Expedition Mars Pre-Mission Content

This lesson booklet is intended to provide foundational content for students as they prepare for their visit to a Challenger Learning Center. There are 5 separate lessons in this booklet. Select the number of lessons depending on your classroom schedule availability and student needs. The final page of this booklet contains a list of literature suggestions that can be shared with middle school students.

Prior to your visit, please complete the following:

1. **Student Job Application**
    a. **This document is a student-facing document that helps students learn more about the jobs for the mission.**
    b. **Students are then directed to "apply" for a job.**
2. **Crew Manifest**
    a. **Use this document to assign each student to a team for the mission. When you arrive at the Challenger Learning Center, please give this document to your Flight Director.**

Day 1: Earth vs. Mars

Prep Time: 10 minutes **Lesson Time:** 45 minutes

Essential Questions:

- How will understanding the characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective:

- Students will be able to compare and contrast the properties of Earth and Mars.

Standards:

- Analyze and interpret data to scale properties of objects in the solar system. (MS-ESS1-3)
- The orbits of Earth around the sun and of the moon around Earth, together with the rotation of Earth about an axis between its North and South poles, cause observable patterns. These include day and night; daily changes in the length and direction of shadows; and different positions of the sun, moon, and stars at different times of the day, month, and year. (5-ESS1.B)

- CCSS.ELA-Literacy.RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
- CCSS.ELA-Literacy.RST.6-8.9: Compare and contrast the information gained from experiments.

Teacher Prep:

- Create a KWL chart and Venn Diagram on chart paper.
- Video "Mars Compared to Earth – Eight basic differences" cued and ready to play. https://www.youtube.com/watch?v=VvqANiuGcyo
- Print a copy of the 3-2-1 handout for each student.
- Set up the 4 Corners game by printing statement cards and labeling corners.
- Print a copy of the Exit Ticket for each student.
- Print the job descriptions from the Expedition Mars Job Application.

Notes/Background:

- It is helpful to read through all lesson materials, including handouts, before the lesson.
- Students who need extra assistance can be paired up during any portion of the lesson.
- If your classroom does not allow for the 4 Corners game, you can modify it by printing the four options and having individuals or small groups hold up their answers as you read the statements.

Expedition Mars
Day 1 of 5: Earth vs. Mars

ENGAGE

Materials: Chart paper

"Today we will talk about Mars to help prepare us for our trip to the Challenger Learning Center. Let's talk about what we already know about Mars."

K What we know	W What we want to know	L What we learned

Draw a KWL chart on the board or on a piece of chart paper (chart paper preferred so that it can remain in the classroom for reference). Ask students to contribute what they *know* about Mars. Complete the "K" section of the chart.

When answers have been exhausted, ask students what they *want* to learn about Mars and complete the "W" section of the chart.

EXPLORE

Materials: *Mars Compared to Earth* video; *3-2-1* handout

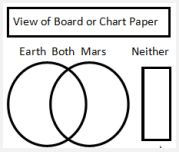
"Now that we have some good ideas about what we already know and what we'd like to learn, we're going to watch a short video highlighting the differences between our planet, Earth, and Mars. At the end of the video, write down 3 things you found interesting, 2 things you learned, and 1 question you still have."

Pass out the 3-2-1 handout before the video so students can write what they learn as they watch. Play the video. Give students a few minutes after the video to complete the handout. Have students share out their 3-2-1 in turn and talk with a neighbor or small surrounding group. Circulate to check for understanding.

EXPLAIN

Materials: 4 Corners statement cards, 4 Corners labels, Venn diagram.

Tip: you may want to put cards in a certain order before starting this lesson to ensure students move around the room.



"We've already learned a lot of new facts about Mars, so let's test our knowledge about the differences between Earth and Mars. We're going to play a game called 4 Corners. I'll read a fact and you need to safely, with walking feet, travel to the appropriate corner where the statement belongs. Our corner choices are **Earth**, if what I say only happens on Earth; **Mars**, if what I say only happens on Mars; **Both**, if it happens on both Earth and Mars; or **Neither**, if my statement does NOT happen on Earth or Mars"

Have the Venn Diagram posted on the board or wall. Have students stand behind desks with chairs pushed in for ease of movement. Read a statement from the 4 Corners cards. Students will move to the correct corner. If students answer incorrectly, have a student at the correct corner share why or read the reasoning at the bottom of the statement card. After reading each card and having students move, tape the statement card to the correct place on the Venn Diagram. When all cards have been read, gather students to review the statements now recorded in the Venn diagram. Check for understanding.

