Middle School: Unit 3, Lesson 3: Pack Your Moon Kit

Challenge Guiding Question: How can we use experiments, models, and rehearsals here on Earth to understand other solar system objects and plan a successful mission to the Moon?

Unit Level Question: *How can studying complex Earth systems help us create sustainable living spaces for humans on the Moon?*

Lesson Level Question: *Once your basic needs are met, what else do you need to take with you to support your health and wellness on the Moon?*

Lesson Summary: *Students will read about the items that NASA astronauts bring with them to support their overall wellness and then develop a list of items they would bring with them on their own journeys. They will assess what is feasible to bring with them using a series of constraints including personalized criteria for success, size and mass limitations, and any other considerations developed by the class. They will also have an opportunity to consider what their families and communities have brought with them on journeys in relation to the nature of forced or chosen journeys.*

Notes for Adapting This Lesson to Remote Learning: *Use the digital versions of the readings and journaling activity. To practice with measuring mass and size, we recommend you use modeling and also engage students in a guided practice, like a scavenger hunt where they find and measure objects on screen so that you can check for understanding.*

Materials Needed

Lesson Links	**Materials Available from NESSP** https://nwessp.org/nessp-companion-course-supplies/	**Materials Provided by the Teacher**
• Printed or digital copies of the NASA readings: one and two • Printed or projected copies of one of the emotion lists if using (see Explore section) • Printed copies of the Items to Consider handout (at the bottom of this lesson)	N/A	• Rulers to measure volume • Scales or balances to measure mass • Items for students to practice measuring • Chart paper, a whiteboard, or any other space on which to record student thinking as a whole group

Before The Lesson

- If your students are participating in the Artemis ROADS Student Challenge, review MO-05: Pack Your Moon Kit.
- **Please note** this lesson will span multiple days with a week long break after the first portion to allow for students to journal. Read through and adjust the timing and pacing as needed for your class and students.

- **Engage**:Preview the articles and modify the readings as needed based on your students' needs, identities, and interests.
- **Explore**:
  - For students participating in the challenge the size and mass are given. See MO-05 for more information.
  - If your students are NOT participating in the challenge, feel free to set the size and mass as convenient to you.
- **Explain**: If you'd like, you can make a physical model of the size of the kit for students to test their items against, and/or a scale 3-D drawing. See the Explain section for more information.

NGSS Standards

MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/MS%20ETS%20Evidence%20Statements%20June%202015%20asterisks.pdf

Asking Questions and Defining Problems (Engage) Ask questions to clarify and/or refine a model, an explanation, or an engineering problem. **Planning and Carrying Out Investigations (Explore)** Collect data to produce data to serve as the basis for evidence to answer scientific questions or test design solutions ~~under a range of conditions~~ **Constructing Explanations and Designing Solutions (Explore/ Explain)** Undertake a design project, engaging in the design cycle, to construct and/or implement a solution that meets specific design criteria and constraints. Optimize performance of a design by prioritizing criteria, making tradeoffs, testing, revising, and retesting. **(Elaborate)** **Obtaining, Evaluating, and Communicating Information (Evaluate)** Communicate scientific and/or technical information orally and/or in written formats, including various forms of media and may include tables, diagrams, and charts.	**ETS1.A: Defining and Delimiting an Engineering Problem** The more precisely a design task's criteria and constraints can be defined, the more likely it is that the designed solution will be successful. Specification of constraints includes consideration of scientific principles and other relevant knowledge that is likely to limit possible solutions. **ETS1.B: Developing Possible Solutions** There are systematic processes for evaluating solutions with respect to how well they meet criteria and constraints of a problem. Sometimes parts of different solutions can be combined to create a solution that is better than any of its predecessors. Models of all kinds are important for testing solutions. **ETS1.C: Optimizing the Design Solution** The iterative process of testing the most promising solutions and modifying what is proposed on the basis of the test results leads to greater refinement and ultimately to an optimal solution.	**Systems and System Models** Systems may interact with other systems; they may have sub-systems and be a part of larger complex systems. Models can be used to represent systems and their interactions— such as inputs, processes and outputs— and energy, matter, and information flows within systems.

