



**Reading Supports**

**Teacher’s Guide:**

**“Mars vs. Titan:
A Showdown
of Human Habitability”**

*October/November 2018*

<http://www.acs.org/chemmatters>



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of Human Habitability”***

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# Reading Supports

The pages that follow include reading supports in the form of an Anticipation Guide, a Graphic Organizer, and Student Reading Comprehension Questions. These resources are designed to help students prepare to read the article, and then locate and analyze information from the article.

* **Anticipation Guide (p. 5):** The Anticipation Guide helps to engage students by activating prior knowledge and stimulating student interest before reading. If class time permits, discuss students’ responses to each statement before reading each article. As they read, students should look for evidence supporting or refuting their initial responses.

**Or** consider the following ideas to engage your students in reading:

**Mars vs. Titan: A Showdown of Human Habitability**

* Before reading, ask students what they know about requirements for human space travel to other planets, and what humans would need to survive.
* As they read the article, ask students to compare their original ideas about human space travel with information from the article. Ask them to write questions they have about the science in the article.
* **Graphic Organizer (p. 6):** The Graphic Organizer is provided to help students locate and analyze information from the article. Student understanding will be enhanced when they explore and evaluate the information themselves, with input from the teacher, if students are struggling. Encourage students to use their own words and avoid copying entire sentences from the article. The use of bullets helps them do this.

If you use the aforementioned organizers to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

* **Student Reading Comprehension Questions (p. 7):** The Student Reading Comprehension Questions are designed to encourage students to read the article (and graphics) for comprehension and attention to detail, to provide the teacher with a mechanism for assessing how well students understand the article and/or whether they have read the assignment, and, possibly, to help direct follow-up, in-class discussion, or additional, deeper assignments.

Some of the articles in this issue provide opportunities, references, and suggestions for students to do further research on their own about topics that interest them.

To help students engage with the text, ask students which article **engaged** them most and why, or what **questions** they still have about the articles. The “Web Resources for More Information” section of the Teacher’s Guide: Tools and Resources provides sources for additional information that might help you answer these questions.

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

## Anticipation Guide

**Directions:**  ***Before reading the article*,** in the first column, write “A” or “D,” indicating your agreement or disagreement with each statement. As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. Titan is a moon of Jupiter.
 |
|  |  | 1. Titan is the only moon in our solar system with an atmosphere and clouds.
 |
|  |  | 1. Methane is a greenhouse gas.
 |
|  |  | 1. Scientists study organic molecules on Titan to learn more about the earliest forms of life.
 |
|  |  | 1. Titan is much warmer than Earth.
 |
|  |  | 1. Travel to Mars would take about five years.
 |
|  |  | 1. Mars’ atmosphere is mostly carbon dioxide.
 |
|  |  | 1. Iron gives Mars its red color.
 |
|  |  | 1. Researchers have successfully grown simple crops in simulated Martian soil.
 |
|  |  | 1. In the past 20 years, scientists have found hundreds of planets in the universe.
 |

## Graphic Organizer

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: As you read, complete the graphic organizer below to compare Mars and Titan.

|  |  |  |
| --- | --- | --- |
|  | **Mars** | **Titan** |
| Atmospheric components & conditions |  |  |
| Atmospheric pressure |  |  |
| Water and its form |  |  |
| Temperature |  |  |
| Possibilities for generating energy |  |  |
| Time required to get there |  |  |
| Technology needed to sustain human life |  |  |

**Summary:** On the back of this paper, write a short email to a friend explaining whether you would like to go to Mars or Titan, providing reasons supported by information in the article.

## Student ReadingComprehension Questions

Name: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Directions**: Use the article to answer the questions below.

* 1. Why are scientists studying Mars, Titan, and other celestial bodies?
	2. List five conditions, similar to those of Earth, that scientists seek when searching for habitable locations across the universe.
	3. (a) What condition on Titan makes it similar to Earth, and (b) how do Titan’s clouds, rain, and lakes differ from those on Earth?
	4. Give two examples of methane’s important role in maintaining atmospheric conditions on Titan.
	5. Why is the formation of complex organic molecules in Titan’s atmosphere important to possible life on this moon?
	6. Give two reasons why Titan is unsuitable for terrestrial life.

**Student Reading Comprehension Questions, cont.**

* 1. (a) According to scientists, what is a possible source of energy available for native life on Titan, and (b) how much energy is produced by the chemical reaction shown in the article?
	2. Give two ways that spectrometers on spacecraft can identify individual atoms and molecules in space.
	3. What is the connection between iron and microorganisms on Mars?
	4. List three reasons why living on Mars is not ideal for humans.
	5. How can Titan, Earth, and Mars be considered a movie trilogy?