Expedition Mars
Day 1 of 5: Earth vs. Mars

ELABORATE
Materials: Job Descriptions from Job Application
"The facts we learned today will help us complete our mission at the Challenger Learning Center. When we go, everyone will have a different job to do to help us complete Expedition Mars. During our mission, we will work together to get to the surface of Mars from its moon, Phobos." Read the Mission description to the students: "The year is 2076. A handful of facilities have been established on Mars, including a greenhouse, a mobile geological survey base, and a centralized research habitat. The primary human habitat is not on Mars, but on one of its moons, Phobos. A large shuttle regularly ferries astronauts and scientists between the base on Phobos and the surface of Mars. This shuttle, or Spacecraft (SC), carries parts to build a remotely operated vehicle (ROV) to continue the search for evidence of life and water. However, when crew members discover an imminent threat to their Spacecraft and the Martian surface facilities, they must act quickly to save their stations, their research, and their lives." Review each job and description with the students. After introducing students to the Expedition Mars jobs, have them think about which jobs sound most interesting. Students will apply for their jobs later.
EVALUATE
Materials: Exit ticket
Students complete their Day 1 Exit Ticket

Extensions and Enrichment

- If more time allows, increase the number of 4 Corners cards you used during the initial activity.
- Based on the video or their own research, have students create their own version of 4 Corners by creating their own statements.

Additional Resources

- NASA Earth vs Mars Lesson: http://www.nasa.gov/offices/education/programs/national/summer/education_resources/earthspacescience_grades7-9/ESS_earth-vs-mars.html#.V7seX4WcE2w
- NASA Mars Education Lessons: https://marsed.mars.asu.edu/stem-lesson-plans

Day 2 of 5: Extremophiles

Prep Time: 20 minutes **Lesson Time:** 45 minutes

Essential Questions:

- How will understanding the characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective:

- Students will be able to explain the significance of the presence of extremophiles on Mars.

Standards:

- Construct an explanation based on evidence that describes how genetic variations of traits in a population increase some individuals' probability of surviving and reproducing in a specific environment (MS-LS4-4).
- Support claim(s) with logical reasoning and relevant, accurate data and evidence that demonstrate an understanding of the topic or text, using credible sources. (CCSS.ELA-LITERACY.WHST.6-8.1.B)
- Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue. (CCSS.ELA-LITERACY.RI.6.7)

Teacher Prep:

- Print *Do Nows* and *Exit Tickets* for each student.
- Print pictures of canyons on Mars and Earth or project in PowerPoint.
- Print one Earth vs. Mars characteristic chart for each group.
- Create enough decks of cards (linked below) for each group of 2-3 students. Differentiate the decks in some way. Put in a zip-top bag for easy distribution and collection.
- Print enough *Put an Extremophile on Mars* handouts for class.
- Video: Have the "Why extremophiles bode well for life beyond Earth" video cued and ready to play: https://www.youtube.com/watch?v=Bsp5JYNMAQE.

Notes/Background:

- It is helpful to read through all lesson materials, including handouts, before the lesson.
- Mars environment cards: https://marsed.mars.asu.edu/sites/default/files/stem_resources/mars-cards.pdf
- Extremophile cards: https://marsed.mars.asu.edu/sites/default/files/stem_resources/cards_0.pdf
- For students who need additional reading support, highlight/underline important information on the cards. The number of options can also be reduced (put in 4 of each instead of 8 of each)

Expedition Mars
Day 2 of 5: Extremophiles

ENGAGE

Materials: *Do Now* handout

For a warm-up/Do Now, have students list items that organisms need to live. Students share out answers, while the teacher compiles a list on the board.

EXPLORE

Materials: Photographs of canyons on Mars and Earth; *Why extremophiles bode well for life beyond Earth* video

"Living organisms need water to live. Some need a lot, some need a little, some need hot water, some need salt water, but all need water. Because of this, evidence of water would prove that life COULD be on Mars."

Show a picture of evidence of water on Mars, compared with a similar photo from Earth.

"By looking at this picture, we can see that water is present on Mars. This leads us to believe that life was potentially on Mars at one point and may still be there today. No life has been found, but this says it **is possible**. Today we will look at the types of life that **could** live on Mars. As we learned yesterday, there is very little oxygen, low pressures, and extreme temperatures. Because of that, we will look at **extremophiles**, organisms that live in extreme environments. Let's watch a video to learn more about extremophiles."

EXPLAIN

Materials: *Earth vs. Mars* chart (1 per group); Mars environment cards; Extremophile cards; *Put an Extremophile on Mars* handout

Give each group an Earth vs. Mars chart as a reference sheet and two sets of cards: extremophiles (found on Earth) and Mars environment. In groups of 3, students will select an extremophile that they believe could survive on Mars and then select an environment where it could live. Students will explain their choices and will present their findings to the class. A sample can be done as a whole class prior to having the students do this in their small groups.

