The Orion Missions

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Unit Overview

The Orion missions are NASA-sponsored missions to send astronauts to the Moon and then to Mars by 2030. In the unit plan, students collaborate to apply sixth grade earth science and math standards, as well critical thinking and problem solving skills to design solar panels for the shuttle missions to Mars. Following the engineering design process, students construct a solar panel prototype that incorporates the use of coding to tilt and rotate to obtain the maximum amount of sunlight each day.

Standards Addressed

1. **ELAGSE6W1:** Write arguments to support claims with clear reasons and relevant evidence.

2. **ENGR-STEM 3:** Students will design technological problem solutions using scientific investigation, analysis and interpretation of data, innovation, invention, and fabrication while considering economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability constraints.

3. **ENGR-STEM 4:** Students will apply principles of science, technology, engineering, mathematics, interpersonal communication, and teamwork to the solution of technological problems.

4. **ENGR-STEM 5:** Students will select and demonstrate techniques, skills, tools, and understanding related to energy and power, bio-related, communication, transportation, manufacturing, and construction technologies.

5. **MGSE6.RP.3:** Use ratio and rate reasoning to solve real-world and mathematical problems utilizing strategies such as tables of equivalent ratios, tape diagrams (bar models), double number line diagrams, and/or equations.

    - **MGSE6.RP.3b:** Solve unit rate problems including those involving unit pricing and constant speed.

    - **MGSE6.RP.3d:** Given a conversion factor, use ratio reasoning to convert measurement units within one system of measurement and between two systems of measurements (customary and metric); manipulate and transform units appropriately when multiplying or dividing quantities.

6. **MGSE6.G.4:** Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems.

7. **S6E6:** Obtain, evaluate, and communicate information about the uses and conservation of various natural resources and how they impact the Earth.

    - **S6E6.a:** Ask questions to determine the differences between renewable/sustainable energy resources (examples: hydro, solar, wind, geothermal, tidal, biomass) and nonrenewable energy resources (examples: nuclear: uranium, fossil fuels: oil, coal, and natural gas), and how they are used in our everyday lives.

8. **VA6.CR.2:** Choose from a range of materials and/or methods of traditional and contemporary artistic practices to plan and create works of art.

    - **VA.6.CR.2b:** Produce three-dimensional works of art using a variety of media/materials (e.g. clay, papier-mâché, cardboard, paper, plaster, wood, wire, found objects, fiber).

    - **VA.6.CR.2c:** Use technology in the production of original works of art.

Day 1 – Contrasting Renewable and Nonrenewable Energy Resources

Standards Addressed: ELAGSE6W1, S6E6

Essential Question: What are the most common sources of energy? What is the best energy source for Georgia?

1. Display for the class a table of U.S. energy consumption using the following U.S. Department of Energy webpage, "Energy Sources Recent Statistics." Have students identify and calculate the percentage of the three largest sources of total primary energy production. Engage the class in a discussion about the most common energy sources that they identified. Define each of the sources.

2. Instruct students to research renewable and nonrenewable energy resources using the U.S. Department of Energy Kids webpage, "Energy Sources." Have students create a T-chart in their science notebook on renewable and nonrenewable energy resources.

3. Using the research from step two, instruct students to construct a short essay on the importance of using renewable energy resources (no longer than one page in the science notebook). Students should have a minimum of three facts or statistics to support their explanations.

4. Have students to research the use of geothermal energy in Iceland from the website titled Iceland on the Web. Based on their research and prior knowledge of plate tectonics, tell students to engage in a discussion with their tablemates about whether geothermal energy is a feasible renewable energy alternative for Georgia. Engage the class in a discussion about their findings.

5. Instruct students to turn in their science notebooks before they leave. Assess the accuracy of the T-chart and their explanation on the importance of using renewable energy resources.

Day 2 – Renewable and Nonrenewable Energy Resources

Standards Addressed: S6E6, MGSE6.G.4

Essential Question: How does solar energy work? How do solar panels function?

> **A NOTE FROM THE TEACHER**
>
> *Use the video to provide a general overview. For advanced learners or more in-depth information, use the link titled "Energy Basics" from the Department of Energy.*

1. Have students read the Powermag article, "Largest Solar Plant in Southeast Will Be Built in Georgia." Engage the class in a discussion about the article. Ask probing questions, like "Why did they choose Georgia as the site?"

2. Students will explore how solar panels work by watching the PBS video, "How Solar Panels Work." Engage the class in a

discussion about the video. Ask probing questions, like "explain in one sentence how solar panels work."

3. Ask students to construct a graphic model illustrating how solar panels work. The graphic model should be labeled and clearly illustrate sun rays striking the photovoltaic cell, the releasing of electrons from atoms, and the flow of electricity.

4. Ask students the following questions. Students should use their knowledge from step one through three and their background knowledge of seasons to answer the questions:
    a. During which time of year would a solar panel make the maximum amount of energy? Why?
    b. During which time of year would a solar panel make the least amount of energy? Why?

