The rock absorbs the energy and heats up. When the sun sets, the rock releases the energy back into the environment.

When a silicon atom absorbs enough energy from sunlight, it will release an electron. This electron will urgently seek a free place to land. It can be useful to think of the electron as frenetically, *electrically,* seeking a new home. Electrons are released more easily if the molecules are unstable. This is why impure, or "doped," silicon is used in the production of photovoltaic cells.

Silicon doped with boron is known as "P-type" silicon, while "N-type" silicon has been doped with phosphorous. In a photovoltaic cell, these two types of silicon are layered on top of each other, like a sandwich, creating an electric field. Like a battery, this field has a positive and negative terminal. This field also forces electrons freed by photons to move in one direction while searching for places to bind. The rapid movement of electrons through the electric field creates a current which, when connected to an external load (a TV for instance), creates electricity.

REPRODUCIBLES FOR CLASSROOM USE

This lesson plan contains the following reproducible documents for classroom use:

- **Reproducible #1 – The Importance of the P-N Junction**
- **Reproducible #2 – Photon Scramble Comprehension**
- **Reproducible #3 – Solar Careers Investigation: List of Careers**
- **Reproducible #4 – Solar Career Investigation**

Photon Scramble Comprehension

1. How did this game illustrate the production of an electrical current from sunlight?

2. What did the game leave out?

3. Was your level of physical exertion equal to the amount of "electricity" your team produced?

4. Did you figure out a way to work together or was it every electron for himself/herself? What do you think is a more realistic representation of how electrons actually behave?

5. What factors influence the efficiency of solar panels?

6. Why do electrons only flow in one direction?

7. Why does the p-n junction exist in solar panels?

Solar Career Investigation: List of Careers

Name	Description
Architect	Designs, plans, and/or implements various solar projects for individuals, governments or businesses alike. Installs solar-related equipment, such as photovoltaic modules.
Electrical Engineer	Performs electrical installation of solar equipment and assists in getting equipment certified.
Environmental Lawyer	Defends various entities and opportunities related to the promotion and implementation of solar energy.
Environmental Planner	Writes government agency documents and manages environmental projects, such as installing solar projects on federal lands. Often involved in the permitting of projects.
Field Researcher	Collects first-hand knowledge to further the study of solar technologies, including the viability of solar in specific locations.
Fundraiser	Assists an organization in raising funds for solar-related projects.
Government Grant Writer	Writes and evaluates grants for solar energy research and project development opportunities.
Non-profit Director	Educates the public and promotes solar-related opportunities communities nationwide.
Professor	Teaches about solar energy at a college or university. May conduct research on solar-related subjects.
Sales & Accounts Manager	Handles the contracts for clients seeking to install solar energy in their homes or businesses. Often handles tax rebates and other incentives.
Solar Installer	Installs solar-related equipment, such as photovoltaic modules. Develops guidelines and recommendations for the use and promotion of solar power for businesses, organizations and/or governmental entities.
Solar Manufacturer	Produces and sells solar-related equipment.
Solar Policy Analyst	Develops guidelines and recommendations for the use and promotion of solar power for businesses, organizations and/or governmental entities.
Solar Research Technician	Conducts research into the performance, maintenance, and/or development of solar power.
Solar Scientist	Conducts research on new products, materials and/or mechanisms for enhancing solar power.
Systems Engineer	Analyzes and implements ways to integrate solar research and projects into real-world applications.

