

## **Astronomy Unit 13: Planets in our Solar System**

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### **Lesson 1: Terrestrial Planets**

Learning Target: I can learn about the terrestrial Planets in our solar system

Do Now: What are the 4 closest planets in our solar system?

Mini Lesson: Terrestrial Planets

Activity: Planet Cards - group activity

Standards: **ESS1.A: The Universe and Its Stars**

### **Lesson 2: Jovian Planets**

Learning Target: I can learn about the Jovian Planets in our solar system

Do Now: What are the 4 outermost planets in our solar system?

Mini Lesson Jovian Planets

Activity: Planet Cards - group activity

Standards: **ESS1.A: The Universe and Its Stars**

### **Lesson 3: Satellites**

Learning Target: I can determine what qualifies as a satellite

Do Now: Draw what you think of when you hear the word satellite

Mini Lesson: What are satellites + examples

Activity: JPL's Build a Satellite Activity

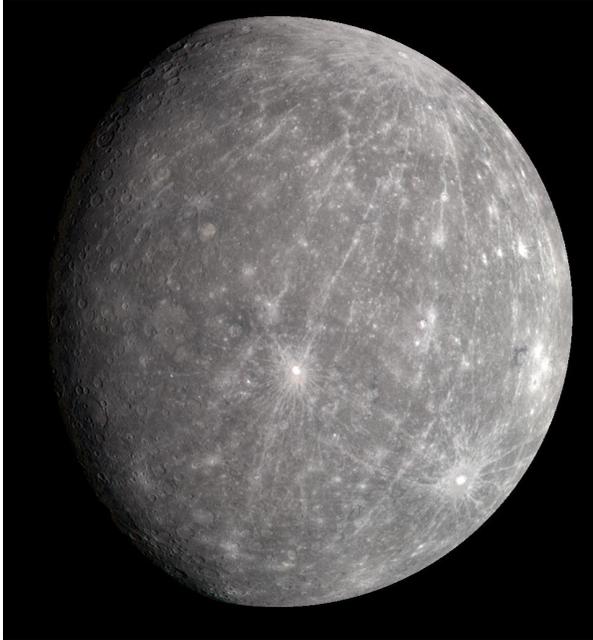
Standards: **ESS1.A: The Universe and Its Stars**

## Lesson 1: Terrestrial Planets

Do Now	What are the 4 closest planets in our solar system?
Standards	<b>ESS1.A: The Universe and Its Stars</b>
Mini Lesson	Terrestrial Planets What are they? How do we classify them? Where are they? Why do they form?
Activity	<b>Planet Cards - Part 1</b> Students are in groups of 4 and are given 4 task cards with the 4 terrestrial planets on them. Each student is responsible for one planet and filling out a task card for their planet. Students will use computers to conduct research on their planet and answer the blanks/find facts about their planets Students in their groups will then present their planet to their group members while their group members take notes.  <b>Differentiation:</b> Students may work in pairs if they feel this task is too challenging to complete independently.
Exit Ticket (if applicable)	N/A

Plant Cards:

**Mercury**



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

**Venus**



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

## Earth



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

This planet is composed of \_\_\_\_\_

This planet is \_\_\_\_\_ AUs away from the sun.

## Mars



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

## Lesson 2: Jovian Planets

Do Now	What are the 4 outermost planets in our solar system?
Standards	<b>ESS1.A: The Universe and Its Stars</b>
Mini Lesson	Jovian Planets What are they? How do we classify them? Where are they? Why do they form?
Activity	<b>Planet Cards - Part 2</b> Students are in groups of 4 and are given 4 task cards with the 4 Jovian planets on them. Each student is responsible for one planet and filling out a task card for their planet. Students will use computers to conduct research on their planet and answer the blanks/find facts about their planets Students in their groups will then present their planet to their group members while their group members take notes.  <b>Differentiation:</b> Students may work in pairs if they feel this task is too challenging to complete independently.
Exit Ticket (if applicable)	N/A

Plant Cards:

### Saturn



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

### Jupiter



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

## Uranus



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

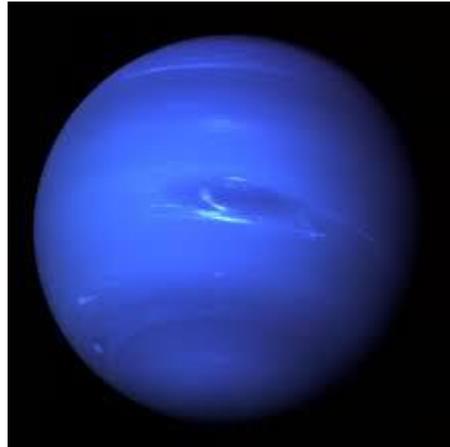
One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

## Neptune



This planet is the \_\_\_\_\_ planet from the sun.