"This card says that Endoliths do not need a lot of water and can survive in extreme hot and cold temperatures. Let's find an environment on Mars that is similar. The Desert Meridiani Planum does not have a lot of water and has temperatures ranging from very cold to very hot. This would be a good match for the Endoliths."

ELABORATE

Materials: *Earth vs. Mars* chart, *Put an Extremophile on Mars* handout

Students work for 10 minutes on this activity. Then each group has 1-3 min. to present their findings. After presentations, reiterate that these extremophiles have not been found on Mars, but since Mars has more extreme conditions, scientists believe these are the key to finding life.

Similar investigations will be done by the **BIO team** during Expedition Mars at the Challenger Learning Center.

EVALUATE

Materials: Day 2 Exit Ticket

Have students complete and turn in an Exit Ticket answering the question: "Why are scientists studying extremophiles?"

Day 3 of 5: The Journey of the Inspiration Rover

Prep Time: 10 minutes **Lesson Time:** 45 minutes

Essential Questions:

- How will understanding characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective:

- Students will be able to describe the aircraft take-off and landing processes on Mars.

Standards:

- Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue. CCSS.ELA-Literacy.RI.6.7:
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion. (MS-PS2.A)
- Gravitational forces are always attractive. There is a gravitational force between any two masses, but it is very small except when one or both objects have large mass—e.g., Earth and the sun. (MS-PS2.B)
- Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly. (CCSS.ELA-LITERACY.SL.6.1)

Teacher Prep:

- Print all three articles (laminate them if you want to reuse them for other class periods)
- Print copies of the graphic organizer (Seven Minutes of Terror), Do Now, and Exit Ticket for each student
- Video: Have the “Curiosity Has Landed” video cued and ready to play: https://www.youtube.com/watch?v=N9hXqzkH7YA
- Have the Expedition Mars Job Descriptions ready.

Notes/Background:

- It is helpful to read through all lesson materials, including handouts, before the lesson.
- Review all pieces of the launch and landing process. The videos can be useful. This is also a helpful animation (Can also share with students): http://mars.jpl.nasa.gov/multimedia/interactives/edlcuriosity/index-2.html
- If your class does not split evenly into groups of three, it is OK to have a few groups of two, as long as students have access to all three articles.

Expedition Mars
Day 3 of 5: The Journey of the Inspiration Rover

ENGAGE

Materials: *Do Now*

Students will complete the *Do Now* at the beginning of class to get them thinking about the take-off/landing process of aircraft.

EXPLORE

Materials: *Curiosity Has Landed* video

Begin by facilitating a discussion using their answers to the Do Now, focusing first on how airplanes take off.

"Planes follow a specific process for taking off and landing to ensure success. They must get up to a certain speed and then they slowly increase their altitude until they're at the proper altitude to fly. When we go to the Challenger Learning Center, we will travel from one of Mars's moons, Phobos, to Mars. For this, we will be using a spacecraft; however, it is still important that it follows a specific take-off and landing procedure, just like airplanes. Today, we will go through a similar journey with our Inspiration Rover.

"In this journey, we will be launching from Phobos, one of Mars's moons, to the surface of Mars. You've seen spacecraft take off from Earth. What do you know about this process? How does the spacecraft launch and leave Earth?" [prompt students to talk about speed]

"In order to "leave" the Earth, it has to escape from Earth's atmosphere and gravity. To 'break free' from something's gravity, an object must go faster than the **escape velocity**. The escape velocity is the speed it takes to escape the gravity of that body. Everything has a different escape velocity: the escape velocity of Earth is 25,000 mph, Mars is 11,000 mph, and Phobos's is about 25 mph. So, based on those numbers, do you think it'll be easier to launch to and from Mars and Phobos or from Earth?

"Our rover has reached the escape velocity and is officially on its way to Mars. The next step is landing. This is challenging because the rover will be going very fast and must slow down quickly to land safely. Rovers must be planned and programmed ahead of time since no one is in the spacecraft. Also, because of the distance, when rovers have been launched from Earth, there is a radio delay in communication. By the time Mission Control gets word that the rover has entered the atmosphere, it will have already actually reached the ground. This means Mission Control waits anxiously to know whether the rover landing was a success."

"The waiting period when Mission Control waits to hear from the rover is called the '**seven minutes of terror**.' The seven minutes of terror refers to the time it takes the rover to go from full speed to a full stop. Because of the radio delay, Mission Control cannot monitor this process. They can only wait. Here is a video about landing a rover on Mars." **[show video]**

EXPLAIN

Materials: Printouts of *Aerobraking: The First Stop*, *The Power of the Parachute*, and *Rocket Thrusters: The Last Stop* (enough for each group of 2-3 students to have one of each article).