Name: ______________________________

Date: ______________________________

Solar Career Investigation

Glue/Print Career Image Here

Job Title: ____

Salary: ____

Education/Training/Certification Requirements:

____

____

Workplace Options (Location, Organization, Business):

____

____

____

List of Responsibilities/Duties:

____

____

____

Hours/Week: ____

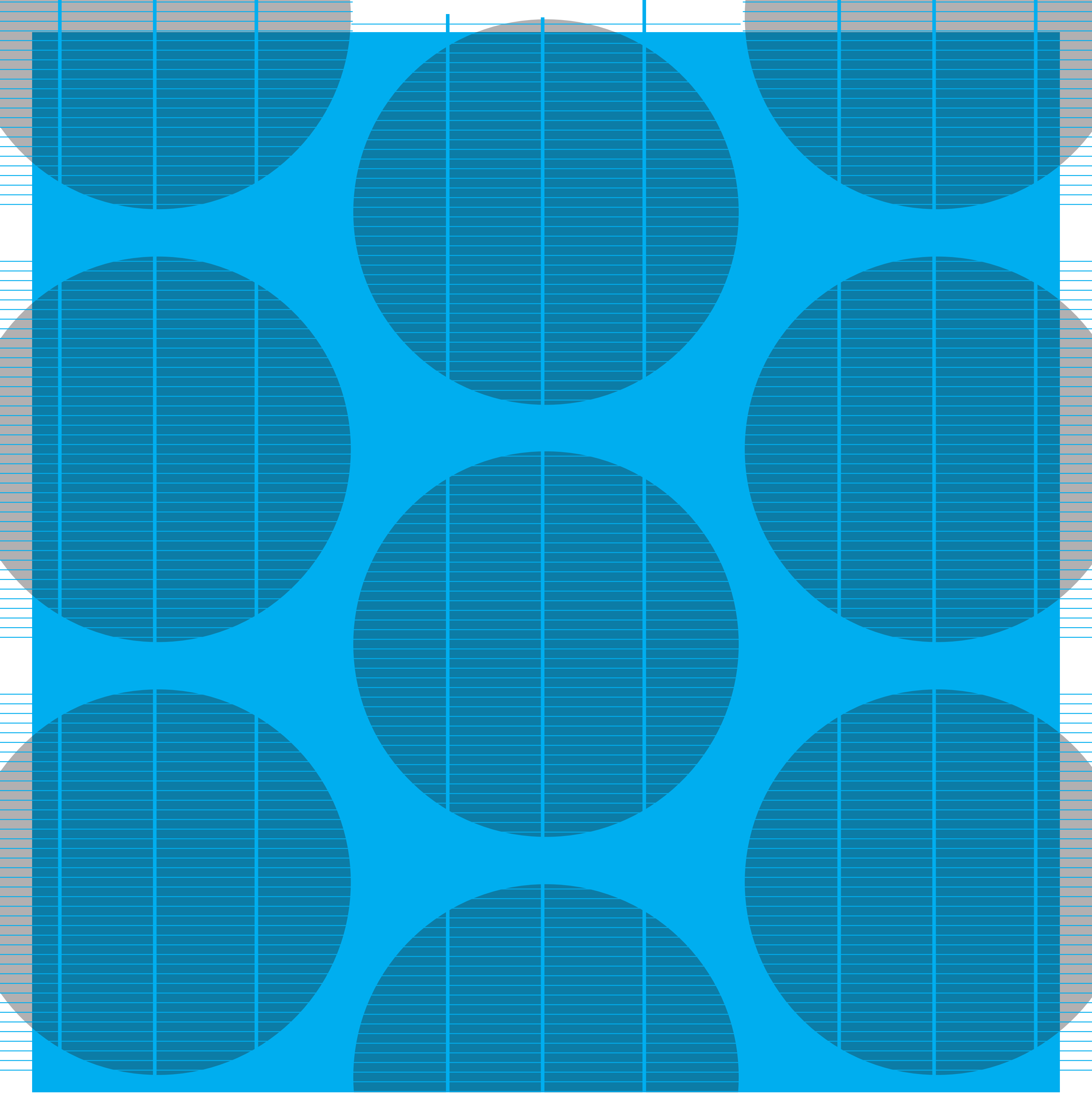
Outlook (Promotion Availability/Job Mobility):

____

____

Similar Jobs:

1. ____
2. ____
3. ____



DOW CORNING

EPARTMENT OF ENERGY

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