



Educational Product

Educators and
Students

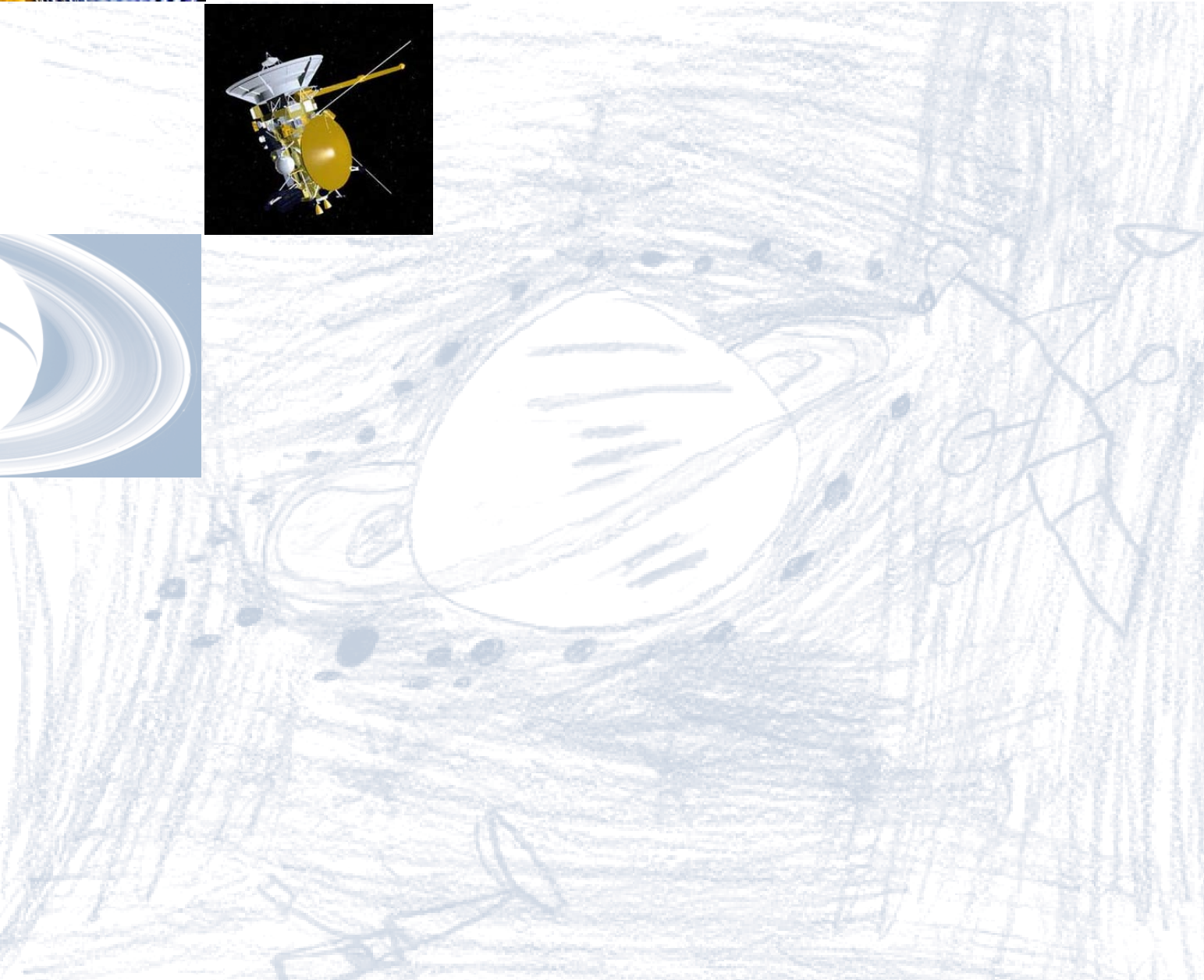
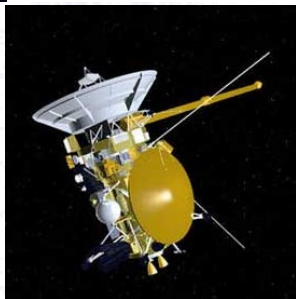
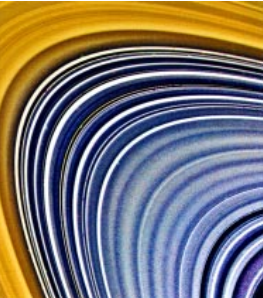
Grades 3–4

EG-2004-03-013-JPL
JPL 400-1138 3/04

M i s s i o n t o S a t u r n E d u c a t o r G u i d e

Reading, Writing & Rings!

