

Lecture Tutorial: Migration to Mars

Description: In this Lecture Tutorial style activity, students consider some of the hazards related to space travel to Mars. In addition to the psychological pressures, the dangers from the Sun and from galactic cosmic rays increase greatly while in space and on the Martian surface. After gaining a more realistic idea of what space travel entails compared to ideas commonly seen in entertainment, students will reflect on their desire to undergo such a trip .

Learning Goals:

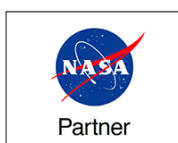
1. Use ratio and proportion to estimate how much food and water would be needed for a four-person crew to travel to Mars and back.
2. Weigh psychological and physical hazards that an astronaut would encounter on the trip to Mars and on the Martian surface.
3. Reflect on one's personal interest in colonizing the Martian surface.
4. Consider the habitability of Mars versus that of Earth.

Prerequisite Ideas:

- Understand that the Sun emits both ions and a range of electromagnetic radiation.
- Galactic cosmic rays are high energy ions that form a background radiation in the solar system.
- Know the role that Earth's atmosphere and magnetosphere plays in keeping us (mostly) safe from the Sun.

Teacher Notes:

- This activity can be done in a unit that is centered around the habitability of various locations in our solar system.
- The Instagram post question (Q8) is designed to help students synthesize their knowledge about a Mars mission in a way that connects with their daily lives and allows for creativity via the proposed use of a social media platform.



Travel to, and the possible habitation of, Mars has been in the news a lot recently. The film *The Martian* was a big hit, and Elon Musk talks frequently of his desires to develop the technology needed to travel to Mars. But how easy will it actually be to travel there and back?

Part I: Intro to Travel to Mars

According to [SpaceX](#), it would take about 6 months for a human to travel from Earth to Mars. Consider what a group of astronauts would need to take to visit Mars. Assume that four astronauts will travel to Mars, spend 3 months there, then travel back.

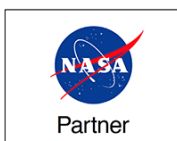


1. How many pounds of food are needed for the same group of astronauts who would go to Mars, spend three months there, and then come back? Each astronaut would need about 5 pounds of food per day.

2. The water the astronauts take with them will be recycled in the same way as it is on the [International Space Station](#) (ISS). Because the ISS is currently in operation, we will base our assumptions on this mission. On the ISS, there is a 530 gallon reserve of water for emergencies. Let's suppose that the astronauts who travel to Mars have this amount in reserve, plus 800 gallons for use and reuse. One gallon of water weighs 8 pounds. How many pounds of water will the astronauts need to take in total?



3. What else do the astronauts need to take with them?



4. The current cost to launch a mission into space is \$10,000 per pound as part of the spacecraft load. Assume that the total mass of the astronauts is 700 pounds (2 people weighing 200 pounds each and 2 weighing 150 pounds each.) What is the total cost of launching the mission, including food, water, and astronauts (but not including the weight of the launch vehicle nor its fuel supply)?

5. Who do you think should pay for this? Explain your reasoning.

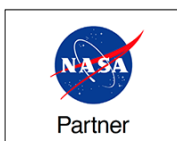
6. Astronauts are exposed to health risks associated with space travel. Go to [this NASA link](#) (or use the QR code to the right) and read the discussion of five such risks by NASA. Of these five, which one concerns you the most? Why?



Part II: The Martian Visit

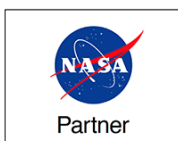
Mars has no breathable atmosphere, so the astronauts will have to bring their own air, and either be in a space suit or another enclosed space at all times while on the Martian surface. Also, the temperatures on Mars are not warm! During the summer, it can get up to nearly 60°F (15°C), but at night it can get down to a very cold -100°F (-73°C).

7. Consider Earth's atmosphere compared to the Martian atmosphere. In what ways would the surface of Mars be more dangerous than here on Earth?



8. Suppose you are one of the astronauts on Mars. Draw and describe one Instagram post from the trip to the red planet, and one Instagram post from your scientific investigations on Mars.

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Suggested supplement for LECTURE-TUTORIALS FOR INTRODUCTORY ASTRONOMY 3

Find more teaching resources at aapt.org/Resources/NASA_HEAT.cfm

This resource was developed by S. Willoughby, J. Bailey, & B. Samie. The co-authors acknowledge useful discussions with B. Ambrose, X. Cid, D. Donelan, R. Lopez, and R. Vieyra, and the support of a subcontract from the NASA HEAT Team to Temple University and the AAPT under NASA Grant/Cooperative Agreement Number NNX16AR36A.