Expedition Mars
Day 3 of 5: The Journey of the Inspiration Rover

ELABORATE
Materials: Seven Minutes of Terror graphic organizer; Calculators (as needed by students)
Students complete a jigsaw. Suggested timing: 5 minutes for students at the station; 10 minutes to report back to the group and finish calculations. Bring the group back together to reflect on the activity. Ask students what they thought about the jigsaw activity. What would happen if someone didn't do their job? How might this relate to a crew in space? It was important that everyone in your team listened and followed directions. If one person didn't know what to do or didn't follow instructions, your team would not have been successful. If you miss a direction or an instruction, what are some problem-solving strategies you can use to help keep your mission moving forward? "Crews in spacecraft usually have one expert on many different topics that they rely on for information. You will see this during Expedition Mars at the Challenger Learning Center. Each person will be on a different team and you will count on each other for information. It's important you do your part."
EVALUATE
Materials: *Exit Ticket*
Students complete their Exit Ticket summarizing the landing process on Mars.

Extensions and Enrichment

- If time allows, show this 5-minute video after going through the process of descent: https://www.youtube.com/watch?v=Ki_Af_o9Q9s
- Students who struggle with math might need more in-depth instruction on what to do with delta.

Day 4 of 5: The Geology of Mars

Prep Time: 25 minutes **Lesson Time:** 45 minutes

Essential Questions

- How will understanding the characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective:

- Students will be able to identify and analyze land features showing evidence of Mars's water.

Standards:

- Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales. (MS-ESS2-2)
- CCSS.ELA-Literacy.RI.6.7: Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.

Teacher Prep:

- Obtain the following materials: one 2-liter bottle, scissors, gauze/cheesecloth, a rubber band, soil, and water.
- Prepare a bottle for the soil demonstration ahead of time. To do this, you need two bottles.
    1. Cut off the base of one bottle to make the container for the soil column.
    2. Cut off the top spout of the other bottle to make a water collector. *Diagram 1*.
    3. Place a piece of gauze or cheesecloth over the bottle's spout, securing the cloth with a rubber band.
    4. Add soil to the bottle. *Diagram 2*.

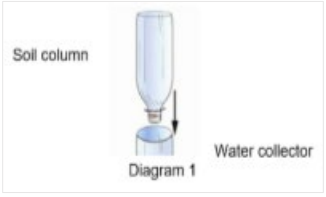


Diagram 1

- Print the picture cards and *Earth and Mars: It's a Match* handout for each small group.
- Video: Have the "NASA Now: Geology: Curiosity -- Main Science Goals" video ready to play: https://www.youtube.com/watch?v=leNAkb1W4H0

Notes/Background:

- It is helpful to read through all lesson materials, including handouts, before the lesson.
- It is hypothesized that rocky planets like Earth and Mars formed from the debris of an exploded star that was once near the location of our current Sun. Over millions of years, the debris accumulated into many larger "clumps" of debris that formed some of the planets, moons, asteroids, and comets that now make up our solar system. According to this theory, both planets should have similar features because Earth and Mars formed through similar processes.

Day 4 of 5: The Geology of Mars

- NASA is investigating plans to send the first humans to Mars within the next two decades. They will explore our planetary neighbor and the possibilities of creating a future habitat for explorers. If this timeline works, the first people who will go to Mars are probably in a middle school or junior high school classroom at this very moment. Could it be one of your students?
- Parts of this lesson were adapted from lessons created by NASA lesson.

Expedition Mars
Day 4 of 5: The Geology of Mars

ENGAGE

Materials: "NASA Now: Geology: Curiosity -- Main Science Goals" video; Dry erase board and markers

Today we're going to talk about Geology on Mars. Geology is the study of a planet's physical structure and properties. We will investigate the physical properties of Mars and discover whether Mars has water. Because water is essential for life, finding water would support a hypothesis that there are building blocks of life on Mars. Watch the **video.** Have students share out one thing they learned in the video. Record answers on the board.

EXPLORE

Materials: 1 prepared sand bottle (directions on the prep page); 50 mL of water for each bottle

"Scientists are investigating if there is, or has ever been, water on Mars. Water is an important building block of life, so it would be a significant piece of evidence in exploring if life is sustainable on Mars. Do you think there is, or ever was, water on Mars? Why or why not?"

Note: Students may say there aren't lakes/oceans. Prompt by asking what they DO see.

"Today, we're going to look at soil. I will pour 50 mL of water into this bottle of soil. What do you think will happen? Do you think 50 mL will come out the other end? If not, where will it go?"