Other Important Content Standards (Math, Computer Science, ELA, 21st Century)

Washington State Standards For Social Emotional Learning
Benchmark 1A: Demonstrates awareness and understanding of one's own emotions and emotions' influence on behavior.
Benchmark 2A: Demonstrates the skills to manage one's emotions, thoughts, impulses, and stress in constructive ways.

Benchmark 2B: Demonstrates responsible decision-making and problem solving skills.

English Language Arts (Common Core State Standards)
CCSS.ELA-LITERACY.RI.6.4
Determine the meaning of words and phrases as they are used in a text, including figurative, connotative, and technical meanings.
CCSS.ELA-LITERACY.RI.8.10
By the end of the year, read and comprehend literary nonfiction at the high end of the grades 6-8 text complexity band independently and proficiently.

Mathematics (Common Core State Standards)
CCSS.MATH.CONTENT.6.G.A.2 Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths, and show that the volume is the same as would be found by multiplying the edge lengths of the prism. Apply the formulas V = l w h and V = b h to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems.
CCSS.MATH.CONTENT.7.G.A.1 Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale.
CCSS.MATH.CONTENT.7.G.B.6 Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms.
CCSS.MATH.CONTENT.8.G.C.9 Know the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems.

Lesson Plan

Phase	Middle School	Materials/Prep
Engage (30 Min)	***Students will consider prompts about which possessions they choose to bring on trips or to class, and why.*** Explain to students, “For astronauts, NASA provides everything they NEED to stay alive and do their jobs. Astronauts are also allowed to bring small personal items to help them stay happy and healthy and fend off boredom, homesickness, etc. NASA astronauts aboard the International Space Station keep a weekly journal, tracking items they use and activities they do regularly to maintain or improve their emotional and mental health. Similarly, we’re going to keep journals for one week in order to track the things that we use in order to maintain our physical and emotional wellness, so that we can incorporate them into our journey.” As a class, in groups, or individually, read the following article: https://www.nasa.gov/feature/the-personal-preference-kit-what-astronauts-take-with-them-to-space Facilitate student discussion of the following prompts using strategies like think to self, think, pair, share or turn and talk: ● What items did you notice the astronaut(s) brought with them? ● Why do you think they brought this? As a class, in groups, or individually, read the following article: https://www.nasa.gov/nasamoonkit	If participating in the challenge, review MO-05.

	Facilitate student discussion of the following prompts using strategies like think to self, think, pair, share or turn and talk: ● Think about a trip you've taken or maybe even what you have with you right now. What is something that you took with you on your trip OR that you have with you right now that is something you WANT, not something you NEED? ● Why didn't you bring every single thing you own with you to class today? How did you decide what to bring and what to leave at home? ● What things are necessary for staying alive and doing your job (learning), and what did you bring just because?	
Explore (60 Min)	***Students will keep an individual journal for a week to consider what items they might want to take and make initial measurements (size and mass) for potential items.*** Explain to students, "As we journal, we'll need to think carefully about what makes sense to bring. We're going to brainstorm criteria for success, review constraints, and talk through any other considerations we want to use as we monitor the items we may want to bring for our wellness." Lead a discussion with students regarding the following considerations they'll use to decide what to bring with them to the moon. Incorporate strategies like think to self, think, pair, share or turn and talk, as needed: "**First**, let's think about what each of us considers a good choice of what to bring–this is our criteria for success. Keep in mind that each person will have their own criteria for success, because every person has different things they will consider important to their wellness on the journey. "Each person, for example, has different things that make them feel happy, connected, or confident. Let's start by thinking about how we want to feel or how we don't want to feel on our journey. What are some other emotions that we may want to have more or less of while we're on our journey?" As needed, review a list of emotion words (such as the emotion wheel linked in the side bar) or review any emotion charts available in your school's social emotional learning curriculum. Again, keep in mind that criteria will be different for every student. For example, reducing boredom might be one student's criteria, while another student's criteria may be that the item helps them feel connected to loved ones. In general, student criteria will likely be about increasing positive emotions and decreasing or managing negative emotions. **"Next**, let's think about what will fit in our kits. Space and mass will be limited on our journey to the Moon, so we'll need to measure what we want to bring to see if it'll fit or if it's too heavy. For example, can we bring our pet elephant? Why not?" Tell students what size and mass constraints they will be using. ● For students participating in the challenge the size and mass are given. Each student's Personal Preference Kit (PPK) have the same size and weight restrictions for NASA astronauts traveling to	Emotion Wheel and List Examples ● https://www.brainframe-kids.com/emotions/m-emotion-wheel.htm ● Feelings-3d-final-design-120916-18x24.png ● https://i.pinimg.com/originals/cb/90/92/cb9092602a4ffafd26534dd98a24a377.jpg Spanish Version: ● Rueda de emociones ● Sentimientos Here are some tools that your students may use as they journal and log the size and mass of objects: ● Printable ruler ● Mass estimates for everyday objects (for comparison to their chosen items) Spanish Version: ● Masa de Objetos Cotidia…

