

Unit 1, Lesson 4: Comparing the Earth and the Moon

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 do we plan a successful mission to the Moon?*

Lesson Level Question: *How do the Earth and the Moon compare?*

Lesson Summary: *Students will begin by activating prior knowledge of Earth's four major spheres or systems (atmosphere, geosphere, hydrosphere, and biosphere), then closely examine examples of interactions between these systems. Then, students will apply these ideas to the Moon and compare Earth's four systems to the Moon's spheres.*

How to expedite this lesson: *Use the Jamboard for Engage and Explore. Be sure to thoroughly discuss the prompts about Earth Systems and humans in the "Explain" section. The "Elaborate" section is essential for student understanding for the remaining lessons as well as several Mission Objectives, so be sure that students gain a firm understanding of conditions and systems on the Moon.*

Standards Information for each grade band can be found here:

- Elementary School (Grades 3-5) Standards Document [A2 ES Standards](#)
- Middle School (Grades 6-8) Standards Document [A2 MS Standards](#)
- High School (Grades 9-12) Standards Document [A2 HS Standards](#)

Materials Needed

Lesson Links	Materials Available from NESSP	Materials Provided by the Teacher
		'Interaction Between Earth Systems' handouts, 1 per group or 1 per student AND/OR Printed interaction card set Paper clips Yarn

Before The Lesson

- If you need supplies for the ROADS Challenge, you can order your supplies through this link.
<https://nwessp.org/artemis-roads-ii-companion-course-sign-up/>
- **Engage and Explore:** Decide if you will use the Jamboard with students. If you want to provide student access for sorting in the Jamboard, make sure you make an editable copy for each student or group and provide the links.
- **Explore:** Consider any interactions that are specific to your graphic region and consider adding them to the interaction card list on the Student Handouts.
- **Explore:** If students will use hard copy handouts, print them.
- **Explain:** Decide if you will do a basic sharing out or an optional whole class physical model (or some other sharing out method). If you will use the whole-class physical model and, if so, prepare the materials.
- **Elaborate:** Preview the Moon resources and decide which ones you will give to your students.

Lesson Plan

Phase	Details	Materials/Prep
Engage (45 Min)	Students will create models (diagrams) to demonstrate what they think they know about the four major Earth systems (biosphere, atmosphere, geosphere, and hydrosphere). NOTE: In this lesson, the words “Spheres” and “systems” are used interchangeably. “Spheres” is more specific and refers to the four main Earth spheres. “Systems” is a more general term. Choose which slide from the “U1 L4 Engage” slide deck to display. Start with the “least support” Slide and then move on if students do not generate many ideas. Ask students to recreate a similar 4-quadrant chart in their individual notebooks or on a piece of paper. Ask them to work on the following prompts individually at first. Prompt: List parts and processes that you have heard of from each Earth System. • Parts, <u>components</u>, or objects are part of each sphere (nouns or things - Example for hydrosphere is “snowflakes.”) • Important <u>processes</u> happen in each sphere (verbs or actions - Example for hydrosphere is “raining”)  Grade Level Adaptation If your students do not have prior understanding of the underlined words, consider ways to ensure that they understand these in their own words. Here is one option: Slide 2 of this Jamboard U1 L4 Four Systems Videos: •  Four Spheres Part 1 (Geo and Bio): Crash Course Kids #6.1 •  Four Spheres Part 2 (Hydro and Atmo): Crash Course Kids #6.2 Circulate while students work to check for understanding, prompting them to add more words or small drawings. If students are reluctant or say they don't know, ask them guiding questions such as “what things do you know that are alive?” or “what	📄 U1 L4 Engage Spanish Version: 📄 A2U1 L4 Enganche