**Critical-Thinking Question**

***Write your answer on another piece of paper, if needed.***

* + 1. Elon Musk, of SpaceX, has vowed to send a colony of people to reside on Mars within the next 50 years. Given the information in this article, (a) how will people prepare for their journey, and (b) what materials will they need for sustained life on Mars?

## Answers to Reading Comprehension Questions

1. **Why are scientists studying Mars, Titan and other celestial bodies**

The study of Mars, Titan and other celestial bodies, can help scientists learn about chemical processes that occur in our solar system.

1. **List five conditions similar to those of Earth that scientists seek when searching for habitable locations across the universe.**

When searching for habitable locations across the universe, scientists look for these conditions:

1. walkable surfaces,
2. oxygen,
3. liquid water,
4. comfortable temperatures, and
5. protection from the Sun’s energetic waves.
6. **(a) What feature on Titan makes it similar to Earth, and (b) how do Titan’s clouds, rain, and lakes differ from those of Earth?**
7. The feature on Titan that makes it similar to Earth is that Titan has an atmosphere and clouds, the only moon in our solar system that does.
8. Titan’s clouds, rain, and lakes differ from those of Earth because they are composed of liquid methane and ethane, instead of liquid water as on Earth.
9. **Give two examples of methane’s important role in maintaining the atmospheric conditions on Titan.**

Two examples of the important role methane plays in maintaining Titan’s atmospheric conditions are:

* 1. methane contributes to the greenhouse gas effect by keeping the temperature high enough for nitrogen to stay in the gaseous state necessary to maintain Titan’s thick atmosphere, and
	2. methane drives the formation of complex organic molecules.
1. **Why is the formation of complex organic molecules in Titan’s atmosphere important to possible life on this moon?**

The formation of complex organic molecules in Titan’s atmosphere may be the building blocks that serve as the basis for early forms of life, including life on Earth.

1. **Give two reasons why Titan is unsuitable for terrestrial life.**

Titan is unsuitable for terrestrial life because

* 1. Earth-life is based on liquid water, and Titan’s surface temperatures are well below the freezing point of water.
	2. Titan’s atmosphere does not contain oxygen.
1. **(a) According to scientists, what is a possible source of energy available for native life on Titan, and (b) how much energy is produced by the chemical reaction shown in the article?**
	1. A source of energy to sustain Titan-life might come from the reaction between acetylene and hydrogen.
	2. The chemical reaction shown in the article produces 311 kJ/mol (for each mole of acetylene that reacts with two moles of hydrogen gas).
2. **Give two ways that spectrometers on spacecraft can identify individual atoms and molecules in space.**

Spectrometers placed on spacecraft can identify atoms and molecules in space by measuring

* 1. the wavelengths of light coming from a cloud or planet and
	2. the mass of individual chemicals.
1. **What is the connection between iron and microorganisms on Mars?**

Martian microorganisms could absorb the energy from iron reduction-oxidation reactions on the planet.

1. **List three reasons why living on Mars is not ideal for humans.**

Three reasons why living on Mars is not ideal for humans are:

* 1. Mars has hazardous levels of UV radiation,
	2. its weak magnetosphere allows the Sun’s radiation to hit planetary visitors, and
	3. Mars has little oxygen for breathing
1. **How can Titan, Earth, and Mars be considered a movie trilogy?**

The prequel Titan shows Earth before life, Earth shows the present environment with life, and Mars represents the sequel showing Earth as a post-terrestrial world.

**Critical-Thinking Question**

1. **Elon Musk, of SpaceX, has vowed to send a colony of people to reside on Mars within the next 50 years. Given the information in this article, (a) how will people prepare for their journey, and (b) what materials will they need for sustained life on Mars?**

Note to teachers: The answers below are taken from the article; however, student answers may also contain material from prior knowledge. Optional: Students may gather information from their own Internet research if this CTQ is structured as a project that builds on the information in the article.

1. Future Mars colonists will need to prepare to live on a spacecraft for the 7 month journey to reach Mars. This will require sufficient oxygen, water and food, plus materials needed for the repair and maintenance of the spacecraft. Colonists will also need spacesuits to protect themselves once they land on Mars. The spacecraft should carry spectroscopes to identify a location that contains liquid water and to look for possible organic matter as they approach possible landing sites. In preparation they will need to practice growing crops in Martian soil. (Students may also mention that physical training is needed to prepare colonists like astronauts for life in zero-gravity conditions during the journey.)
2. Colonists will need spacesuits that can withstand the low Martian pressure. The suits will need dome bubbles that shield inhabitants from the sun’s harmful radiation and provide a source of oxygen with a space for breathing. Using data obtained from growing plants on Earth in Martian soil, colonists will need to prepare to transport seeds and small seedlings of fruits and vegetables, such as tomatoes and peas.