Lesson Overview

During this lesson, students focus on solar energy and experience another engineering challenge. First, students learn about solar energy by watching a video on solar power. With this new information, students discuss how satellites are powered and how solar power works. Using paper as their “solar panels,” students are tasked with generating as much solar power as possible for their cube. Should their solar panels just sit on the top of the cube? Should they go all the way around? Should they deploy from inside the cube? Students work in the same pairs as their previous design experience to devise the system they believe is most optimal.

Connecting to the Common Core State Standards

The optional Day 6 lesson is intended to help students build their understanding of solar power while simultaneously considering mathematics problems embedded in the design problem. Key mathematics standards addressed in this lesson are listed below. The lesson should be adapted to support students as they make progress on these standards.

Connections to the Common Core State Standards

The optional Day 6 lesson can be easily adapted to support student growth in one or more of the following Common Core State Standards for Mathematics:

- **CCSS.Math.Content.5.NF.B.6**: Solve real world problems involving multiplication of fractions and mixed numbers, e.g., by using visual fraction models or equations to represent the problem.
- **CCSS.Math.Content.5.MD.C.3**: Recognize volume as an attribute of solid figures and understand concepts of volume measurement.
- **CCSS.Math.Content.5.MD.C.4**: Measure volumes by counting unit cubes, using cubic cm, cubic in, cubic ft, and improvised units.
- **CCSS.Math.Content.5.MD.C.5**: Relate volume to the operations of multiplication and addition and solve real world and mathematical problems involving volume.
Basic Teacher Preparation

This is another active lesson for students with lots of time built in for student construction of the CubeSat models with the solar panels. Collect the necessary materials, in their respective quantities, ahead of time.

<table>
<thead>
<tr>
<th>Required Preparation</th>
<th>Links/Additional Information</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gather or purchase all required materials for the lesson</td>
<td>Refer to the Materials List below</td>
</tr>
<tr>
<td>Review the Bill Nye video on solar powered satellites</td>
<td>[YouTube Link]</td>
</tr>
</tbody>
</table>

Materials List

<table>
<thead>
<tr>
<th>Item</th>
<th>Description/Additional Information</th>
<th>Quantity</th>
<th>Where to Locate/Buy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cardstock</td>
<td>Precut into 2.5 cm by 2.5 cm squares</td>
<td>Several available for each student team</td>
<td>Available in most schools</td>
</tr>
<tr>
<td>Construction paper</td>
<td></td>
<td>For use with the entire class</td>
<td>Available in most schools</td>
</tr>
<tr>
<td>Tape</td>
<td></td>
<td>1 per student</td>
<td>Available in most schools</td>
</tr>
<tr>
<td>Scissors</td>
<td></td>
<td>1 per student</td>
<td>From student or classroom sets</td>
</tr>
<tr>
<td>Glue</td>
<td></td>
<td>2 per team</td>
<td>From student or classroom sets</td>
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Day 6: Solar Power

Introduction (5 minutes)

As a group, review the growing KLEWS chart. Ask students what they know about solar energy. How does it work? How do they think it works? Have students write their ideas about solar energy in their science notebooks. Then, lead a group discussion, and write any ideas that surface. Ask students to develop questions that can be added to the KLEWS chart.

Investigation: How to Power CubeSats (20 minutes)

Show this video (less than 3 minutes long) on solar powered satellites for students. In this video, Bill Nye explains the Juno satellite that has been launched to study Jupiter. After the video, pose the following math problem to students to study in groups and work on in their science notebooks.

If one square centimeter (cm²) of solar panel can generate 1.5 watts of electricity, how many square centimeters of solar panels will you need to generate 500 watts?

These numbers can be changed based on how adept students are with proportionality and algebraic reasoning.

Review the math problem as a group, and ask students to show how they solved the problem on the board.

Ask students to think about how they might generate solar energy on their CubeSat models. Where might they put solar panels to create the most energy? Write their suggestions on the board. If the idea of deployable solar panels does not surface amongst students, suggest that there may be a way for panels to deploy, or come out of the cube, once the CubeSat is in space.

CCSS Key Moment

Incorporating deployable solar panels motivates the need to incorporate the idea of volume.

Design Work: Adding Solar Panels (20 minutes)

Based on the ideas that surfaced during the previous discussion, ask students to add solar panels to their CubeSat models. To create their solar panels, they can use cardstock or construction paper. In doing so, each team must consider the following constraints:

- Panels should be able to be removed easily. (Students may move panels when they revise their models again over the course of the next two days.)
- The strength of the original CubeSat should not be damaged.
They need to add enough solar panels to generate enough power for the CubeSat to run (400 watts).

As students work, they can draw a model of their CubeSat in their science notebook, including labels and measurements. The model in the notebook should show and explain how solar energy is added to their original CubeSat model.

**Lesson Close (5 minutes)**

Invite students to walk around the room and see how other engineers have added solar panels to their CubeSats. Do the solar panels extend beyond the cube itself? How do the panels deploy in space? Allow students to make any last-minute adjustments and clean up their workspace.

**Assessment**

Use models of solar panels for CubeSats in students' science notebooks to monitor progress during this lesson. Reference Appendix B for suggestions for meeting the needs of all learners.

**Community Connections**

Many communities have software or technology companies that may be doing related satellite work or solar panel construction/installation in homes or businesses. Invite a solar panel specialist to virtually or face-to-face share with the class how solar energy impacts local utility companies and home/business owners. Visit online local city sites to explore how city engineers and city planners are incorporating solar energy into their designs.

**Suggested Teacher Resources**

<table>
<thead>
<tr>
<th>Meeting the Needs of All Learners</th>
<th>CubeSats Teacher Handbook, Appendix B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bill Nye video about solar powered spacecraft (presented by NASA’s Mission Juno)</td>
<td>[YouTube Link]</td>
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