Grades 3–4



Lesson List

1

What Do I See When I Picture Saturn?

Your students begin the unit by creating a Saturn Discovery Log. Students will use their Saturn Discovery Logs to chronicle their journey of discovery about Saturn, the Cassini–Huygens spacecraft, and non-fiction writing. For their first log entry, students will draw what they picture when they hear the words “Saturn” and “Cassini,” and add labels and captions to their drawings. Students will share this illustrated text with a partner. At the end of the unit, students repeat this exercise and observe their growth over the course of the unit.

- Language Arts Focus — Nonfiction Writing Practice: Illustrations with Text
- Science Focus — Pre-Assessing Students: Scientific Ideas and Understandings

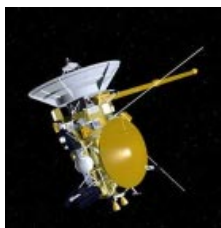


2

The Mysteries of Saturn and Cassini

Your students will start learning about Saturn just as the first observers of Saturn did — by observing and wondering. Your students will look at pictures of Saturn, the Cassini spacecraft, and the Huygens probe and write what they notice, know, and wonder. This activity invites students to observe carefully and learn from each other, while providing you with an idea of students' prior experiences with this topic.

- Language Arts Focus — Nonfiction Writing Practice: Descriptive Writing
- Science Focus — Observing and Wondering: Essential Tools for Science



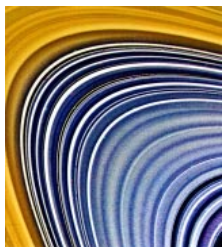
3

Wondering About Saturn: A Short History

Humans have been wondering about Saturn for centuries. Students hear a read-aloud of the history of Saturn discoveries. Next, they learn two reading comprehension strategies (visualizing and wondering) that they can use to become more powerful readers of nonfiction text. Finally, students share their work with partners and the class.

- Language Arts Focus
 - Nonfiction Writing Practice: Summary
 - Nonfiction Comprehension Skills: Visualizing and Wondering
- Science Focus — Reading to Support Inquiry-Based Thinking





4

How Far Away Is Saturn?

Saturn is far away from Earth! Distances in space are difficult for students (and adults) to understand. In this lesson, students use simple props to create a playground model for size and distance for the Sun, Earth, and Saturn — they actually take a “walk of wild size” to Saturn. Writing activities engage students in reflecting on experience and in comparing and contrasting.

- Language Arts Focus
 - Nonfiction Writing Practice: Descriptive Paragraph
 - Nonfiction Writing Practice: Compare/Contrast Paragraph
- Science Focus — Understanding Size and Distance by Creating Sun/Earth/Saturn Models

5

Discovering Saturn, the Real “Lord of the Rings”

At this point in our imaginary journey, we have arrived at Saturn. Students extend and enhance their current understandings about Saturn by reading a series of Saturn minibooks, and learn a note-taking technique that will help them better understand nonfiction text. They use their notes for descriptive writing and to compare and contrast with new information that we learn about Saturn from Cassini. Students will practice the illustration with text strategy learned in Lesson 1. For the final activity, students build 3-D models of Saturn and its rings. Learning all about Saturn prepares students for designing their own spacecraft.

- Language Arts Focus
 - Nonfiction Reading Practice: Saturn Minibooks
 - Nonfiction Writing Practice: Descriptive Paragraph
- Science Focus — Understanding the Saturnian System by Building 2-D and 3-D Models of Saturn

6

My Spacecraft to Saturn

Students get the chance to think like engineers as they are presented with problems that the NASA team faced when designing a spacecraft to travel to Saturn. Students work with partners to think of solutions to address those problems, and to use these ideas to sketch their spacecraft. (In the next lesson, students have the opportunity to compare their ideas to the ideas of the NASA team.)

- Language Arts Focus
 - Nonfiction Reading and Writing as Tools for Problem-Solving
 - Nonfiction Reading Practice: Summary
- Science Focus — Thinking Like an Engineer: Problem-Solving Spacecraft Design



7

My Spacecraft and Cassini

Students will be curious to hear how NASA solved the design problems that they faced in Lesson 6 — they hear the NASA solutions to the questions they wrote about in the previous lesson. Students write a nonfiction piece comparing their spacecraft to Cassini, and share these pieces 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.

