MISSION MOON DUST: DIGGING INTO LUNAR SOIL

DURATION

1 Lesson

1-2 Class periods (50 min)

GRADE LEVELS

4-7

LESSON PLAN

OVERVIEW

In this engineering-focused lesson, students work in teams to design a rover arm that collects "lunar regolith". Students will learn about Blue Origin's mission to utilize space resources for the benefit of Earth, with a focus on lunar permanence. They will explore Blue Moon and Artemis missions, then design a rover arm attachment to collect lunar regolith. The lesson concludes with student presentations on their designs.

LESSON OBJECTIVES

By the end of this lesson, students will be able to:

- Define and state the purpose of lunar permanence.
- Design a regolith collection device.
- Demonstrate their understanding of Blue Origin's space resource mission by designing a rover arm attachment for lunar regolith collection and presenting their design, including key design elements and rationale, to their peers.
- Collaborate effectively in teams to research, design, and present a rover arm attachment for lunar regolith collection, demonstrating communication, problem-solving, and shared responsibility throughout the project

STANDARDS

NEXT GENERATION SCIENCE STANDARDS (NGSS)

MS ETS 1-2

Evaluate competing design solutions based on jointly developed and agreed-upon design criteria using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS ETS 1-3

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

COMMON CORE: ELA

CCSS.ELA-LITERACY.W.6.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

CCSS.ELA-LITERACY.SL.6.5

Include multimedia components (e.g., graphics, images, music, sound) and visual displays in presentations to clarify information.

CCSS.ELA-LITERACY.L.6.1
Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

CCSS.ELA-LITERACY.L.6.2
Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

CCSS.ELA-LITERACY.L.6.3
Use knowledge of language and its conventions when writing, speaking, reading, or listening.

MATERIALS

- Crafting materials:
  - Rover arm materials:
    - Popsicle sticks, tape, paper cups, printer paper, string, cardboard, straws, etc.
  - Regolith materials:
    - Indoor examples: bucket filled with sand, dirt, small rocks.
    - Outdoor example: playground or parking lot with small debris or mulch.
- Club for the Future Lunar Regolith Lesson

LESSON PLAN

INTRODUCTION (30 MINUTES)

1. Begin by introducing Blue Origin and Blue Moon
   - Checkpoint: Identify the purpose of lunar permanence.
     - » Why do we go to space? What is lunar permanence and its purpose? What is on the moon?
   - Checkpoint: Define lunar regolith.
2. Discuss rovers and possible designs
   - Checkpoint: Identify well-known rover missions.
     - » What is Curiosity? What is its purpose? What is Perseverance and its mission objectives?

DESIGN CHALLENGE (35 MINUTES)

PART 1: ROVER ARM DESIGN CHALLENGE (15 MINUTES)

1. Divide students into small groups or pairs.
2. Students are introduced to the challenge and presented with material availability and constraints.
3. Groups are tasked with drawing their designs for a regolith collection device using limited materials and begin the building process.

PART 2: REGOLITH COLLECTION TESTING (5 MINUTES)

1. Instructor either fills a large bucket with various debris such as dirt, sand, and small pebbles or finds outdoor space where such materials can be found.
2. Students in each team test their designs to collect the regolith (approx. 3 minutes per spacecraft).

PART 3: DESIGN PRESENTATION (15 MINUTES)

1. Teams take turns presenting their designs, considerations made throughout the process, and how effective they were at harvesting the regolith (approx. 2 minutes per team).

EXTENSION ACTIVITIES

- Research Mars rovers such as Curiosity and Perseverance and write a reflection over the importance of interplanetary space exploration.
- Design your own lunar mission with a drawing and a paragraph explanation.

ASSESSMENT

- Students present their regolith collection devices to the class.
- Student Mission Packet is filled out and turned in.

ADDITIONAL ACCOMMODATIONS

1. **For Visual Learners:**
   - Provide Blue Moon promotional videos discussing the mission objectives.
2. **For Auditory Learners:**

- Include audio recordings of the first moon landing.

3. **For Kinesthetic Learners:**
   - Encourage these students to be in charge of rover arm assembly.
4. **For English Language Learners (ELL):**
   - Provide a word bank of moon-related vocabulary.
   - Allow student to use notes or a script for the presentation.
5. **For Students with Learning Disabilities:**
   - Offer notes sheet with fill-in-the-blank spaces as a learning aid.
6. **For Gifted Students:**
   - Encourage research on moon landings throughout history.
   - Additional reflection on why lunar permanence is important.
7. **For Students with Physical Disabilities:**
   - Ensure all materials are accessible (ex. large print, digital formats).
   - Provide adaptations for launching (ex. brightly colored regolith/sand, audio cues from teammates describing the regolith collection, peer guidance).
8. **Flexible Grouping:**
   - Form groups considering varied abilities to promote peer support.
9. **Tiered Assignments:**
   - Offer different levels of complexity in final reflection activity.