Pour 50 mL of water into the container. As it drains, ask students for observations. Ask one student to record everyone's observations on the whiteboard. Once the water is poured, have a student measure the amount of water in the collection cup. Write that number on the board.

"Knowing we started with 50 mL of water, did all the water come out? Only some? Where is the rest of the water? Knowing this, why do you think scientists are looking underneath the soil on Mars? Also, notice how the appearance of the soil has changed. How can you tell that water has flowed through it?"

"We know that there aren't lakes or oceans on Mars, but we also know that water can be underground. Think about when it rains; a lot of the water is absorbed into the soil under the grass. When you water a plant, the water is absorbed into the soil. Scientists are drilling underground and looking at rock samples to see if the soil was exposed to water, just like how water was stored in the soil in our demonstration.

Studying rocks and landforms can be a very useful way to learn more about the history of planets. Because of this, geologists play an extremely important role in helping to determine the presence of water on Mars. This research is related to the work the **GEOLOGY team** will do during Expedition Mars."

EXPLAIN

Materials: Picture cards (1 set per group); *Earth and Mars: It's a Match* handout (1 per group); Tape/glue

"Now that we know how water travels through different types of soil and how it can be stored let's think about how water can affect the physical properties of a planet, such as landforms. The best example of water affecting land on Earth is the Grand Canyon. It was formed over millions of years as water eroded the Earth. Have you seen a weather event, like a flood or a hurricane, affect your own backyard or your community? Single events can change an area's landscape, so pictures of a planet or landform can tell a lot about its history. Let's explore a little more into the geology of Mars.

You will have 10 pictures (5 Mars, 5 Earth). Match a picture from Mars that is like a picture from Earth, looking at craters, canyons, and other landforms. Then determine which picture is from which planet."

ELABORATE

Materials: Picture cards (1 set per group); *Earth and Mars: It's a Match* handout (1 per group); Tape/glue

What physical processes occur on both Mars and Earth?

Pair students or create small groups of 3-4 to complete this activity. Give each group a picture card set. Students will look at several pictures to match the two pictures of similar landforms - one picture from Earth and one picture from Mars.

Ask the students to study the cards and find two cards that they think show similar landforms. Tape or glue each picture to the Investigation Log (one per group). Have the students write 1-2 sentences about what the pictures have in common. Then, students will predict which photograph is Mars and which is Earth.

Do an example together- Figure 1 pairs with Figure 2. Show students the similarities and write Mars on Figure 1 (Olympus Mons, Mars) and Earth (Island of Maui) on Figure 2.

After students have completed the activity, if time allows, have each small group share one of their picture matches. Students can correct their work as you review the matches if time permits.

Answer Key:

Figure 3: Ares Valles "Twin Peaks," Mars / Figure 7: Lavic Lake Desert, Earth

Wind erosion occurs frequently in arid (dry) environments. There is little vegetation to hold material down, so wind causes most erosion.

Figure 4: Yuty Crater, Mars / Figure 6: Meteor Crater, Earth
Meteors produce unique landforms on both Earth and Mars. Vegetation obscures some craters on Earth.

Figure 5: Warrego Valles, Mars / Figure 11: Yemen, Earth
Streams/rivers produce the distinctive branching pattern seen in both images. Yemen, like Mars, was once a much wetter environment than it is today.

Figure 8: Grand Canyon, Earth / Figure 9: South Candor Chasma, Mars
Over time, running water can be powerful enough to create canyons.

EVALUATE

Materials: Day 4 Exit Ticket

Students should complete the Day 4 Exit Ticket. Teachers can remind students that water is a building block of life, so water is a good clue that life COULD exist on Mars, either in the past or now.

Day 5

Two Lesson Options

Lesson 5A – Human Bodies on Mars: Requires a 60-minutes class period. This lesson features hands-on learning stations that require materials and teacher preparation time.

Lesson 5B – Living in Space: Requires a 45-minute class period. Students participate in a space habitat design challenge.

Day 5A: Human Bodies on Mars

Prep Time: 30 minutes **Lesson Time:** 55 minutes

Essential Questions

- How will understanding the characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective

- Students will be able to design a space station to safely sustain human life on Mars.

Standards

- Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LS1-5)
- Develop and use a model to describe the role of gravity in the motions within galaxies and the solar system. (MS ESS1-2)
- Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. (CCSS.ELA-LITERACY.RST.6-8.3)

Teacher Prep/Supplies

- Obtain the following supplies: dry sponge, wooden spools, pipe cleaner, container of water, two coffee cans, dried beans, newspaper/padding, string (1ft per pair of students), scissors, markers, timer, Styrofoam cups (1 per student), hole puncher
- Print copies of the Lab Observation Sheet, Do Now, and Job Applications.
- Prepare all stations in advance of the lesson:

  Initial whole-class demonstration: Sponge Spine:

  1. Cut a dry sponge that expands when wet into three 1-2-inch squares and use a hole-puncher to punch a hole in the middle of each square.
  2. Place alternating pieces of sponge and wooden spool on your pipe cleaner.
  3. Use a pipe cleaner to add arms and legs to the spine.
  4. Leave space between the “spine” and “legs” for when the spine expands.
  5. Have a container of water ready for the demonstration.