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

8

All About Titan and the Huygens Probe

Students extend and enhance their understandings of Titan and the Huygens probe by listening to a narrative “told” by the Huygens probe. Visualization and drawing are used as motivators to enhance comprehension and to get students thinking about Titan and what we might find there. Students draw what they envision the surface of Titan will look like to the Huygens probe. Next, they read an article about Titan and the Huygens probe and write a summary. This lesson gives the students additional background for Lesson 9.

- Language Arts Focus — Nonfiction Writing Practice: Summary
- Science Focus — Building Mission Background Knowledge

9

Drop Zone! Design and Test a Probe

Students are invited to participate in a challenging activity. Using the information learned in Lessons 6, 7, and 8 — and their own creativity and problem-solving skills — students design and test a parachuting probe that will withstand a fall from a high point and land intact, be able to float in a liquid, descend slowly, and cost the least to launch into space. Extensions provide an option if the teacher has limited time, and also invite the students to simulate other experiments that will be carried out by the Huygens probe. While this lesson provides opportunities and invitations for students to integrate reading, writing, and experimenting, writing provides the unifying thread for student learning.

- Language Arts Focus — Writing to Plan, Problem-Solve, and Analyze
- Science Focus — Designing and Testing a Parachuting Probe



10 **What Do I See Now When I Picture Saturn?**

Students are coming to the end of their journey of discovery about Saturn, the Cassini spacecraft, and nonfiction writing. To reflect on what they have learned, students repeat the exercise that they did at the beginning of the unit in Lesson 1. Students draw everything they picture when they hear the words “Saturn” and “Cassini,” add labels and captions to their drawings, and look back at their first exercise and compare the two. They end the lesson by sharing their work with a partner.

- Language Arts Focus — Nonfiction Writing Practice: Illustrations with Text; Compare and Contrast
- Science Focus — Post-Assessment of Scientific Ideas and Understanding

11 **Pulling It All Together**

Students now have a working knowledge of Saturn and Cassini, as well as their Saturn Discovery Logs full of notes and observations. Students will organize notes to prepare to write one of the following types of nonfiction for their final piece: descriptive, compare and contrast, or summary.

- Language Arts Focus — Nonfiction Writing Practice: Descriptive; Compare and Contrast; Summary
- Science Focus — Synthesis of Information and Reflection

12 **Celebrating Saturn and Cassini**

Though this unit on Saturn is coming to a close, students will begin a life-long journey of learning more about the mysteries of space and challenges of space travel. For the final lesson, students will use prewriting notes to write a nonfiction piece about Saturn or Cassini. These final projects provide a way for children with varying learning styles to consolidate and share their learning.

- Language Arts Focus — Final Nonfiction Writing Practice: Descriptive; Compare and Contrast; Summary
- Science Focus — Sharing New Knowledge with Peers

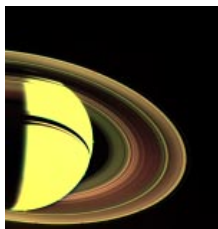


Foreword

Children begin rudimentary scientific thinking from the time they are born as they explore their natural environment and seek to make sense of it. When they acquire language, they begin asking questions about what they experience, observe, and think. Once they are in school, children's natural curiosity links closely with science learning, which offers an ideal opportunity to help young students expand their budding knowledge about the world. Science learning is also an ideal opportunity to involve students in rich reading and writing activities that not only help improve the quality of their learning but also help make them better readers and writers — a key goal in the elementary years.



A Saturn storm as seen by the Hubble Space Telescope.



A view of Saturn's rings by Voyager 2.

The sets of lessons you are about to encounter purposefully bring together reading, writing, and science in ways that underscore the belief that scientific thinking and the intelligent use of language go hand-in-hand. These lessons build good language use into the science curriculum, helping students use reading and writing to learn. In doing so, the lessons also help spur students' growth in vocabulary as they acquire new words through their engagement in authentic learning experiences.

While the lessons are grouped for grades 1/2 and 3/4, they can readily be used interchangeably as needed. Older students with little space science background might benefit from the grades 1/2 lessons. English learners might benefit from the early grades' reading and writing activities, too, finding them more accessible. The upper-grade lessons can also be used for enrichment for younger students who are ready for further study. We encourage teachers to look at the lessons as a whole and use them as best suits their teaching context.

