Science and Innovation

A Boeing/Teaching Channel Partnership

MISSION TO MARS

Teacher Handbook

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Mission to Mars

Day 1: Introduction to the Mission to Mars

Grade Level	Middle School
Lesson Length	One 50-minute session

Lesson Overview

In this introductory lesson, students explore and study a brief history of space travel and some of the engineering challenges that have emerged over time. They learn that the next frontier for space travel is a manned mission to Mars. Students are presented with the design challenge and the mission elements. Students brainstorm initial ideas regarding each mission element. Students write a letter to NASA explaining their current understanding and thinking related to the design problems involved in sending a manned Mission to Mars.

Connecting to the Next Generation Science Standards

On Day 1, students make progress toward developing understanding across the following three dimensions:

- Science and Engineering Practices: Asking Questions and Defining Problems
- Disciplinary Core Ideas: ETS1.A Defining and Delimiting Engineering Problems
- Crosscutting Concepts: Influence of Science, Engineering, and Technology on Society and the Natural World

In the following table, the specific components addressed in this lesson are underlined and italicized. The specific connections to classroom activity are stated.

Performance Expectations		
This lesson contributes toward building understanding of the following *engineering* performance expectation: 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.		
Specific Connections to Classroom Activity In this lesson, students are introduced to a design problem. They brainstorm criteria and constraints for different elements of the design problem. Students write a letter to NASA to explain what they believe a successful solution would entail. At this point, students have yet to incorporate relevant scientific principles into the criteria and constraints, but they should consider potential impacts on people and the natural environment.		
Dimension	**NGSS Element**	**Connections to Classroom Activity**
Science and Engineering Practices	**Asking Questions and Defining Problems** • *Define a design problem that can be solved through the development of an object, tool, process, or system and includes multiple*	After being given the overall design problem, students define the criteria, constraints, and possible solutions. In future lessons, students incorporate

	criteria and constraints, including scientific knowledge that may limit possible solutions.	science ideas to further define and solve the design problem.
Disciplinary Core Ideas	**ETS1.A: Defining and Delimiting Engineering Problems** • *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 likely to limit possible solutions.	Students work to precisely define a design task for different elements of a mission to Mars. Students consider the criteria and constraints, but don't yet incorporate the science ideas related to the design problem.
Crosscutting Concepts	**Influence of Science, Engineering, and Technology on Society and the Natural World** • *The use of technologies and limitations on their use are driven by individual and societal needs, desires, and values*; by the findings of scientific research; and by differences in such factors as climate, natural resources, and economic conditions.	After exploring the history of space travel, students consider the reasons why space travel to Mars may be desirable by individuals and society.

Basic Teacher Preparation

To prepare for this lesson, pre-read a brief history of spaceflight. Be ready to summarize it for students and translate its events to a timeline. The same information can be displayed with a projector, or students can view the pages on laptops or tablet computers.

Required Preparation	Links/Additional Information
❑ Gather or purchase the required materials for the lesson	Refer to the Materials List below
❑ Ensure technology is available to project information from the recommended websites, or print and copy relevant information for students to place in their notebooks	Refer to the Suggested Teacher Resources at the end of this lesson
❑ Review suggested teacher preparation resources to prepare for the history of space flight mini-lesson and the introduction of different engineering fields	Refer to the Suggested Teacher Resources at the end of this lesson

Materials List

Item	Description/Additional Information	Quantity	Where to Locate/Buy
Computer (or computers) with Internet access and a projector		1 per class for projecting to entire class, or access to a computer lab	Available in most schools
Roll of butcher paper		1 per class	Available in most schools

Day 1: Introduction to the Mission to Mars

Introduction (5 minutes)

Kick off the module with a brief class discussion. Invite students to share times they have gone on a long trip. Ask:

- *What did you have to do to prepare for the trip?*
- *What did you take?*
- *How much money do you think it cost?*

Give students 5 minutes to answer this prompt in their science notebooks, *If you knew you were going to be away from home for 2 years, what would you do to prepare?*

Whole Group Discussion: History of Space Travel (10 minutes)

Prepare and share a brief history of space flight. One good way to help students understand such a continuum is to put the dates and activities you select on a long sheet of butcher paper, creating a timeline of the highlights of space travel for the front of the classroom. Refer to the milestones while you speak.