5. Evaluate the students' graphic models of the solar panel. Provide feedback based on the accuracy of the components included on the model. Be prepared to discuss common misconceptions depicted on the models on the following day.

Day 3 – Calculating Unit Rate & Metric Conversions

Standards Addressed: MGSE6.RP.3b, MGSE6.RP.3d

Essential Question: What is a kilowatt-hour and how do we convert watts to kilowatts?

1. Discuss some common misconceptions that you assessed on the graphic models of the solar panels.

2. Show students a YouTube video titled "What's a Kilowatt-Hour?" After the video, discuss the formula and practice with the students. After the practice, display a picture of a standard 75-Watt lightbulb and ask students the following questions:
    a. How many 75-watt light bulbs would it take to use one kilowatt-hour? *Answer: About 13 lightbulbs*
    b. How long would it take a 75-watt light bulb to use one kilowatt per hour? *Answer: About 13 hours*

3. Instruct students to get into teams of four. Students will work in their group to create a list of ten common appliances astronauts would need on Mars. Next, students will research the wattage of these appliances using the Department of Energy website titled "Estimating Appliance and Home Electronic Energy Use."

4. Provide students with a **Calculating Kilowatt and Unit Rate** activity sheet. Show students how to convert watts to kilowatt-hours. Next, students will calculate the kilowatt-hours of ten common appliances. After the groups finish the calculations, instruct them to construct

an explanation of how math can be used in the NASA Orion missions to determine energy needs.

5. Explain how energy companies charge customers a flat rate per kilowatt-hour to determine the electric bill. Students will use the information on the bill to calculate the unit rate per kilowatt-hour charged by the electric company.

6. Students will submit their energy bill calculations. Evaluate the calculations and assess for misconceptions. Be prepared to discuss the misconceptions the following day.

Day 4 – Renewable & Nonrenewable Energy Resources
Standards Addressed: S6E6, ELAGSE6W1

Essential Question: What is the purpose of a solar panel and what are the components?

1. Begin the class by discussing the strengths and misconceptions that you assessed from the energy bill calculations. If needed, conduct a brief reteach and let the students practice the concepts.

2. Show students the trailer for the Martian movie. Engage the class in a discussion using the following guiding questions:
    a. Which energy resource would be the most feasible to use on Mars?
    b. What are some constraints of this energy resource due to the Martian environment?
    c. What new technologies need to be invented for this energy resource?

3. Working in pairs, instruct students to research the geology and general facts about Mars using the NASA webpage, "Mars Exploration Program."

4. Review the Claim-Evidence-Reasoning writing format. Instruct students to construct an explanation about why solar energy is the most feasible energy resource to use on Mars. using the Claim-Evidence-Reasoning writing format. Students will write in their science notebooks.

5. Model the standard design of a solar panel using a pool noodle and a composition book. Using the model, probe students understanding of the limitations of solar energy (i.e. sun is not always out, maximum amount of energy from the sun is limited during the day, etc.). Next, students will work in teams of four to design a solar panel prototype to be used on Mars. Students will work through the engineering design process to sketch their design on copy paper.

6. Remind students to bring materials to build their solar panel prototype.

7. Evaluate and provide feedback to groups' solar panel designs. Be prepared to discuss misconceptions with the class on the following day.

Day 5 & 6 – Engineering Design Process and Surface Area
Standards Addressed: ENGR-STEM 3, ENGR-STEM 4, ENGR-STEM 5, MGSE6.G.4, VA6.CR.2b

Essential Question: How do I use the engineering design process to build a solar panel prototype?

1. Provide feedback on the solar panel prototype designs. Allow time at the beginning of day five for groups to improve upon their original designs.

> **A NOTE FROM THE TEACHER**
> *Consider purchasing supplementary materials from the dollar store or the thrift store. This will allow students to supplement the materials they bring from home.*

2. Students should have materials from home to begin building their solar panel prototype.

3. Day Five: After students revise their solar panel prototype designs to incorporate your feedback, they can begin the building process. Students will use the engineering design process by building a three-dimensional model of their solar panel prototype sketch from day four. Supply supplementary building materials, such as glue sticks, hot glue guns, and paint, if possible.

4. Day Six: Students will continue to use the engineering design process by finalizing the building of their solar panel prototype sketch from day four. Supply supplementary building materials, such as glue sticks, hot glue guns, and paint, if possible.

Day 7 – Presenting the Solar Panel Prototype, Part One
Standards Addressed: ENGR-STEM 3, ENGR-STEM 4, ENGR-STEM 5, VA6.CR.2b, VA6.CR.2c

Essential Question: How do I present about my solar panel using Flipgrid?

1. For the first thirty minutes of class, give students a tutorial on how to use Flipgrid.

2. After the tutorial, give groups the rest of class to create a presentation about their first solar panel prototype using the video recording site Flipgrid. Tell them that they will have two minutes to present about their solar panel prototype. Inform groups that they will present to the whole class on the following day.