Most important, the lessons open up the world of Saturn and emerging data about this planet to young children, and invite them to be part of space exploration. The scientific concepts, language, and content have been reviewed for accuracy by NASA's Jet Propulsion Laboratory staff.

Connecting Theory and Practice

Common to the reading and writing activities found in the lessons is an underlying belief that metacognitive skills practiced in socially interactive situations can contribute to young children's capacity to think scientifically.

The lessons aim to improve science learning by enhancing metacognitive skills. For example, in science notebooks and logs, students are asked to think about what they have learned and think about how they have learned, both key components of metacognition, which concerns the ability to reflect on our own cognitive processes (the process of knowing) and knowledge about when, how, and why to engage in various cognitive activities (Flavell, 1981). A number of key sci-



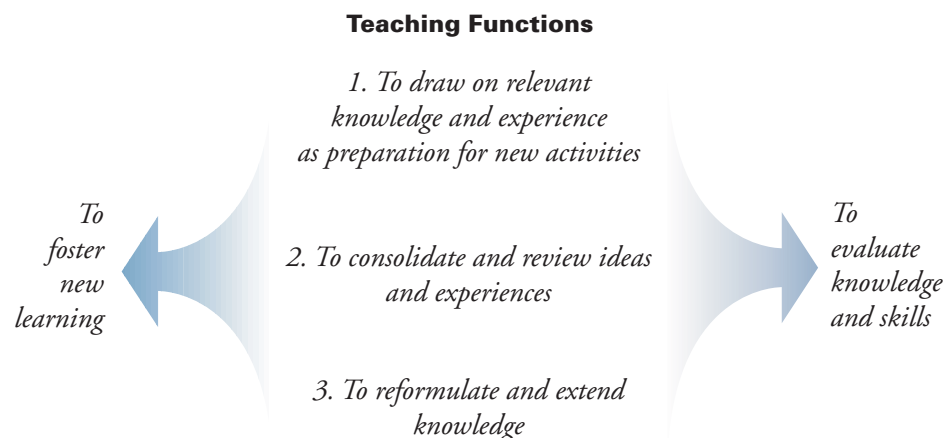
ence process skills are metacognitive in nature and have close correspondence with the skills of reading and writing. The skills of observing, classifying, comparing, predicting, describing, inferring, communicating, interpreting data, organizing information, and drawing conclusions are among the skills young children engage in as they explore a scientific concept, read a text, draw a picture, or compose a piece of writing. The lessons seamlessly integrate and reinforce these important skills.

The instructional activities enable students to be active learners and take responsibility for their own learning. Children first learn how to engage in various problem-solving tasks such as those listed above through social interaction with others (Vygotsky, 1978). The lessons highlight social interaction through exploratory talk (Barnes, 1976) with teachers, partners, and in small groups, and the use of expressive language (Britton, 1990) in talk and writing. This kind of language use among adults and peers helps students clarify ideas and work through new concepts. Little by little, students begin to internalize these new skills and processes.

Connecting Reading, Writing, and Science Learning

Reading and writing are central activities in each lesson. The lessons focus mainly on expository (explanatory) reading and writing. This kind of reading and writing tends to take a backseat to personal narration in the early grades. As a result, young students become very familiar with structure of a story but less familiar with the structure of expository and informational texts, even though learning how to read and write to explain, analyze, and report are essential skills for students as they move through the grades. Through engaging reading and writing activities, the lessons enable deeper learning by involving students in using writing to help organize and clarify their thinking.

Writing is essential to learning both the content and the processes of science. Langer and Applebee (1987) have identified three important teaching functions of writing that can scaffold students' learning of new content (see table at end of Foreword that relates functions to writing activities in the lessons):



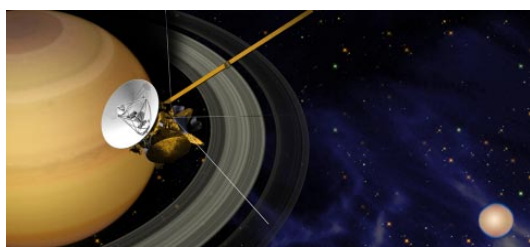
Writing encourages active engagement in learning and helps students activate their schema for the concepts to be explored. Expressive writing in notebooks and logs in children's own everyday language is their thinking written down, made permanent so that students can revisit their first impressions and revise their thinking as their understanding deepens. Writing helps students gain awareness of their developing knowledge and helps teachers to assess what students are learning and not learning, what they are interested in, and what difficulties they are experiencing. Further, research has shown that the more that scientific content is manipulated through analytic writing tasks, the better it is recalled (Langer, 1986, Wotring, and Tierney, 1981).