Web Resources

These websites can provide useful information about key dates and milestones to aid in preparation:

- Aerospace [Web Link]
- Space.com Timeline [Web Link]

Ask students to note the year of their birth on the timeline. In later lessons, the birthdates of students' parents and grandparents can also be entered, bringing a sense of relevancy to this progression. Point out how much significant space exploration has happened in the past 100 years.

Whole Group Discussion: Mission to Mars (15 minutes)

Show the Boeing film Let's Go Beyond Earth. Ask students to discuss in small groups the reasons for space exploration. Allow approximately 5 minutes for group discussion and a similar amount of time for class discussion. Follow the first video with the second Boeing film, The Path to Mars. Discuss with students the technology needed for the manned Mission to Mars.

Video Link

- Let's Go Beyond Earth [YouTube Link]
- The Path to Mars [YouTube Link]

Transition from this discussion to an introduction of the module design problem, *How can we plan a mission to Mars?* Tell students that they will be the engineers and scientists working on the first manned mission to Mars (reference The Path to Mars video). To prepare for the challenge,

students engage in a first draft Mission to Mars. In this module, students consider multiple aspects of the mission. Students develop a mission plan to present to NASA. The mission plan includes the following:

Mission Elements

- Leaving Earth (Rocket)
- Landing on Mars (Rocket)
- Traveling to Mars
- Living on Mars
- Temperature Control on Mars

As students plan the mission to Mars, they engage in the Engineering Design Process (Appendix A). Introduce students to the Engineering Design Process by reviewing key elements. Be sure to mention that the engineering design process is not a linear process. Rather, scientists and engineers engage in all of the steps, often jumping between steps.

NGSS Key Moment

Engineers often refer to the **engineering design process** when they discuss their work. In the NGSS, the Science & Engineering Practices are used in place of the engineering design process. Students should understand that the engineering design process is not linear in practice. Rather, engineers engage in all of the steps, often jumping between steps. Students may want to think of the engineering design process as a web of practices.

Design Work: Defining the Problem (15 minutes)

To design an effective solution, students must understand the elements of the design problem. For each design problem (leaving Earth, landing on Mars, traveling to Mars, living on Mars, and temperature control on Mars), have students brainstorm a list of criteria and constraints for the design problem. Prompt students by asking, *What would a successful design solution include?* Have students brainstorm a list of possible solutions.

Tell students their client, NASA, must know they understand the design problem. Have students write a letter to NASA explaining their understanding of the design problem. In the letter, students should start by explaining the individual and societal needs that drive the mission to Mars. Next, students should include criteria, constraints, and possible solutions for all of the mission elements. Finally, students should discuss what a successful design solution would entail to meet all of the Mission Elements.

NGSS Key Moment

The letter to NASA can be used to formatively assess student progress on MS-ETS1-1. In the letter, students should define the design problem, include criteria and constraints, and propose initial solution ideas. Be sure to emphasize the connection between space travel and individual or societal needs.

Lesson Close (5 minutes)

Have students share their letters with a classmate. As students share, they should provide kind, specific, and helpful feedback to their classmates. All feedback should relate to defining the problem, outlining criteria and constraints, and incorporating societal needs driving the manned mission to Mars.

Homework

Have students continue to work on their letters for homework. They should revise their letters based on their discussions with their classmates.

Assessment Opportunities

The letter to NASA explaining the criteria, constraints, individual and societal needs driving the mission, and possible solutions for the Mission Elements can be used to formatively assess students understanding of the design problem. Read the letters to determine whether concepts from Day 1 should be revisited or expanded on. Reference Appendix B for suggestions for meeting the needs of all learners.

Community Connections

Identify and investigate local firms that rely on engineering and engineers. Share some examples of familiar companies with students. Consider inviting an engineer to visit the class to share his or her experiences and to help with the design problems.

Suggested Teacher Resources

Engineering Design Process	Mission to Mars Teacher Handbook, Appendix A
Meeting the Needs of All Learners	Mission to Mars Teacher Handbook, Appendix B
Aerospace	[Web Link]
Space.com Timeline	[Web Link]
Let's Go Beyond Earth	[YouTube Link]
The Path to Mars	[YouTube Link]