This planet takes \_\_\_\_\_ days to orbit the sun

One day on this planet is \_\_\_\_\_ Earth Days

This planet is (smaller than/bigger than/the same size) as Earth

This planet is \_\_\_\_\_ AUs away from the sun.

This planet is composed of \_\_\_\_\_

### Lesson 3: Satellites

Do Now	Draw what you think of when you hear the word satellite
Standards	<b>ESS1.A: The Universe and Its Stars</b>
Mini Lesson	Satellites What are they? How do we classify them?  Man-made satellites Why we have man-made satellites Parts of satellites  Examples of Satellites - both man made and natural occurring.
Activity	NASA JPL's Build a Satellite Activity
Exit Ticket (if applicable)	N/A

**Rubric:**



Teacher Answer Key

**Engineering Design Rubric**

	<b>Does not meet expectation (1 point)</b>	<b>Approaches expectation (2 points)</b>	<b>Meets expectation (3 points)</b>	<b>Exceeds expectation (4 points)</b>
<b>Identifying the Problem</b>	Relevance and context of problem is unmentioned. Scope and constraints are poorly defined resulting in unclear direction for investigation.	Relevance and context of the problem is included, but vaguely defined. Scope, criteria for success and constraints are included but only superficially.	Problem is specifically defined in a relevant way with context. Criteria for success are defined. Investigation considers relevant constraints.	Problem is specifically defined, as are root causes. Constraints are identified, specific, and testable.
<b>Building a Model or Prototype</b>	Constructs only one concept or solution to the problem.	Describes multiple solutions although without principles to guide how they address the problem at hand.	Multiple concepts or solutions are proposed with justification based within the constraints of the problem.	Multiple concepts or solutions are proposed with not only justification from constraints, but from external research.
<b>Testing and Evaluating the Design</b>	Evidence for design success is unsupported by testing.	Evidence for design success is weakly aligned to metrics that represent criteria and constraints.	Evidence for design success is well aligned to metrics that capture the criteria and constraints being explored.	Considers multiple metrics that align to several relevant criteria and constraints.
<b>Optimizing the Design</b>	Makes no iterative modifications to test changes in performance.	Makes changes to original model, but the changes are not iterative or are not guided by evidence from data.	Uses iterative modifications based on evidence from data.	Uses iterative modifications based on testing and justifies final design from data.
<b>Sharing the Solution</b>	Documentation of results does not cite references and lacks crucial information.	Documentation is organized but contains very little evidence and suggestions for further work.	Documentation communicates design strengths and weaknesses and makes recommendations for further work.	Documentation communicates design strengths and weaknesses. Evaluates tradeoffs between relevant constraints.
				<b>Total / 20</b>

