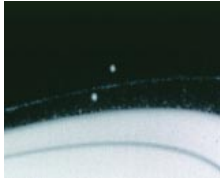


My Spacecraft and Cassini

Two tiny shepherding moons keep Saturn's F ring in line.



LESSON TIME

1 hour for the activity and 15 minutes for sharing (the sharing can occur during a different time in the day or week).

MATERIALS CHECKLIST

Per pair of students plus one for the teacher:

- Copies of “Cassini Spacecraft Design – Problems and Solutions”; “My Spacecraft and Cassini Worksheet”; “Writing Assignment: Compare and Contrast Writing Instructions”

For each student:

- Paper, pencil
- Saturn Discovery Log

LESSON NO. 7

- *Language Arts Focus*
—Nonfiction Reading Practice: Summary
—Nonfiction Writing Practice: Compare and Contrast
- *Science Focus* — *An Eye for Comparison*

OVERVIEW

Students will be curious to hear how NASA solved the design problems that they faced in Lesson 6. In this lesson, the students hear the NASA solutions to the problems they wrote about in the previous lesson. Students will write a nonfiction piece comparing their spacecraft to Cassini, and share their writing with the class. This introduction to design prepares students for the task of trying to design a working model of a probe to land on Saturn’s moon, Titan.

WHY THIS WORKS

This lesson, combined with the previous lesson, gives students a way to connect with the Cassini spacecraft and the engineers who built it. Students benefit from writing a compare and contrast piece with a partner. Discussions about what to write provide students with the opportunity to see multiple ways to express ideas and revise as they work. The writing assignment provides guidance for writing a compare and contrast writing piece to prepare children to organize original pieces for a final project.

Objectives

Students will:

- Learn how the Cassini spacecraft was designed to meet certain requirements of space travel.
- Learn the structure of a compare and contrast piece of writing.

Teacher Preparation

- Print out and photocopy one copy each per pair of students (plus one copy for yourself) student handouts 1, 2, and 3:
 - “Cassini Spacecraft Design — Problems and Solutions” (3 pages)
 - “My Spacecraft and Cassini Worksheet”
 - “Writing Assignment: Compare and Contrast Writing Instructions” (2 pages)
- Decide what you will do if the student’s partner from the previous lesson is absent for this lesson. Depending on the student’s ability level, you may have him or her join another team or work alone.



What to Do

Read About Cassini — Suggested time 10 minutes

1. Tell the class that the design teams (pairs of students) are going to learn how NASA engineers solved the design problems that they thought about during the last lesson.
2. Read aloud to the class student handout 1, “Cassini Spacecraft Design — Problems and Solutions.”

Compare Your Spacecraft to Cassini — Suggested time 15 minutes

1. Give each pair of students a copy of “Cassini Spacecraft Design — Problems and Solutions” and student handout 2, “My Spacecraft and Cassini Worksheet.”
2. Have students complete the worksheet using “Cassini Spacecraft Design — Problems and Solutions” as a resource, while you circulate to provide assistance.

Introduce Compare and Contrast Writing Assignment — Suggested time 5 minutes

1. Give each pair of students a copy of student handout 3, “Writing Assignment: Compare and Contrast Writing Instructions.”
2. Read over the writing assignment with your students.
3. Tell the class that partners will have the opportunity to share their written pieces with the class.

Write the Compare and Contrast Piece — Suggested time 30 minutes

1. Ask students to complete the compare/contrast writing assignment.
2. Circulate and assist students as they complete the writing assignment.

Share with the Class — Suggested time 15 minutes

1. Encourage pairs to decide who will share what during the presentation.
2. Have pairs volunteer to share their compare and contrast pieces with the class.
3. Have the class share things they like about the work and questions and suggestions.
4. Ask students to put the name and date on their work, decide which partner will store it, and put it inside the Saturn Discovery Log. You may want to offer to make a copy of the work, so that each student can have the work in his/her Saturn Discovery Log.



Extensions

Where Is Cassini Now?