3. Circulate the room to provide feedback as groups work on their presentations.

Day 8 – Presenting the Solar Panel Prototype, Part Two
Standards Addressed: ENGR-STEM 3, ENGR-STEM 4, ENGR-STEM 5, VA6.CR.2b, VA6.CR.2c

Essential Question: How do I present about the solar panel and incorporate feedback to make improvements?

1. Allow groups a few minutes at the beginning of class to finalize their Flipgrid videos.

2. Groups will present their first prototype solar panel using the video recording site Flipgrid. Students will have two minutes to explain their solar panel design. Students should explain the rationale behind their design and the selection of their materials. After each presentation, ask the class to provide feedback. Provide feedback to each group, as well.

3. Evaluate each group's Flipgrid presentations, providing more specific feedback that they can incorporate to improve upon the design. Assess the presentation for their ability to clearly communicate their ideas, evidence of teamwork, and the accuracy between the sketch and three dimensional model.

Day 9 & 10 – Adding a Constraint to the Solar Panel Design: Needs to Rotate
Standards Addressed: ENGR-STEM 3, ENGR-STEM 4, MGSE6.G.4, VA6.CR.2b

Essential Question: How and why does my solar panel need to rotate?

1. Day Nine: Begin the class by adding a constraint to the solar panel prototype. Explain that most solar panels are fixed in one position and face one direction. However, a fixed solar panel would not be an ideal model for Mars. With solar energy being the only energy resource on Mars, the panels need to be able to track the path of the Sun at all times. Engage the class in a discussion about the possible ways to make the prototype designs mobile to resolve this constraint.

2. After a discussion, allow groups to discuss the ways that they will modify their current prototype. Groups should add to their original prototype sketch from day four. Circulate the room as groups work on their modifications. Provide feedback.

3. Days Nine & Ten: Once you approve the modifications, allow groups to start modifying the 3D designs. Allow students a day and a half to complete the model, inclusive of the modification.

Day 11 & 12 – Adding a Constraint to the Solar Panel Design: Needs to Account for Dust
Standards Addressed: ENGR-STEM 3, ENGR-STEM 4, MGSE6.G.4, VA6.CR.2b

Essential Question: How and why would I modify my solar panel to account for dust?

1. Day Eleven: Show students a snippet of the NASA video titled "A Journey to Mars" (start video at 9:26 and stop video at 11:15). In the video, students will learn about dust storms on Mars. Engage the class about the content from the video by using the following guiding question: How can your first solar panel prototype be improved to combat the dust storms on Mars?

> **A NOTE FROM THE TEACHER**
> *If you have access to a 3D printer, you may consider letting students design parts for their prototype and building them with the printer.*

2. Students will explore options to account for dust on their solar panel. Have students modify their design sketch. Circulate the room as students work and provide feedback on their designs.

3. Next, instruct students to construct an explanation of why the engineering design process requires multiple redesigns before finalizing the operable prototype.

4. Day Twelve: Once the students have made their modifications on their original design sketch, they can begin modifying the 3D prototype. Students will add new materials to their designs or print 3D parts (if 3D printer is available). Students will begin building their models and will have one day to finalize their prototype.

5. Simultaneously, part of the group should be working on their final Flipgrid presentation. Remind students that they have three minutes to present their prototype and the process it took to arrive at the final design. They will need to incorporate the sketch and the final model in the final presentation.

Day 13 – Claim-Evidence-Reasoning, Engineering Design Process, and the Visual Arts
Standards Addressed: ELAGSE6W1, ENGR-STEM 3, ENGR-STEM 4, MGSE6.G.4, VA6.CR.2b

Essential Question: Why is my group's design the best model for Mars?

1. Show students National Geographic video titled "Mega Dust Storms Mars."

2. Have students work individually to use Claim-Evidence-Reasoning to write a short essay explaining why their final solar panel prototype is the most innovative and effective panel to use on Mars, making sure to include why it is the best design for the constraints, as well.

3. Circulate the room to provide feedback to students needing guidance. Students should submit their essays at the end of class.

Day 14 – Claim-Evidence-Reasoning, Engineering Design Process, and the Visual Arts
Standards Addressed: ELAGSE6W1, ENGR-STEM 3, ENGR-STEM 4, MGSE6.G.4, VA6.CR.2b

Essential Question: How do I effectively present my group's solar panel?

1. Students will present their final 3D models to the class using Flipgrid. In addition, students will use their final 3D model during the presentation. Students will have two minutes to explain their new design and describe why NASA should choose their prototype as the official solar panel for Mars.

2. Evaluate final group designs based on their Flipgrid presentations and the 3D model. Assess groups based on their ability to clearly communicate their ideas, evidence of teamwork, and the accuracy between the sketch and three dimensional model. Use the **Final Solar Panel Design Rubric** to grade the final design and presentation.