Reading also encourages active learning by students and has much in common with science process skills. Whether exploring a new area of science or reading a text connected to science, students are engaged in several of the same problem-solving processes. The reading skills of visualizing, questioning, determining im-

portant ideas, and understanding text structures resonate with the science process skills of making inferences, making predictions, and drawing conclusions.

Effective vocabulary development is essential as well, especially in science where children's limited meanings for words can limit their understanding of concepts and the subject being studied (Herber, 1978). New vocabulary learning in science is developmental, where a definition is a start, but expanded meaning and knowledge require multiple experiences with the word. Through well-planned reading and writing activities and hands-on experiences with new content, children begin to learn, retain, and then use their newly acquired knowledge of scientific concepts and terms.

Strong reading and writing skills can unlock the doors to unlimited learning for our students. Students need practice, though, in reading and writing in a broad range of genres and content areas to reach this level of literacy. The design of the lessons in this program offer students chances to use their emerging literacy skills for real scientific learning, while giving them much needed experiences in reading nonfiction texts and using writing to describe, compare, and explain.



The Cassini-Huygens Mission

During an exciting four-year mission of discovery, the Cassini spacecraft will study Saturn's rings, magnetosphere, and atmosphere, and observe the planet-size moon Titan and a number of the icy satellites. The Huygens probe will collect data about the atmosphere, winds, and surface conditions of Titan. Cassini-Huygens is an international collaboration of the National Aeronautics and Space Administration (NASA), the European Space Agency, and the Italian Space Agency. The Jet Propulsion Laboratory, a division of the California Institute of Technology, manages the Cassini-Huygens mission for NASA's Office of Space Science.



Teaching Functions and the Lessons

This table illustrates the Langer and Applebee teaching functions as they relate to grade levels and writing activities in the lessons.

TEACHING FUNCTION	GRADES / LESSONS
1. To draw on relevant knowledge and experience as preparation for new activities	Grades 1/2: Lesson 1 Grades 3/4: Lessons 1, 2, 3, 4, 5
2. To consolidate and review ideas and experiences	Grades 1/2: Lessons 2, 3, 4, 5, 7, 8 Grades 3/4: Lessons 4, 5, 9, 10, 11, 12
3. To reformulate and extend knowledge	Grades 1/2: Lesson 6, 8, 10 Grades 3/4: Lessons 6, 9, 12

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What Do I See When I Picture Saturn?

Saturn and four small icy moons.



LESSON TIME

1 hour

MATERIALS CHECKLIST

For the teacher:

- Easel with paper and marker, or chalkboard or whiteboard

For the students:

- Crayons
- Colored pencils
- Pencils
- For Saturn Discovery Log: 12 by 18 inch construction paper (1 sheet for each student) and 8-1/2 by 11 inch paper (1 sheet for each student)

TO SEE EXAMPLES OF STUDENT WORK, [CLICK HERE](#)

LESSON NO. 1

- Language Arts Focus — Nonfiction Writing Practice: Illustrations with Text
- Science Focus — Pre-Assessing Students: Scientific Ideas and Understandings

OVERVIEW

Your students begin the unit by creating their Saturn Discovery Logs. They will use the Saturn Discovery Log to chronicle their journey of discovery about Saturn and Cassini through nonfiction writing. For their first log entry, students will draw what they picture when they hear the words “Saturn” and “Cassini,” and add labels and captions to their drawings. Students will share their work with partners. At the end of the unit, students will repeat this exercise, observe their growth, and reflect on increased knowledge.

WHY THIS WORKS

Saturn is the sixth planet from the Sun and is often called the “jewel of the solar system” because of its beautiful rings. It is the second largest planet in our solar system. Saturn is named for the Roman god of agriculture.