	the international space station! ○ A maximum of 10 items ○ Must fit in a 5" X 8" X 2" (12.7 cm X 20.32 cm X 5.08 cm) bag ○ Maximum weight limit of 3.3 lbs (1.5 kg) ● If your students are NOT participating in the challenge, feel free to set the size and mass as convenient to you. For example, if each of your students has a pencil box or cubby or some other object that is the same size, feel free to use those dimensions and adjust the mass accordingly. Model for students how to take measurements of everyday objects (length, width, and height) in order to estimate volume, as well as how to estimate mass using a scale or by comparing to the mass of everyday objects. If students don't have access to a scale, here is a chart with mass approximations that can be used. Feel free to add the mass of other common objects that all students might have access to. As needed, engage students in a guided practice where they measure the volume and mass of classroom objects (books, crayons, journals, etc.) individually or in small groups as you, the instructor, circulate and check their work. **"Last**, let's think about any other considerations we want to use to guide us while we think through items to bring for our wellness. For example, can we bring fireworks, if fireworks always make us happy and it would fit in our kit? Why not? What other things might we want to consider?" If students have trouble coming up with ideas, consider asking probing questions, such as: ● Is it safe to bring to space? ● If you are in space for two months, will your item be OK that whole time? ● What will your crewmates think about your item? After discussing the criteria for success, constraints, and any other considerations for your kits, show students the template for the journaling they will engage in (located at the bottom of this lesson) and model how to complete the journal for an example item of your choosing, prioritizing student thinking and reasoning as much as possible. Task students with journaling for approximately one week. Check in at least once after a few days of journaling for students to share some ideas about what they are considering taking. Continue with the remainder of the lesson after approximately one week of journaling has been completed. –PAUSE HERE AND RESUME LESSON AFTER JOURNALING–	
Explain (45 Min)	***Students will decide on and document their individual kits, then share their plans with others.*** Now that students have engaged in recording the personal items they would like to bring on their journey, students will use their measurements from the week to plan their Personal Preference Kits. In small groups, have students check their peers' work against the class considerations developed in the Explore (criteria for success, size and mass constraints, and any additional considerations set by the	