TIME	MATERIALS	ACTIVITY
30 min	Slides Student Mission Packet	1. (Slide 1) • Introduce the new lesson to students. 2. (Slide 2) • Go over the learning objectives. • Pass out the student mission packet. 3. (Slide 3) • **A little background information, anyone heard of Blue Origin?** • Wait for hands. • **Who knows what they do at Blue Origin?** • Take some answers. 4. (Slide 4) • **Blue Origin is a space company that builds rockets that take people and things to space. Their vision is to have millions of people living and working in space for the benefit of Earth.** • **What are ways we could utilize space to benefit Earth?** • Wait for hands. Take some answers. • **Those are great answers!** 5. (Slide 5) • **Let's watch a video about how they are doing this at Blue Origin!** • **As you saw in the video, Blue Origin is building rockets and flying people to space... all for the benefit of Earth.** 6. (Slide 6) • **Blue Origin has a 3-part mission, and as you can see, the third mission is "To inspire the Next Generation", that's where all of you come in.** • **If millions of people are going to live and work in space, it's going to take a lot of time and brain power and it's not going to happen in just my lifetime.** • **We need you to help us take on this mission and help us build this life in space.** 7. (Slide 7-9) • **Let's talk about why we even go to space. What are some reasons we go to space? What is in space that might interest us?** • Take some hands and then go over the slides 8 and 9. 8. (Slide 10) • **Now for the main topic of the day, the moon!** 9. (Slide 11) • **Can anyone tell me what the moon is?** • Wait for hands. Take some answers. • Go over definition. Give students time to take notes. • **In the past, we have done a lot of research on the moon's surface and the rocks on the moon.** • **The powdery soil on the moon's surface is what we call "lunar regolith"** • Go over definition. Give students time to take notes. 10. (Slide 12-13) • Go over slides 12 and 13. Leave time for students to take notes on the student worksheet. 11. (Slide 14) • **Why do we care about the moon's surface? It tells us about the history of the moon and what it is made of. It also contains resources that we can use.** • **Utilizing space resources is one way we can make space more sustainable.** • Go over the definition of space sustainability. Allow students to take notes.

		12. (Slide 15) • **Now let's look at how they are doing this at Blue Origin.** • Show video • **Now that you've seen why it would help us to collect lunar regolith, let's talk about how we would collect it. How do you think we collect lunar regolith or any samples from another planet?** • Take some ideas from the students. 13. (Slide 16) • **We do this using rovers! Anyone know what a rover is or what it looks like?** 14. (Slide 17-18) • Go over slides
30 min	Student Mission Packet Rover Arm Building Materials "Lunar Regolith" Materials	1. (Slide 19-21) • Go over the requirements and what students will be doing. • Break them up into teams. • Designs must be drawn on their sheets. • Make sure students test out their rover arm and rebuild. • Go over materials they can use. You can edit the materials list based on what you have. • Go over what they should present to the class. • Then give them work time to build their rover arms. • Once they are finished, have each group present their rover arm designs to the class. 2. (Slide 22) • Each group will send a representative to operate the rover arm to collect lunar regolith and hand it to a team member. • Usually, 1-2 minutes is enough time. You can allot 2 minutes or until all the regolith is gone. • Feel free to utilize anything you want to represent the regolith they have to pick up. • The team with the most objects, wins! 3. (Slide 23) • Have students fill out their reflection and turn in their packets.

STUDENT MISSION PACKET

MISSION MOON DUST
STUDENT MISSION PACKET

PROMPT:

1. Why do we go to Space?
   a. _____
   b. _____
   c. _____
   d. _____
2. Moon:_____
   _____
3. Lunar Regolith:_____
   _____
4. Lunar Permanence:_____
   _____
5. Space Sustainability:_____
   _____
6. Rovers:_____
   _____

COMPETITION OVERVIEW:

We are on the brink of an exciting new era in lunar exploration, and we need your help! As part of Mission Moon Dust, your team has been selected to design a rover arm that will be used to collect valuable lunar regolith samples. These samples will provide critical insights into the Moon's history and help us prepare for future human missions.

COMPETITION SPECIFICS:

1. The rover arm must be the only thing that touches the lunar regolith.
2. Must use the materials provided.
3. Cannot run into other rovers.

ROVER DESIGN

Draw your rover design below. Be sure to label all the parts.

CONCLUSION

Answer the following conclusion questions.

1. *What was your team's initial design?*

2. *Did the final product turn out as planned?*

3. *How did your material selection affect your team's design?*

4. *How did your rover arm perform in the final competition?*

5. *What did your team struggle with?*

6. *What was a success?*

7. *What changes would you make if you were to do the challenge again?*

8. *What did you learn from this experience?*