The spacecraft Cassini–Huygens (pronunciation: kuh seen ee / hoy gens) was launched from Earth in 1997 and arrives at Saturn in July 2004. Cassini will explore the mysteries of Saturn and its rings, while the Huygens probe will attempt a landing on Saturn’s largest moon, Titan, in January 2005. If you would like to explore more background about the mission, space travel, or the solar system, the links in the Resources section of this lesson will be useful.

In this unit, students will keep everything related to Saturn and Cassini learning in their Saturn Discovery Logs. Calkins (1986) states that while children spend 44 percent of their classroom time writing, they only spend 3 percent of this time composing, actively thinking, sorting, or organizing while writing. The writing projects in the unit will require students to distill, organize, and reflect on the information they have gathered in their logs.

You are encouraged to learn with your students throughout this unit. Teachers often fear teaching science because of the learning curve a new topic such as this presents. This unit provides your students with the opportunity to see you as a learner too!



Objectives

- Teachers will:
Learn the extent of individual student knowledge about Saturn and Cassini.
- Students will:
 1. Practice organizing and presenting their thinking in illustrations with text format.
 2. Practice noticing strengths in each other's work.

Teacher Preparation

Decide if you are going to allow the children to choose the color for their construction paper (if there is more than one choice). On the chalkboard or easel paper, write the following Saturn Discovery Log prompt where students can see it — “Draw everything that you picture when you hear the words Saturn and Cassini. Add labels to your drawing.” Try to find a book, newspaper, or magazine article that has illustration with text to use as an example to show the class — the Science Times section of the *New York Times* (in the Tuesday paper) often features excellent illustrations with text to explain new discoveries. Decide if students will have the same partner or will change partners for Saturn Discovery Log sharing throughout the unit. The advantage of having the same partner is that a relationship has time to build and children become more willing to take risks. The advantage of changing partners is that students have opportunities to connect with a larger number of students. Think about the unique strengths and needs of your class to make this decision.

What to Do

Introduce the Unit — Suggested time 15 minutes

1. Tell the class you are going to read something to them, and have them try to picture it. Read the following paragraph:
“Imagine space, magnificent space. Now imagine our solar system with a blazing Sun in the center. Spinning around it are beautiful planets. One of these planets is Earth. Another is Saturn. A spacecraft is flying through space to try to find out more about this mysterious planet.”
2. Explain that for the next few weeks, you will be learning about Saturn and the Cassini–Huygens mission. The Cassini spacecraft is traveling to visit Saturn, and the Huygens probe is going to try to land on Saturn’s largest moon, Titan.
3. Explain to the students that as “you learn about Saturn and the mission, you will also learn how to write excellent nonfiction, and will learn strategies to help you read nonfiction writing better.”
4. Ask the class to spend five minutes brainstorming all of the types of nonfiction that they can think of. Jot their ideas on the board.



teacher TIP

The format for the Saturn Discovery Log is just one suggestion. Basically you want to create something that can hold student's writing and worksheets for the unit in an organized way. You may have folders or other organizers that you would like to use to accomplish this.

5. Tell the class that there are many, many different types of nonfiction, and that you will be focusing on descriptive writing, compare and contrast writing, illustrations with text, and summary writing. Read the following to give brief examples of each of these types of nonfiction writing:
 - Saturn is a jewel in the sky. *This is an example of descriptive writing.*
 - Saturn has at least 31 moons, and Earth has just one moon. *This is an example of compare and contrast writing. The writer is comparing Saturn and Earth.*
 - Here is a sketch of Saturn. [Draw Saturn and its rings, and draw a label connected to the planet that reads Mysterious Planet, and a label that connects to the rings that reads Beautiful Rings.] *This is an example of illustrations with text.*
 - In a nutshell, in this unit, we are going to learn about Saturn, the Cassini spacecraft, and the probe that will land on Titan. *This is an example of summary writing.*

Create Your Saturn Discovery Log — Suggested time 15 minutes

1. Tell the class that you would like to start the unit by creating a Saturn Discovery Log and that they will use the log to keep track of discoveries they make about Saturn and Cassini. Explain that they will be keeping all of their work during this unit in their own Saturn Discovery Logs, just as scientists keep journals like this to record their thoughts.
2. Tell the class that “today you will make the cover for your Saturn Discovery Log, and write your first log entry.”
3. Pass out construction paper and crayons or markers. Ask the class to fold the construction paper in half to make a folder that will hold 8-1/2 by 11 inch paper. Ask students to write “Saturn Discovery Log” and his or her name on the front cover of the construction paper folder. As students work, check that everyone has written his or her name on the cover.

