

Power Your Own Lunar Base*

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Subject: Science

Grade Level: 5-9

VITAL INFORMATION

Site: CLC at Wheeling Jesuit University, Wheeling, WV

Mission Scenario: Return to the Moon

Application to Mission Preparation: This is a problem of engineering design for a remote Moon base. Life support requires power to be generated.

Whole Group/Small Group/Individual: Individual. Small groups may want to share their responses and double check each other's math.

Team (if applicable): The Life Support team studies the power being generated by the sun using photovoltaic arrays.

Summary: Learn about the power generating possibilities of a photovoltaic array and use math to design their own power system, complete with hair dryers and microwave ovens.

LESSON AT A GLANCE

Objective: Students use math to learn the scientific concept that appliances consume electrical power and other systems provide power. Power consumption may be measured using kW per hour.

Standards:

USA- National Science Education Standards

- **Chapter Chapter 6:** Science Content Standards
- **Grade Level :** 5-8
 - **Content Standard B:** Physical Science: As a result of their activities in grades 5-8, all students should develop an understanding of
 - **Ability/ Concept :** Transfer of energy
 - **Detail :** Energy is a property of many substances and is associated with heat, light, electricity,

mechanical motion, sound, nuclei, and the nature of a chemical. Energy is transferred in many ways.

■ **Detail :** Electrical circuits provide a means of transferring electrical energy when heat, light, sound, and chemical changes are produced.

■ **Detail :** In most chemical and nuclear reactions, energy is transferred into or out of a system. Heat, light, mechanical motion, or electricity might all be involved in such transfers.

■ **Detail :** The sun is a major source of energy for changes on the earth's surface. The sun loses energy by emitting light. A tiny fraction of that light reaches the earth, transferring energy from the sun to the earth. The sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation

Time Required: 1 class period. 15 Min. per class.

Essential Question: The sun creates energy which may be transferred/ converted to electrical energy, used in appliances.

Lesson Overview: Students engineer their own power system by balancing power being generated with the power drain of necessary sub-systems and appliances.

TEACHER PREPARATION

Subject Matter Overview: The physical process by which a photovoltaic (PV) cell changes light energy into electrical energy is called the Photovoltaic Effect. The light rays from the sun are made up of packets of solar energy called “photons”. When a PV cell is exposed to photons the energy can either be reflected by the material or absorbed by the material. The amount of energy absorbed depends on the intensity and orientation of the light energy source with the PV arrays. Upon absorption, the energy is converted to electrical energy.

Photovoltaic cells have varying levels of efficiency at converting sunlight energy to electrical energy. On a moon base, this efficiency will decrease as solar radiation and solar storms damage the solar cells. Most PV cells are "radiation-hardened", meaning they are mostly resistant to many types of damaging radiation. Because PV cells are not very efficient, huge numbers of cells are required for human needs. The solar

arrays on the ISS, for instance are as large as a football field. Computer-controlled motors constantly adjust the position of the solar arrays so that they remain perpendicular to the sun's light rays. If the angle of orientation is not constantly adjusted, power generation decreases dramatically.

- Materials:**
- Student worksheet
 - Calculator (optional)

Preparation: No preparation necessary

Differentiated Instruction: This activity is good for concrete learners and learners of multiple abilities. Because it uses math in the process of teaching science, students who are weak at addition and multiplication may need assistance.

TEACHING THE LESSON

Lesson Management: Discuss the big science ideas as a class, then pass out the worksheets to each individual student. Upon completion, students may share their designs. Debrief by discussing the idea of sunlight, energy transfer, and the constant need for power generation when there is a power load. You may want to assign the "Going Further" questions as homework.

Teaching Tips: To build excitement for the engineering design of lunar bases, project some lunar base artists' concepts for students to spur their imaginations. You may want to mention the idea of how important artists are to envisioning future projects in many fields.

Links

1. [Colonization of the Moon- Wikipedia](#)
2. [Gallery of Lunar Exploration Artists' Concepts](#)
3. [Moon Base Resources \(Challenger\)](#) A list of resources which link NASA missions and images with Challenger activities.
4. [NASA List of Scenario Concept Images](#)

Student Instructions: All student instructions may be found in the attached worksheet

Student Worksheets: [Power Your Own Lunar Base](#)

Resources:

- Materials and resources:
no special resources needed

Links

1. [In-Situ Fabrication of Lunar Solar Cells](#) Scientific article produced by NASA
2. [Lunar Base Designs](#)
3. [Lunar Surface Arrays](#) Scientific article produced by NASA
4. [Materials Refining for Solar Array Production on t](#) Scientific article produced by NASA
5. [Materials Refining for Solar Array Production on t](#) Scientific article produced by NASA. Silicon, aluminum, and glass are the primary raw materials that will be required for production of solar arrays on the moon. A process is proposed for producing materials from lunar regolith-- separating the required materials from lunar rock with fluorine.
6. [Preliminary investigations on large solar cell arr](#) Scientific article produced by NASA
7. [Solar Power for Lunar Living](#) This artist's concept shows the deployment of solar arrays, which convert sunlight into electricity, on an initial lunar camp of the future.
8. [Technology for solar array production on the moon](#) Scientific article produced by NASA
9. [The Lunar Base: How to Settle the Moon](#) Popular Mechanics article: A four-time Space Shuttle astronaut explains what life will be like on NASA's four-man outpost come 2020, when the anti-Apollo mission will cast off aboard a new rocket and send explorers to hazardous territory.

ASSESSMENT AND EXTENSIONS**Rubrics:**

[Worksheet tasks*](#)

Extension Activities: The student worksheet contains extension/ homework activities. See attachment under "student worksheet"