	do you know about water?" After at least 10 minutes of individual work time, ask students to pair up or form small groups and discuss their charts, adding new ideas to their paper based on discussions.  Local and Cultural Relevance LOCAL ADAPTATION OPTION: Say: Many scientists use this four-system way to talk about how the Earth is organized. What other ways could you organize Earth's systems? How have different people made sense of their world? Lead students in a discussion or ask them to talk to people at home about this idea. For example, many cultures include the Sun, Moon, and stars in their organizational systems to explain things here on Earth. Others divide the Earth into regions like below the Earth, above the Earth, and on the Earth's surface.	
Explore (45 Min)	Students will work in small groups to examine various ways that Earth systems interact, sorting them based on which systems are interacting. Then, they will focus on interactions that involve their two assigned systems. Hand out copies of the "Interaction Between Earth Systems" handouts pages. Ask students to take a few minutes in the "alone zone" considering their answers to Part I of the handout. If your students will need an example before beginning, consider using the first two examples on the handout, discuss as a class, and acknowledge that some of the examples are more straightforward than others! NOTE: Teacher guidance is provided for this handout at the end of the lesson. NOTE: Consider providing 4 different colors of pencil, pen, or highlighter to students for use with this handout (one color assigned to each sphere). Students can highlight key words that relate to the different spheres on their first reading of the handout, which may support them in deciding which spheres are involved in the interaction.  Grade Level Adaptation Jamboard: Use Slide 3 as an alternative to the handout OR to support students as they work on the handout U1 L4 Four Systems If you prefer a simpler approach to this lesson segment, give pairs of students access to their own copy of Slide 3 of the Jamboard and ask them to sort the cards, then discuss as a group. Otherwise, follow the handout and the recommended sequence below, especially for middle and high school students. Divide the class into six equally-sized groups (Note, if your class size is very large, you may consider 12 small groups, with two groups each in the following categories.) Each group will represent the interactions between two Earth Systems. The groups will be: • Atmo/Bio • Atmo/Geo • Atmo/Hydro • Bio/Geo • Bio/Hydro	'Interaction Between Earth Systems' handouts, 1 per student (see end of lesson) Spanish Version: A2 U1 L4 Interacción entre es...

	• Geo/Hydro Part 1: Ask each group to discuss each example and decide which two earth systems are interacting, paying special attention to the ones that fall into their group. Circulate as students work, prompting them to move on to Parts 2 and 3 of the handout as they are ready. Note: If you had two groups each for the categories above, consider giving those two groups a few minutes to compare answers before having one person share out for each category	
Explain (60 Min)	<i>Each group will share out about the interactions that involve their two spheres. The teacher will moderate a whole class discussion about any areas of confusion or disagreement.</i> Decide if you will do a basic sharing out or an optional whole class physical model (or some other sharing out method). <i>Option 1: Basic Sharing Out:</i> Each group will share out which interactions they believe involve the two earth systems assigned to them (Part 2). Each group gets 5 minutes to present, with discussion and questions to follow. Note areas of possible disagreement (particularly if NO team claims an example or if more than one team claims the same example. Moderate a discussion of these areas of disagreement. <i>Option 2: Whole class physical model:</i> Set up 4 chairs (each labeled with one of the spheres) and connect each chair with yarn (This forms an “X” in a box, like this: ). As student groups share out, ask them to use a paper clip to attach the interaction card on the yarn connecting their two spheres. You can also do this on a bulletin board or white board where you have each sphere in a corner, connected by lines or strings. If you are using the whole class model, expect interaction cards to move or be more complex than the model allows (involving three spheres not just two). Discuss the limits of our model and how it could be adapted to show these more complex interactions. It is OK to leave some of the interactions and questions unanswered, as long as students understand the basic components of each system and basic ways the systems interact. One desired outcome of this activity is that students understand that the Earth systems are complex and interact with each other in complex ways. This means that every answer is not always clear! Next, ask students to focus on how each sphere and the interactions between spheres are important to humans. Students should consider what new interaction cards they could make (Handout, Part 3). Prompts can include: • What spheres are important for humans? Give specific examples. ◦ Which interactions help humans survive and thrive? ◦ Which interactions are harmful to humans? • Are there other ways that humans impact these spheres or other interactions caused by humans? ◦ What ways do humans harm different parts of Earth's spheres? ◦ What ways do humans help different parts of Earth's spheres? Finally, ask students to revisit their models (diagrams) from the “Engage” portion of the lesson. The interaction cards should have given them many new ideas of what is found in each system and how the systems might interact. Give students 10 minutes to add to their models (diagrams).	For Optional Whole Class Physical Model: Printed interaction card set Paper clips Yarn Spanish Version:  A2 U1 L4 Tarjetas de inter...