Draw and Write in Saturn Discovery Log — Suggested time 20 minutes

1. Point out the writing prompt to the students that you have previously written on the chalkboard or easel paper — “Draw everything that you picture when you hear the words Saturn and Cassini. Add labels to your drawing.”
2. Explain to the class that they are going to spend 20 minutes drawing everything they picture when they hear these two words — “Saturn” and “Cassini.” Explain that they are going to add labels or captions to the drawing.
3. Give the class an example of a drawing and adding labels or captions. (For example, you can draw Earth and the Moon, and draw a line with words to explain more about each one. You might draw a line from Earth saying, “Where we live,” and a line from the Moon saying, “Our only moon. Humans first landed on the Moon in 1969.” You may want to point out illustrated text in books like *The Magic School Bus*, and point out the method of magnifying a certain portion of the illustration to feature its information in more detail.)



4. Encourage the class to write informative, detailed captions. Explain that this type of illustration and writing is often used by scientists to explain things. Tell the class that this type of drawing and writing is sometimes called illustrations with text.
5. Tell the students that they will be sharing their illustrations with text with a partner at the end of the lesson, and sharing one thing they like about their partner's work.
6. Pass out a sheet of paper for the first log entry. Circulate and ask students to tell you more about what they are drawing. Encourage them to add what they say to the captions.

Share with a Partner — Suggested time 10 minutes

Have students share their illustrated text with a partner. Have the partners take turns sharing one thing they liked about their partners' work. Ask students to write their name and the date on their work, and put it inside their Saturn Discovery Log.

Extensions

Buddies

If your class has a "buddy" class, ask the other class to do the same exercise (perhaps just the drawing portion of the activity if it is a younger class). The buddies can meet to share and talk about what they drew and why.

Resources

Cassini and NASA Websites for Kids

You may want to have these websites bookmarked on the computer for the children to explore.

- This site provides background on the solar system. "The planets" section is particularly fun for children to explore — <http://sse.jpl.nasa.gov/index.cfm>
- This site provides child-friendly background about the Cassini–Huygens mission — <http://saturn.jpl.nasa.gov/kids/index.cfm>
- This site provides child-friendly information about space travel. It includes quiz games and a history of space travel — <http://www.jpl.nasa.gov/kids/>



Assessment

As you read over the children's work, ask yourself the following questions:

1. Who are the students who have had a great deal of experience with this topic?
Ask those students how they learned about it. Children who have a great deal of information about Saturn and Cassini can be honored as experts throughout the unit, as they expand their knowledge of the topic.
2. Who are the students who have not had a great deal of experience with this topic?
If there are a lot of children who have not had strong experiences in space science, you will be able to determine what background you need to provide (basics about how the solar system works, etc.). If your students do not know the basics about the solar system, you might want to use and adapt Lesson 2 of the Grades 1–2 unit as your next lesson in the unit. You can read aloud nonfiction books that provide necessary background knowledge, and make these books available for independent reading.

Standards

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

All students must have opportunities to:

- 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.
- 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 an understanding of objects in the sky (Earth and Space Science).



Examples of Student Work



Pre-Assessment



Post-Assessment



The Mysteries of Saturn and Cassini

Artist's rendition of Cassini at Saturn.



LESSON TIME

*1 hour for the activity
plus 15 minutes for
reflective writing and
sharing*

MATERIALS CHECKLIST

- Pencils
- Printouts of seven Saturn/Cassini-Huygens images
- Seven pieces of butcher paper marked with three columns the long way

LESSON NO. 2

- *Language Arts Focus — Nonfiction Writing Practice: Descriptive Writing*
- *Science Focus — Observing and Wondering: Essential Tools for Science*

OVERVIEW

It is fitting that your students start learning about Saturn as the first observers of Saturn did — by observing and wondering. Your students will look at pictures of Saturn, Cassini, and the Huygens probe and write what they notice, know, and what they wonder. This activity invites students to observe carefully, and learn from each other, while providing you with an idea of students' knowledge of this topic.

WHY THIS WORKS

The images in this lesson provide breathtaking pictures of Saturn and the Cassini-Huygens mission. Students will see that the images are numbered but not labeled. This lesson uses three prompts (what I notice, know, and wonder) to promote three types of thinking: observing, forming conclusions, and wondering. Writing “what I know” forces students to consider whether they are really sure about their conclusions.