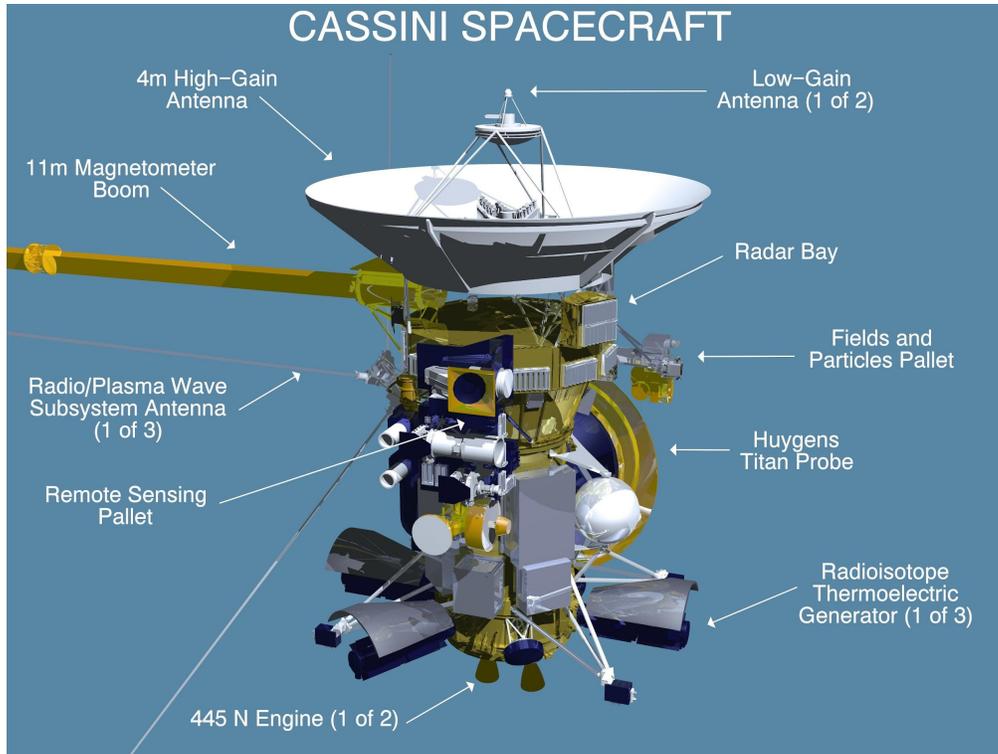
**Activity Directions:** Students will use the engineering design process to design, build, test and improve a model satellite. The satellite must meet certain instrumentation criteria and robust constraints in order to successfully overcome vibration testing.

## Materials:

- Oatmeal canister or mailing tube to simulate the rocket fairing size constraint
- Metric or standard ruler (one per team for shake testing)
- Images of satellites with components labeled – [Download Cassini Diagram](#) | [Mars Odyssey Diagram](#)
- Student worksheet – [Download PDF](#)
- (Optional) [NASA's Eyes on the Solar System](#)
- An assortment of building materials, especially recycled or “found” materials, such as: Aluminum foil, cardboard, paper tubes or cardstock/manila folders to roll, construction paper, index cards, toothpicks, dowels or popsicle sticks, glue or tape, clay dough, buttons, pony beads, transparent copies of graph paper (to cut for solar panels), small cereal or other boxes, water bottles, string for hanging completed model (if desired)

## Procedures:

1. Assess students' prior knowledge by asking them what a satellite is, what satellites look like, what they do and what we use them for.
2. Discuss the similarities and differences between natural satellites such as the Moon and human-made satellites such as GPS, communications, weather and planetary exploration satellites. All satellites orbit a celestial body.



3.

Diagram of the parts and science instruments on NASA's Cassini spacecraft. Image credit: NASA/JPL-Caltech