	Depending on how much time you have, allow groups to share their ideas for Part 3 of their handout as well. If you have even more time, consider some of the optional “Extend” activities here.			
Elaborate (60 Min)	Students will investigate the target body for this year’s challenge and create a model (diagram) of the major systems present on this diagram. Ask students to review their diagrams of the parts and processes of the four Earth systems and the interaction card list. Then ask them how the Moon is different from the Earth. Which parts, processes, and interactions can happen on the Moon, and which cannot? Give them a 10 minutes to discuss as a pair or small group before taking ideas from the class. Give students access to the following links. The goal is for them to understand how the Moon compares with the Earth. PROMPT: Does the Moon have four systems, too? If so, how are they similar and how are they different from those on the Earth? <table><tr><td> Grade Level Adaptation </td><td> Elementary / Middle School • https://solarsystem.nasa.gov/moons/earths-moon/overview/#otp_kid-friendly_moon • https://spaceplace.nasa.gov/all-about-the-moon/en/ Middle / High School • https://solarsystem.nasa.gov/moons/earths-moon/overview/ NASA’s overview of the moon. Direct students to scroll down or click on “In Depth” to find more information about the 4 spheres. • https://moon.nasa.gov/inside-and-out/overview/ Scroll down or click on the menus at the top like “Water on the Moon” to learn more. High School • Atmosphere: https://science.nasa.gov/mission/ladee/ and https://www.nasa.gov/content/goddard/ladee-lunar-neon • Hydrosphere: https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon and https://moon.nasa.gov/inside-and-out/water-on-the-moon/ • Geosphere: https://moon.nasa.gov/inside-and-out/what-is-inside-the-moon/ and https://www.nasa.gov/feature/nasa-studies-new-50-year-old-lunar-sample-to-prep-for-return-to-moon • Biosphere: https://www.nasa.gov/ames/lunar-biology-lab </td></tr></table> Circulate, asking guiding questions. It is likely that students will generate questions such as “does the Moon have life?” or “what is the surface like on the Moon?” Allow students to conduct additional research online, with a priority for information from NASA websites. If students worked alone, have them pair up and share their ideas about systems on the Moon. If they worked in pairs, have them join another pair to form a small group. Ask them to share ideas about how the Earth and the Moon compare. Finally, ask students to consider how spheres on the Moon interact with each other. This is a tricky question and might depend on the resources that your students chose to explore. For example, since there is no (known) life on the Moon, there is one	Grade Level Adaptation 	Elementary / Middle School • https://solarsystem.nasa.gov/moons/earths-moon/overview/#otp_kid-friendly_moon • https://spaceplace.nasa.gov/all-about-the-moon/en/ Middle / High School • https://solarsystem.nasa.gov/moons/earths-moon/overview/ NASA’s overview of the moon. Direct students to scroll down or click on “In Depth” to find more information about the 4 spheres. • https://moon.nasa.gov/inside-and-out/overview/ Scroll down or click on the menus at the top like “Water on the Moon” to learn more. High School • Atmosphere: https://science.nasa.gov/mission/ladee/ and https://www.nasa.gov/content/goddard/ladee-lunar-neon • Hydrosphere: https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon and https://moon.nasa.gov/inside-and-out/water-on-the-moon/ • Geosphere: https://moon.nasa.gov/inside-and-out/what-is-inside-the-moon/ and https://www.nasa.gov/feature/nasa-studies-new-50-year-old-lunar-sample-to-prep-for-return-to-moon • Biosphere: https://www.nasa.gov/ames/lunar-biology-lab	
Grade Level Adaptation 	Elementary / Middle School • https://solarsystem.nasa.gov/moons/earths-moon/overview/#otp_kid-friendly_moon • https://spaceplace.nasa.gov/all-about-the-moon/en/ Middle / High School • https://solarsystem.nasa.gov/moons/earths-moon/overview/ NASA’s overview of the moon. Direct students to scroll down or click on “In Depth” to find more information about the 4 spheres. • https://moon.nasa.gov/inside-and-out/overview/ Scroll down or click on the menus at the top like “Water on the Moon” to learn more. High School • Atmosphere: https://science.nasa.gov/mission/ladee/ and https://www.nasa.gov/content/goddard/ladee-lunar-neon • Hydrosphere: https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon and https://moon.nasa.gov/inside-and-out/water-on-the-moon/ • Geosphere: https://moon.nasa.gov/inside-and-out/what-is-inside-the-moon/ and https://www.nasa.gov/feature/nasa-studies-new-50-year-old-lunar-sample-to-prep-for-return-to-moon • Biosphere: https://www.nasa.gov/ames/lunar-biology-lab			