  Station 1: Beans in Space

  1. Line two coffee cans (or another opaque container) with padding materials, such as newspaper or packing peanuts. The padding will keep the beans from rattling.
  2. Label one can “EARTH” and pour 3 cups of dried beans into it. Add more packing if needed to prevent rattling.

3. Label the other can “MARS” and pour 1 cup of dried beans into it. Add more packing if needed to prevent rattling.
4. Put lids on both cans and use tape to secure the lids.

Station 2: Measuring Up

1. Cut string into 1-foot pieces.
2. Confirm you have enough pieces for all student pairs to use one.

Station 3: Bones

1. Gather enough Styrofoam cups for each pair to have two.
2. Label half “EARTH (or BONE ON EARTH)” and poke 5 holes around the sides using a sharp pencil.
3. Label the other half “MARS (or BONE ON MARS)” and poke ~15 holes around the sides.

Notes/Background:

- This lesson begins with a demonstration. Please read the lab activities and have materials prepared in advance.
- Set up your classroom to allow students to move to different stations around the room.
- This lesson needs the full 60 minutes to complete the activities. If less time is needed, remove the initial Sponge-Spine demonstration to allow enough time for students to pick Mission roles at the end of the lesson, as that selection directly impacts their mission visit

Expedition Mars
Day 5A: Human Bodies on Mars

ENGAGE

Materials: Do Now, Sponge-spine model; Container of water; Lab Observation Sheet; Ruler

"What would happen to your body on Mars? Today we will explore how our bodies would react to being on the red planet. What do we know about Mars? How does gravity on Mars compare to gravity on Earth? We talked on Day 1 about how you would weigh less on Mars, but would your height change? Why or why not?"

[Students complete Do Now.]

"Here we have a model of a human. This is the spine on Earth; the sponges are the discs and wooden spools are the vertebrae. On Earth, our bodies are always experiencing gravity. It is constantly pulling us down toward the Earth. Let's compare Earth to Mars."

[Measure the "spine" or ask for students to help.]

"On Mars, our bodies no longer experience the same gravity as on Earth. In space we experience microgravity. This means there is less gravity pushing down on us. Let's see what happens if there is less gravity. This pool of water will represent space, or in this case, Mars."

[Put the spine model into the water. Allow a minute for the sponges to absorb water. Pull it out and measure the "spine" again. It should have expanded.]

"This is how our bodies would react on Mars, where there is less gravity than on Earth. Based on your observations, what would happen to your height on Mars? If your spine gets longer, what do you think would happen?

We will try a few more experiments to learn about our bodies in space.

[Explain the stations to the students. Break students into 3 groups and have students rotate to the next station every 5-7 minutes.

EXPLORE

Materials:
Beans in Space: Two cans labeled EARTH and MARS. (See "Prep" for instructions on making these); Lab Observation Sheet; Lab Station Directions

Measuring up: For each group of 2 students, you need: 2 different colors of markers; 1 (12–18-inch) length of string that will not stretch; writing utensil and scrap paper; timer or watch

Bones: Styrofoam cups labeled EARTH and MARS

Expedition Mars
Day 5A: Human Bodies on Mars

Students rotate through 3 stations:

Station 1 – Beans in Space
Complete an experiment to determine how much more you need to exercise in space due to its lower gravity.
Students will do 20 curls with each container and compare which used more effort and helped build muscles faster.

Station 2 – Measuring up
Complete an experiment to measure how blood flow changes in space.

Each pair of students will take turns with the following steps:
While your partner is standing, wrap the string once around your partner's ankle. Make a mark where the end of the string comes back into contact with the rest of the string. Using a ruler, measure the distance from the end of the string to the mark and record your measurement. Have your partner lay on the floor near a wall with his or her legs in the air leaning against the wall for one minute. After one minute, measure his or her ankle again — while his or her legs still are propped against the wall —with a different color, and record that measurement. Be sure to measure the ankle at the same place.

What do you notice? Hypothesize why that might happen, based on your knowledge of gravity and blood flow.

Station 3 – Bones
Complete an experiment to compare bone structures on Earth and Mars.