	class). For example, students can take turns in their small groups explaining the criteria for success they used and explain how their kit helps them meet it. Allow an opportunity for students to give one another feedback that can be incorporated into any revisions (see the Evaluate section). To support students in assessing and visualizing what will fit in their kits, you can make a physical model of the size of the kit to test their items against, and/or a scale 3-D drawing. For example, if students are engaging in the challenge, each student's Personal Preference Kit (PPK) must fit in a 5" X 8" X 2" (12.7 cm X 20.32 cm X 5.08 cm) bag. You can make a physical model of the PPK bag using cardboard or construction paper, and/or you can create a scale drawing of the bag on paper.	
Elaborate (45 Min)	***Students will explore what others, including their family members or ancestors, have taken with them on long journeys.*** First, as a class, in groups, or individually, read the following article to explore what NASA astronauts have taken to space: https://www.nasa.gov/feature/space-station-20th-music-on-iss Then, invite students to consider other journeys they have learned about, their family has taken, etc. For homework, invite students to ask family members or elders about things people in their family or culture took on journeys, and the reasons they went on those journeys. –PAUSE HERE AND RESUME LESSON AFTER HOMEWORK– After students have had a chance to talk to family and community members, facilitate student discussion of the following prompts using strategies like think to self, think, pair, share or turn and talk: ● What was a time that your family made a journey? ● What, in your experience, are some of the reasons that people make journeys (choice, exploration, quest, forced, disaster, etc.)? ● How can the reason for a journey impact the planning and ability to take anything at all? ● Do you see any patterns in the kinds of things that people choose to bring?	Consider this resource: http://www.spaceflownartifacts.com/flown_ppks.html On the art of displaced peoples: https://www.displacementjourneys.org
Evaluate (50 Min)	***Students will consider feedback from the Explain section as well as information from the Elaborate section to revise their kits as needed.*** Lead students in considering the information from the Explain and Elaborate sections and invite them to revise their kits as needed. Provide time for them to make adjustments and take new measurements before finalizing their kits. Encourage students to collaborate and share ideas with one another. If participating in the challenge, have students review this checklist of deliverables in accordance with MO 5 and evaluate the degree to which their kits have met requirements (also listed below): ● For each team member's Moon Kit, MDLs will include a photo of the Moon Kit, the final dimensions, final mass, and a list of items selected. ● Each student should describe how the size and weight limits (constraints) of this task impact their choices. What items did students consider bringing, but reject for some reason? What was too	

	big or too heavy to bring? What other limits (constraints) did they consider?	
Extend (Optional)	***Students will consider alternatives constraints and considerations for the personal preference kits.*** To extend student thinking, change the rules slightly and allow students to reconsider how they'd create their kits. For example, instead of each team member getting to fill their own personal kit, what if: ● Each person gets a very small individual kit (same criteria as before) but the team also gets a slightly larger "shared" personal bin. (Give volume and mass criteria about 2x what each individual kit got. What shared items can the team agree on to support mental health and wellness of the group while in space? ● There were no individual decisions - The team had one larger bin and had to agree on all contents. (provide criteria of 4 or 5 times bigger (volume and mass) than the individual containers. Ask students to consider the following either in group discussion or in writing:: ● How would this change impact your existing kit and what you'd bring? ● How might this change impact the way you conceptualize your criteria for success or any other considerations for what to bring in the kit?	Spanish Version of the handout: Elementos para considerar (unid…

HANDOUTS:

Items to Consider (Metric Units)

As you think of items you might want to bring, record them here. Final decisions will be made later. Remember, all of your objects must meet the following criteria:

Size, no more than _____ by _____ by _____ cm Mass, no more than _____kg

Name of Item	Why am I bringing this item (what feeling do you want to experience more or less of)?	Mass (g)	Size (l, w, and h) (cm)	Other Considerations

Items to Consider (American Units)

As you think of items you might want to bring, record them here. Final decisions will be made later. Remember, all of your objects must meet the following criteria:

Size, no more than _____ by _____ by _____ in Mass, no more than _____oz

Name of Item	Why am I bringing this item (what feeling do you want to experience more or less of)?	Mass (ounces)	Size (l, w, and h) (inches)	Other Considerations

MDL MO 5 Submission Checklist:

- ☐ For each team member's Moon Kit, MDLs will include a photo of the Moon Kit, the final dimensions, final mass, and a list of items selected.
- ☐ Each student should describe how the size and weight limits (constraints) of this task impact their choices. What items did students consider bringing, but reject for some reason? What was too big or too heavy to bring? What other limits (constraints) did they consider?