	system we can eliminate. There is also an extremely limited atmosphere--some sources for younger students may say that there is no atmosphere. That leaves the hydrosphere and the geosphere. Can students consider ways these interact on the Moon? Note: these limited sphere interactions are the main reason why the Moon changes so little over time, and things like impact craters are visible there for a much longer time than they are visible on Earth, where wind and water erode them and vegetation grows to cover them. To conclude this portion of the lesson, ask students to share which sphere they think they know the most about on the Moon, and which system they have the most questions about. Vote as a class to see if there is agreement.	
Evaluate (30 Min)	<i>Students will compare and contrast the Moon and the Earth.</i> Each group should including the following in their MDL: 1. List at least three similarities and three differences between the Earth and the Moon. 2. List or write a paragraph to answer this question: What do humans need from Earth's systems that are NOT present on the Moon? 3. List at least three questions they have about the atmosphere, biosphere, hydrosphere, or geosphere on the Moon.	
Extend (Optional)	<i>Students will expand on the interaction list from the "Engage" portion of the lesson.</i> Refer students to the list of interactions from the "Explore" portion of this lesson. Choose from the following list of extended learning opportunities around this list, or allow students to choose: 1. Order the interaction list from fastest to slowest 2. Order the interaction list from smallest impact to largest impact 3. List one interaction on each slide in a slide deck. Ask students to find photos that show each interaction and compile them into the slide deck. (This can be done at the end of "Engage" if students are not as familiar with the 4 systems). 4. Extend each interaction in the list to what happened before the specific interaction and what will probably happen after each interaction (Example: Tectonic plates built up forces at a plate boundary (geo). A massive earthquake on the ocean floor creates a tsunami (giant wave) (geo - hydro). The wave crashes into land (hydro-geo), wiping out the plants and animals (bio) found there. The debris is swept out to sea, where it causes water pollution in the shallow ocean near the land (hydro). 5. Create "chains" of impact that start in one sphere but eventually impact every sphere (Example: A wind storm (atmo) knocks down and kills trees on a hillside (Bio). Then, rain (Hydro) causes a mudslide (Geo) because the tree roots aren't holding the soil in place.)	

Interaction Between Earth Spheres

Part 1: For each interaction, list which two earth spheres (Atmosphere, Biosphere, Geosphere, Hydrosphere) that you think are interacting.

#	Interaction	Which Two Systems?
1	A windstorm sweeps up huge dust clouds.	
2	A river carves a canyon a little bit deeper each year.	
3	A coyote stalks and kills a rabbit.	
4	A drought kills a farmer's crops.	
5	A fast-moving lava flow buries a forest.	
6	A forest fire creates huge clouds of soot and smoke.	
7	A glacier melts, creating a new river.	
8	A huge rainstorm saturates a hillside, causing a mudslide.	
9	A landslide blocks a river's path, creating a new lake.	
10	A massive earthquake on the ocean floor creates a tsunami (giant wave).	
11	A plant's roots take water in through the roots.	
12	A puddle on the sidewalk has "disappeared" a few hours later.	
13	A sudden gust of wind blows over several trees.	
14	A tornado destroys a farmer's crops.	
15	A volcanic eruption spews rocks and steam high into the air.	
16	Animal droppings (poop) enrich the soil.	

17	People breathe in oxygen and breathe out carbon dioxide	
18	People cut down trees to build their homes.	
19	Plant roots anchor the soil in place and resist erosion.	
20	Plants take in carbon dioxide from the air	
21	Pounding waves cause an ocean-side cliff to collapse	
22	Strong winds move clouds quickly across the sky.	
23	The winds across the desert cause the sand dunes to grow and shift.	
24	Worms burrow, providing air and nutrients to the soil.	
25	A hurricane's huge waves destroy a bridge.	
26	A wastewater treatment plant overflows, releasing sewage into a river.	
27	Algae produce oxygen during photosynthesis.	
28	An algae bloom makes a lake unsafe for swimming.	
29	An oil spill kills hundreds of sea birds.	
30	Rising ocean temperatures cause coral reef bleaching.	
31	When rain is falling at low elevations, it is snowing on top of nearby mountains.	

Part 2: Our Interactions: Prepare to discuss your answers to this part with your classmates.

We are group _____. The interactions above that involve our two spheres are: _____.

For each of the interactions that involve your two spheres, discuss the following questions:

1. Which sphere is the cause and which sphere is being affected?
2. Is the interaction fast or slow?
3. Are any other spheres involved in this interaction?