Stand each of the "bones" (cups) upright on a flat surface. The cup with 5 holes represents the bones on Earth and the cup with 15 holes represents the bones on Mars. Place your hand, palm down, on top of the Earth bone. Gently press down and observe how difficult it is to collapse the cup. Gently press down on the "space bone" and observe how difficult or easy it is to collapse. What do the students notice? Have the students make predictions based on their observations.

EXPLAIN

Materials: Lab Observation Sheet

Debrief on stations
Gather students back together. Discuss each station, what the students observed, and what conclusions they made after their experiments. Use the explanations below to guide your follow-up conversation with your students as you see fit.

Station 1 – Beans in Space
On Mars (a lower gravity environment), everything weighs less than it would on Earth, just like how the Mars can weighs less than the Earth can. When things weigh less, astronauts' muscles don't have to work as hard to lift their bodies or equipment. Because their muscles are not working as hard, their muscles **become smaller and weaker**.
To combat this, astronauts exercise almost two hours every day while they are in space, and even *then,* they *still* lose muscle mass.

Station 2 – Measuring Up
Note: It may be challenging for students to make the connection independently, so you may need to scaffold content and conversation for the students.
Blood and water are constantly circulating through the body. You don't feel it, but gravity is pulling your

blood downward on Earth. When there is less gravity, like on Mars, fluids like blood and water float. They aren't being pushed downward, so they will move higher up in your body. This is why when astronauts first get to space the top half of their body will look bigger, their face will look puffy, and their legs and ankles will be smaller. This is what happened to your ankles. When you put your ankles on the wall, gravity was no longer pulling your blood down to your ankles, so they got smaller.

Station 3 – Bones
Explain that astronauts' bones become weak in space (a microgravity environment). Astronauts' muscles don't have to work as hard, and the muscles don't have to pull as hard on the bones to support the astronauts' bodies, just like we learned in the CAN Station. The "space bone" became weak because it didn't get enough exercise and lost minerals, represented by the many holes. Astronauts must exercise almost two hours daily and have a calcium-rich diet to keep their bones from weakening.

It is important to emphasize that being in space does not create holes in bones. This activity uses models of bones (cups) to demonstrate the effects of mineral loss in bones because of being in space. The "bone" (cup) with more holes models a bone that is less healthy than the "bone" (cup) with fewer holes.

ELABORATE

Materials: Expedition Mars Job Descriptions

"The last step in preparation for our visit to the Challenger Learning Center is to pick your role on the Mission Crew. Let's review the roles in Expedition Mars."

Distribute Job Descriptions and Job Applications

EVALUATE

Materials: Expedition Mars Job Application

Each student completes and turns in their Job Application.

Extensions and Enrichment:

- Students can research more about humans in space. Students can create a poster or PowerPoint presentation to share with younger grades or community members during a science night or fair.
- Students can create their own habitat for Mars that would include ways for astronauts to keep their bodies healthy.
- Students can create a Healthy Human plan to combat the effects of Mars.

Note: Parts of this lesson are adapted from The Lunar and Planetary Institute Health in Space: http://www.lpi.usra.edu/education/explore/space_health/space_stations/

Day 5B: Living in Space

Prep Time: 20 minutes **Lesson Time:** 45 minutes

Essential Questions

- How will understanding the characteristics of Mars lead to a successful Expedition Mars mission at a Challenger Learning Center?
- What would the human experience be on Mars, and how does it affect or limit exploration?

Objective

- Students will design a space station to safely sustain human life on Mars.

Standards

- Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. (MS-LS1-5)

Teacher Prep

- Set up the spine experiment. Build the spine and have a container of water ready.
    1. Cut a dry sponge that expands when wet into three 1-2-inch squares and use a hole-puncher to punch a hole in the middle of each square.
    2. Place alternating pieces of sponge and wooden spool on your pipe cleaner.
    3. Use a pipe cleaner to add arms and legs to the spine.
    4. Leave space between the “spine” and “legs” for when the spine expands.
    5. Have a container of water ready for the demonstration.
- Videos Cued and ready to play.
    - Explorers living on ISS, sleeping quarters, bathroom, food, etc. (8:41) https://www.youtube.com/watch?v=tBVUTFPate0—
    - Tours the laboratory modules, and discusses the need for exercise (5:10) https://www.youtube.com/watch?v=ntYP7cRozhk—
    - Shows observation window, more exercise equipment, etc. (6:07) https://www.youtube.com/watch?v=jbZ7lDlVeIo—
    - Tours the Russian segment (the oldest), how the Spacecraft is docked at the ISS (9:39) https://www.youtube.com/watch?v=IJT0FMN_Ua0
- Print copies of *Create a Space Habitat*, *Job Application*, and *Do Now*.
- Print the Expedition Mars Job Application, including Job Descriptions.

Notes/Background

- This lesson can be adapted to different class lengths. Choose the number of videos that best fits the time allotted.