Encourage your students to visit the Cassini–Huygens website to see where Cassini is now, find more images of Cassini, and learn more about the spacecraft and the mission.

<http://saturn.jpl.nasa.gov/>

Compare and Contrast Writing Practice

Ask students to write a paragraph comparing a human to a Cassini spacecraft. Have students write one paragraph about how they are the same and another paragraph about how they are different. This can be a homework assignment to practice compare and contrast writing.

Spacecraft Design Research

After students finish their designs, you can encourage them to go to the NASA website at <http://www.nasa.gov/home/index.html> to look at other spacecraft and think about how they are the same or different from Cassini.

Assessment

Your students will complete a checklist after they write their compare and contrast pieces. As you read over the children’s work and look at the checklist, ask yourself the following question:

- Do you agree with the students’ self-evaluation?

If so, jot them a note letting them know this. If not, either write them a note, or set up a meeting to discuss the differences. This checklist is very basic, but exposes children to the idea of using criteria to evaluate their own writing. If your students have had previous exposure to checklist and rubrics, you may want to develop a more sophisticated version of this checklist for your class.



Standards

National Council of Teachers of English and International Reading Association Standards for the English Language Arts

All students must have opportunities to:

- Read a wide range of print and nonprint texts.
- Apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts.
- Employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.
- Participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.
- Use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

National Science Education Standards

As a result of their activities in grades K–4, all students should develop:

- Understanding of properties of objects and materials (Physical Science).
- Abilities of technological design (Science and Technology).
- Understanding about science and technology (Science and Technology).
- Understanding of science as a human endeavor (History and Nature of Science).



Cassini Spacecraft Design — Problems and Solutions

(A note from the author to the students: Engineers at NASA had to brainstorm solutions to the same design problems that you thought about in the last lesson, plus they had to think about a lot of other design issues. Building Cassini involved about 4,500 people from the United States and 16 other countries, all working together as a team. Besides engineers and scientists, the project depended on work carried out by computer programmers, educators, machinists, electricians, secretaries, security guards, and travel agents. Here is a summary of how the Cassini team designed their spacecraft to get to Saturn.)

1) How will you keep the spacecraft from burning up when it leaves Earth?

Cassini has a multilayer fabric to keep it warm. It will keep the heat generated by the spacecraft from escaping. You can think of the multilayer fabric as the spacecraft's clothes. For the outer layer, we used a material called Mylar®, which traps things well — it can even keep the tiny atoms of helium sealed inside. That is why helium balloons for parties are sometimes made of Mylar.

2) How will you control and keep in touch with your spacecraft?

The spacecraft has a large antenna plus two small ones to send and receive signals. From Earth, we have to aim our signals to travel through millions of miles of space so that they hit the spacecraft's antenna correctly. To receive Cassini's signal, the large dish antennas of NASA's Deep Space Network have to be pointed exactly at the spacecraft. The signals from the spacecraft have only as much power as a refrigerator light bulb, but they travel millions of miles.

3) How will you keep the spacecraft safe from being hit by a space particle?

Well, in movies it seems like there are lots of space rocks and asteroids ready to hit a spacecraft, but most of space is actually mostly empty when you are traveling through it. Even the asteroid belt between Mars and Jupiter is pretty empty because of the large distances between the asteroids. We are going to fly through the rings of Saturn, but we have chosen a spot in the rings that is should be pretty clear to fly through. If Cassini does get hit, we hope it will be by very small particles that don't really hurt our spacecraft.



4) What do you want the spacecraft to try to find out at Saturn?

The scientists have a lot of questions, but we engineers had them choose certain ones to focus on. That way we can build the spacecraft and instruments to operate efficiently. We will try to learn more about what Saturn and its rings are made of. We will try to figure out why there are such fast, strong winds on Saturn. One exciting thing is that we are going to try to land a probe to finally see beneath the clouds of Titan, Saturn's largest moon. We think the atmosphere on Titan might be sort of like the atmosphere on Earth as it was billions of years ago. We may be able to learn something about Earth's first days from Titan. It may be difficult to get the probe to land correctly. We aren't sure exactly what the probe will be landing on, since we can't see past the clouds. The probe is designed so that it can land on something solid or liquid. We will try to use radar to get a map of Titan's surface once we land there.