Part 3: New Interactions

What other ideas do you have for interactions between your two spheres, or between one of your spheres and humans? For each new idea, which sphere is the cause and which is being affected?

Teacher Guidance, Interactions Between Earth Systems

#	Interaction	Which 2 Spheres? (Answers and guidance)
1	A windstorm sweeps up huge dust clouds.	A to G
2	A river carves a canyon a little bit deeper each year.	H to G
3	A coyote stalks and kills a rabbit.	B to B
4	A drought kills a farmer's crops.	H (or A) to B
5	A fast-moving lava flow buries a forest.	G to B
6	A forest fire creates huge clouds of soot and smoke.	B (or H?) to A
7	A glacier melts, creating a new river.	H to H
8	A huge rainstorm saturates a hillside, causing a mudslide.	H (or A) to G
9	A landslide blocks a river's path, creating a new lake.	G to H
10	A massive earthquake on the ocean floor creates a tsunami (giant wave).	G to H
11	A plant's roots take water in through the roots.	B to H
12	A puddle on the sidewalk has "disappeared" a few hours later.	H to A
13	A sudden gust of wind blows over several trees.	A to B
14	A tornado destroys a farmer's crops.	A to B
15	A volcanic eruption spews rocks and steam high into the air.	G to A or H
16	Animal droppings (poop) enrich the soil.	B to G
17	People breathe in oxygen and breathe out carbon dioxide	B to A
18	People cut down trees to build their homes.	B to B
19	Plant roots anchor the soil in place and resist erosion.	B to G
20	Plants take in carbon dioxide from the air	B to A

21	Pounding waves cause an ocean-side cliff to collapse	H to G
22	Strong winds move clouds quickly across the sky.	A to H (or A)
23	The winds across the desert cause the sand dunes to grow and shift.	A to G
24	Worms burrow, providing air and nutrients to the soil.	B to G
25	A hurricane's huge waves destroy a bridge.	H (or A) to ?? B? G?
26	A wastewater treatment plant overflows, releasing sewage into a river.	B (or H?) to H (or B?)
27	Algae produce oxygen during photosynthesis.	B to A
28	An algae bloom makes a lake unsafe for swimming.	B to H (or B)
29	An oil spill kills hundreds of sea birds.	G (or B) to B (do students see the oil as G, since it comes from within the Earth or B, since it is made by plants? Or do they see the cause of this as humans, which are part of the B?)
30	Rising ocean temperatures cause coral reef bleaching.	H (or A) to B
31	When rain is falling at low elevations, it is snowing on top of nearby mountains.	G to H or A (if they see the mountain's elevation as impacting the weather)

Interaction cards for printing (if using physical model)

1	A windstorm sweeps up huge dust clouds.	9	A landslide blocks a river's path, creating a new lake.	17	People breathe in oxygen and breathe out carbon dioxide	25	A hurricane's huge waves destroy a bridge.
2	A river carves a canyon a little bit deeper each year.	10	A massive earthquake on the ocean floor creates a tsunami (giant wave).	18	People cut down trees to build their homes.	26	A wastewater treatment plant overflows, releasing sewage into a river.
3	A coyote stalks and kills a rabbit.	11	A plant's roots take water in through the roots.	19	Plant roots anchor the soil in place and resist erosion.	27	Algae produce oxygen during photosynthesis.
4	A drought kills a farmer's crops.	12	A puddle on the sidewalk has "disappeared" a few hours later.	20	Plants take in carbon dioxide from the air	28	An algae bloom makes a lake unsafe for swimming.
5	A fast-moving lava flow buries a forest.	13	A sudden gust of wind blows over several trees.	21	Pounding waves cause an ocean-side cliff to collapse	29	An oil spill kills hundreds of sea birds.
6	A forest fire creates huge clouds of soot and smoke.	14	A tornado destroys a farmer's crops.	22	Strong winds move clouds quickly across the sky.	30	Rising ocean temperatures cause coral reef bleaching.
7	A glacier melts, creating a new river.	15	A volcanic eruption spews rocks and steam high into the air.	23	The winds across the desert cause the sand dunes to grow and shift.	31	When rain is falling at low elevations, it is snowing on top of nearby mountains.
8	A huge rainstorm saturates a hillside, causing a mudslide.	16	Animal droppings (poop) enrich the soil.	24	Worms burrow, providing air and nutrients to the soil.		