Expedition Mars
Day 5B: Living in Space

ENGAGE

Materials: Sponge-spine model; Container of water; Ruler

What would happen to your body on Mars? Today we're going to explore how our bodies would react to being on the red planet.

What do we know about Mars? How does the gravity on Mars compare to the gravity on Earth? We talked about how you would weigh less on Mars, but would your height change? Why or why not?

Here we have a model of a human. This is the spine on Earth; the sponges are the discs and wooden spools are the vertebrae. On Earth, our bodies always experience gravity. It is constantly pulling us down toward the Earth. Let's compare Earth to Mars.

[Measure the "spine" or ask for students to help.]

On Mars, our bodies no longer experience the same gravity as on Earth. In space we experience microgravity. This means there is less gravity pushing down on us. Let's see what happens if there is less gravity pushing on us. This pool of water will represent space/Mars.

[Put the spine model into the water. Allow a minute for the sponges to absorb water. Pull it out and measure the "spine" again. It should have expanded.]

This is how our bodies would react on Mars where there is less gravity than on Earth. So, what would happen to your height on Mars? If your spine gets longer, what do you think would happen?

Currently, there are astronauts dealing with these effects living on the International Space Station. Astronauts from all over the world go for 6 months at a time to do research and experiments. Let's watch a few videos as a NASA astronaut gives a tour of their home for these months.

EXPLORE

Materials: Videos

Space Station. Play as many or as few as you see fit or have time for. These are in order of interest/importance, with their running time.

- Explores living on ISS, sleeping quarters, bathroom, food, etc. (8:41)
  https://www.youtube.com/watch?v=tBVUTFPate0—
- Tours the laboratory modules, and discusses the need for exercise (5:10)
  https://www.youtube.com/watch?v=ntYP7cRozhk—
- Shows observation window, more exercise equipment, etc. (6:07)
  https://www.youtube.com/watch?v=jbZ7lDlVeIo—
- Tours the Russian segment (oldest), how the Spacecraft is docked at the ISS (9:39)
  https://www.youtube.com/watch?v=IJT0FMN_Ua0

Expedition Mars
Day 5B: Living in Space

EXPLAIN

Materials: Create a Space Habitat handout; Markers/Crayons/Colored Pencils

"Based on the video and what you have learned about Mars all week, what do you think are the biggest issues for humans in Space, specifically Mars?"

Suggested answers: Low gravity, lack of oxygen, cold, needing to find water and make it safe for humans, no food, getting sick, psychological effects, the danger of launching/landing/travel, the unknown—who knows what's out there and what could happen?

Radiation hasn't been discussed yet, but it is an important human risk. Radiation is energy that travels in waves. Low levels of radiation are not dangerous, but high levels can be very harmful to humans. On Earth we have the ionosphere to protect us; however, Mars is not protected against this radiation from the Sun, this high energy radiation getting into bodies can change DNA and cause cancer.

"You will be working with a partner to design a space habitat. This will live on Mars and house astronauts for long periods (or forever). You will want to have places in your habitat that addresses the concerns and needs of humans but remember, be creative! This habitat doesn't exist yet, so you can make it whatever you want—as long as it's scientifically accurate!"

[Distribute Create a Space Habitat handout. Students work for 10 minutes. If time allows, have them present their habitats or set up a Gallery Walk for students to look at other creations. You may also choose to have students complete the Scientific Explanation handout.]

ELABORATE

Materials: Expedition Mars Job Descriptions

"What we have studied today is like what the **Medical (MED)** and **Life Support (LS) teams** will do during Expedition Mars at the Challenger Learning Center. Now, we are ready for Expedition Mars at the Challenger Learning Center. As we discussed, each of you will have an individual role on the Mission team. Let's review the roles again and then you will pick your top three choices and tell why you are the best fit for the role."

Distribute Job Descriptions and Job Application

EVALUATE

Materials: Expedition Mars Job Application

Students will complete and turn in their Expedition Mars Job Application.

Literature Suggestions

Mars Is written by Suzanne Slade

- **A nonfiction photo gallery book showcasing Martian landforms and surface features. Images were taken by the Mars Reconnaissance Orbiter's camera.**

The Sirens of Mars: Searching for Life on Another World written by Sarah Stewart Johnson

- **A detailed account of the stories and investigations that researchers have conducted in searching for life on Mars.**

Exploring Mars written by Scott Hubbard

- **A detailed account of the Mars Exploration Program, written by Scott Hubbard who was in charge of revitalizing the program in the early 2000.**

Mars Up Close written by Marc Kaufman

- **In collaboration with National Geographic, this book shares the story of the Curiosity mission to Mars, including engaging images of the mission.**

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