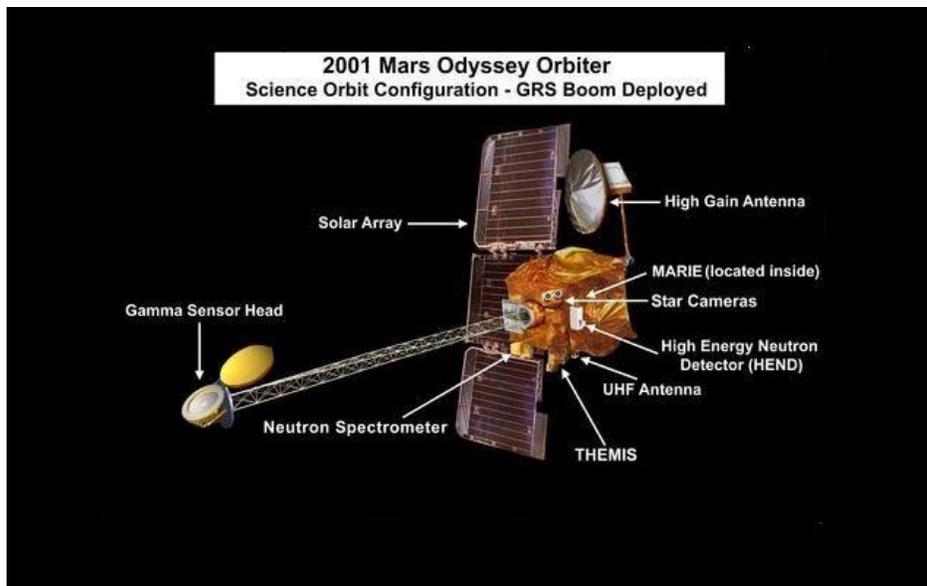


Diagram of the parts and science instruments on NASA's Mars Odyssey spacecraft. Image credit: NASA/JPL-Caltech Show [this video](#) as an example of an Earth-orbiting satellite.

4. Show students images of satellites from the materials list or from [NASA's Eyes on the Solar System](#). Explore different satellites, what they do and what they look

like. Note that satellites orbit or fly by an object, but they are not designed to land.

5. Explain the main parts of a human-made satellite and point out examples: main bus, power system, science instruments, communication antennas. Two example satellite images that clearly shows all of these parts are the [Cassini spacecraft](#) and [Mars Odyssey](#).
6. Explain to students that they are going to work in teams to design and build a model of a satellite that will orbit a planet. The teacher may specify which planet for unity or allow students to choose their own planet for variety.
7. Show these videos about building satellites and discuss some of the challenges shown in the videos.
  - [So, You Want to Build a Satellite: Part One](#)
  - [So, You Want to Build a Satellite: Part Two](#)
8. Assign teams.
9. Show students the available materials.
10. Explain that their finished product, just like a real satellite, must fit inside a rocket fairing (represented by the oatmeal canister or mailing tube) for launch.
11. Explain that their satellite must include all the main parts of a satellite (main bus, communication antenna, power systems, etc.), including at least three science instruments, two of which deploy (pop out or unfold) upon release from the rocket fairing after launch. The goal is to include as many science instruments as possible in order to achieve the most science return (as noted by “science value” on the student worksheet).
12. Explain that the total simulated mass of the science instruments, communication antennas and power systems must be no more than 60 kg. Each component can be represented by the simulated mass measurements noted on the student worksheet.
13. Explain that a lot of vibration occurs during launch and their satellite models must be able to pass a shake test upon build completion to verify that they will survive launch.
14. Show [this video](#) of the James Webb Space Telescope shake test.
15. Demonstrate how to conduct a shake test. Use a poorly-built simple model of a satellite that will suffer some damage during the shake test. In order to encourage student design, do not use a fully built satellite model. Instead, consider using a model that has only one component attached, such as the solar panels. Shake the satellite model by moving it rapidly back and forth over a distance of 15 cm. Move at a rate of approximately 30 cm/s, so each back and forth movement will take one second. Do this for 15 seconds.

16. Explain that each completed satellite model will be assessed by another team using the quality assurance worksheet. Review the quality assurance worksheet with the class.
17. Instruct teams to choose team names appropriate to the project.
18. Instruct teams to commence brainstorming about the design of their model, completing the mass table on their worksheet and sketching their ideas.
19. Instruct students to have their final sketched design approved by the teacher.
20. Once the design is approved, have teams construct their satellite model.
21. Once construction is completed, have teams pair up and complete the quality assurance form by examining the spacecraft for size and component compliance and conducting a shake test.
22. Have students make repairs and retest satellite models as needed.
  
23. Bring the class back together to present satellite models and findings from environmental tests. Each group should make a short presentation explaining the functionality of their satellite and the outcomes of the quality assurance review.

## Discussion

- Ask students to discuss the process they followed while designing and constructing their satellite models. They likely followed steps similar to those in the [engineering design process](#). After they have described their steps, introduce the engineering design process and explain that this process is what engineers follow to solve all sorts of problems. Point out that the students' natural tendencies to try and test solutions then redesign or improve their ideas are in line with the engineering design process.
  
- Ask students to discuss the impact of the constraints of this project. If they had more time, what would they do differently? If they had different materials, could they improve their design? If they had a larger mass allowance, how might that impact their satellite design?

Citation:

NASA. (2020, December 31). *Educator guide: Build A satellite*. NASA. Retrieved April 25, 2022, from <https://www.jpl.nasa.gov/edu/teach/activity/build-a-satellite/>