5) Do you think you should send humans on the spacecraft? If you think you should send humans, how will they survive?

Bringing enough air, food, and water for humans to stay alive would make the spacecraft too heavy and too expensive. Also, we don't know what happens to humans' bodies if they are away in space for years at a time. In addition, Cassini does not have enough power to make the return journey to Earth, so we wouldn't want to leave humans stranded out in space with no way to live.

6) What are some things that could go wrong with the spacecraft on the journey to Saturn?

We hope that we always know where Cassini is and never lose it. That is our biggest fear — that one day, we will send a signal and not hear back from our spacecraft. We have to be careful of certain things. If we try to have the spacecraft take pictures and send signals to us at the same time, for example, that could make it use too much power. If any parts break, we almost always have a back-up part for it on the spacecraft, but if the back-up parts break, we are in trouble.

7) What will you name your spacecraft?

We named our spacecraft Cassini-Huygens.

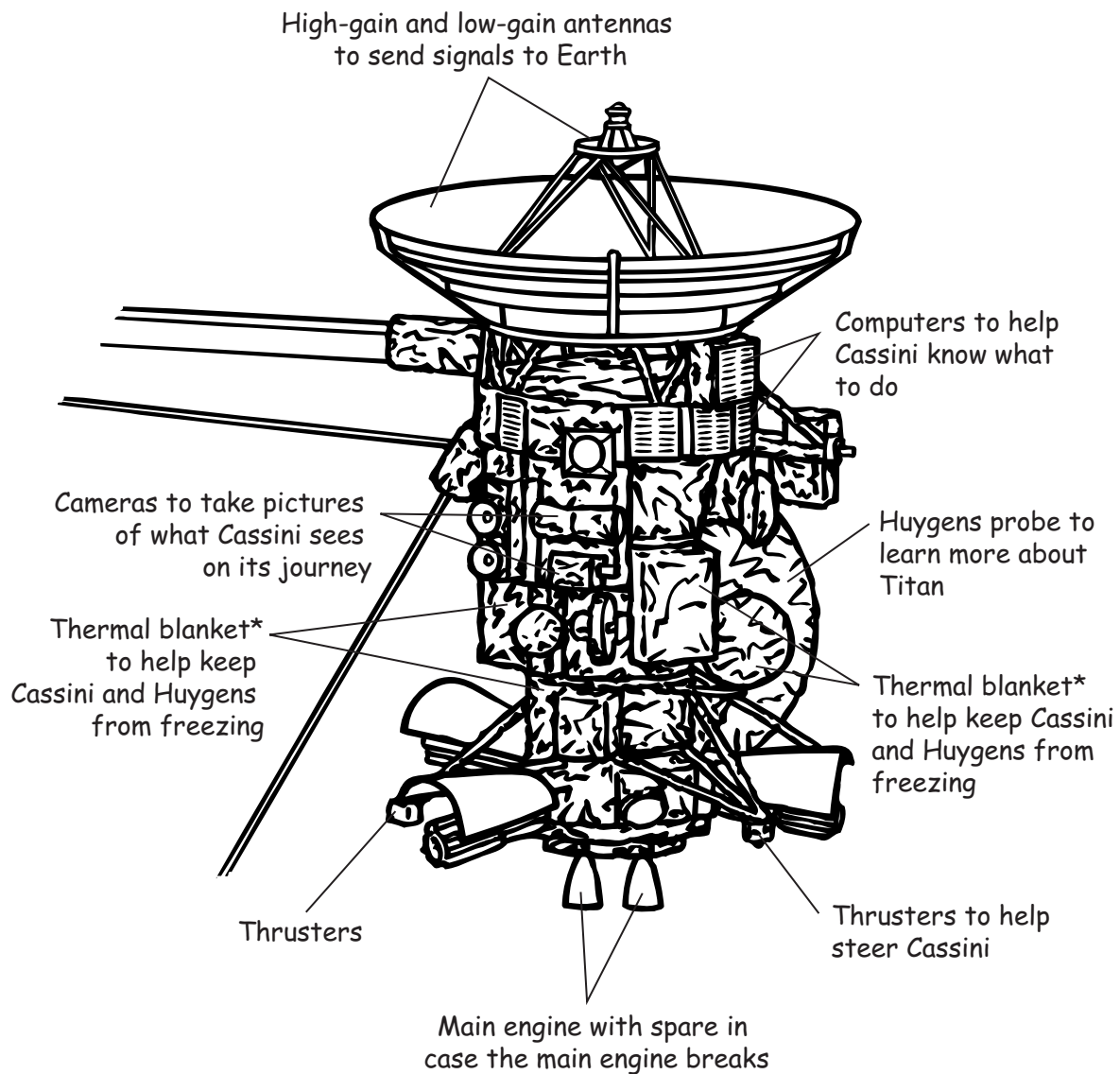
8) Why did you choose that name?

We named it after the astronomer Jean-Dominique Cassini. He discovered that there was a big gap in the ring that divided it into two separate rings, and he



found four moons of Saturn. We named the probe that will land on Titan after Christiaan Huygens, because he was the person who discovered the moon we now call Titan.

9) Draw the design of your spacecraft. Use arrows and write words to explain what its parts do. Make sure you include your answers from question 1 through 8 in your sketch. After you finish your drawing, go back through questions 1 through 8 and make sure all of your ideas are shown in your sketch.



*The protective thermal blanket is a layered material known as multi-layered insulation or MLI.



My Spacecraft and Cassini Worksheet

Date _____

Team Member Name _____

Team Member Name _____

Directions: Reread "Cassini Spacecraft Design—Problems and Solutions" with your partner. Write down the ways that your spacecraft is the same as or different from the Cassini-Huygens spacecraft. Write small so you can fit in more ideas!

1. How Cassini-Huygens is similar to my Saturn spacecraft:

2. How Cassini-Huygens is different from my Saturn spacecraft:

3. Read through all of your ideas, and see if there are any more similarities and differences that you can think of. Add them to your lists.

4. Now read through your ideas again. Work with your partner to try to agree on the three most interesting similarities and the three most interesting differences. Circle them.



Writing Assignment

Compare and Contrast Writing Instructions

1. On a separate sheet of paper, write a title for your Compare and Contrast piece.
2. Write your name and your partner's names on the piece of paper.
3. Decide how you will take turns writing. (You will need to discuss and agree on what you will write about.)
4. Write your first paragraph.

Writing Hints

You might start your first paragraph with the sentence:

_____ and _____ designed a spacecraft named _____ to travel to Saturn. NASA also designed a spacecraft named Cassini–Huygens to travel to Saturn. Here is how the two spacecraft are similar.

Or—Here is what the two spacecraft have in common.

Or—Here is how the two spacecraft are the same.

In this paragraph, write about the three most interesting ways that your spacecraft is similar to Cassini–Huygens (the ones that you circled on your “My Spacecraft and Cassini” worksheet).

5. Write your second paragraph.

Writing Hints

You might start your second paragraph with the sentence:

Although our spacecraft has some things in common with Cassini–Huygens, there are also differences between the two spacecraft.

In this paragraph, write about the three most interesting differences between your spacecraft and Cassini–Huygens (the ones that you circled on your worksheet).



6. Write your third paragraph.

Writing Hints

You might start your third paragraph with the sentence:

During this project, we learned some things about designing a spacecraft. Here is what we noticed and learned.

In this paragraph, write what you noticed and learned about designing a spacecraft.

7. Checklist

When you are finished, put a check by each item below that you have completed. If you need to revise your piece in order to put a check mark by each item, then do this now.

- My partner and I have our names on our paper.
- My partner and I have a title on our paper.
- My partner and I have written three paragraphs.
- My partner and I have included three similarities in the first paragraph, and three differences in the second paragraph.
- My partner and I have attached this checklist to the back of our paper.