Identifying questions forms the basis for inquiry throughout the unit. The National Science Education Standards state that, “Inquiry into authentic questions generated from student experiences is the central strategy for teaching science.” Throughout the rest of this unit, students will read actively to find answers to their questions. Unanswered questions spark a lifelong curiosity to learn more about space, and follow discoveries as they are made. You may want to model your learning process by participating in this activity and writing what you notice, know, and wonder.

Objectives

- Teachers will:
Learn the extent of your class's previous experience with Saturn, Cassini, and space science.
- Students will:
Learn to observe carefully and record observations and questions.



Teacher Preparation

Print out teacher references pages 1 through 7 and cut out the Saturn/Cassini-Huygens images. The images are:

Image 1 — Saturn (Photo by Voyager)

Image 2 — The Saturn system (Photo by Voyager. The moons shown are, starting at upper right and proceeding clockwise, Titan, Mimas, Tethys, Dione [directly in front of Saturn], Enceladus, and Rhea.)

Image 3 — Cassini spacecraft approaching Saturn

Image 4 — Cassini launch

Image 5 — Cassini's path to Saturn

Image 6 — What the Huygens probe looks like as it descends to Titan's surface

Image 7 — Drawing of Saturn ring particles

Create seven charts by attaching images to the tops of sheets of butcher paper (long way). Using a large marker, divide each sheet of butcher paper into three columns under the image and label as follows — “What I Notice,” “What I Know,” and “What I Wonder” (for student writing exercise). Decide how you will partner students so that all groups will have a chart to write about. (For example, if there are 28 students in your classroom, the students will work in groups of four.) Place charts and paper in seven locations around the room. Decide what signal you will use to have the students rotate images, and how you will make sure the rotation goes smoothly.

What to Do

Introduce the Activity — Suggested time 10 minutes

1. Tell the class they will begin learning about Saturn and Cassini by looking at some pictures of the planet, the spacecraft, and the probe. Tell the class that they will be looking at the pictures in groups of (the total number of children in your class divided into seven groups), and explain how those groups will be determined.
2. Look at one of the images and model what you notice, know, and wonder before the students begin. For example, you could look at the first image (Saturn) and read:

“Here is what I notice: I notice that there seem to be different colors swirling around the planet. I also notice a dark space in the rings. Here is what I know: I know that Saturn is considered a planet. Here is what I wonder: I wonder how astronomers decide that something is a planet. I wonder why there are different colors on the planet, and what would cause the dark space in the rings. I wonder who or what took this picture of Saturn. I wonder if it is a real picture.”
3. Hand out the seven Saturn charts with images, one per group. Explain the directions for today's assignment to the students:
 - a) When a chart arrives at your group, look at the image carefully.
 - b) In the first column, record what members of the group notice under the label “What I Notice.”



- c) In the second column, discuss what you know with the group. Record a few things on the chart.
 - d) In the third column, discuss what you wonder with the group. Record a few things on the chart.
 - e) At the signal, one person in your group will take the chart to the next group.
 - f) When you get your new chart, you will do the same activity with the new image.
 - g) Make sure you discuss ideas with your group before you write anything on the chart.
4. Explain the order for rotating the images.
 5. Ask the students to brainstorm ideas for what they should do if they run out of space to write.

Observe, Discuss, and Write — Suggested time 50 minutes

About every seven minutes, give the signal to have the students rotate the charts.

Write in Saturn Discovery Log — Suggested time 10 minutes

1. Post the charts with the images in the classroom, and encourage students to circulate to see what everyone wrote.
2. Explain that after they look over the images, they will do a five-minute “quick-write” in their Saturn Discovery Log entry to the prompt: “What did you notice about doing this activity?” “What surprised you about doing this activity?” Tell students that they will be sharing their entries with a partner at the end of the lesson.

Share with a Partner — Suggested time 5 minutes

1. Have students share their log entries with a partner.
2. Ask students to write their name and date on their work, and put it inside their Saturn Discovery Log.

Extensions

You may want to have the gallery of images on the Cassini website bookmarked on the computer for the children to explore — <http://saturn.jpl.nasa.gov/multimedia/index.cfm>



Assessment

While children are working, ask yourself the following questions: Are the students engaged in dialogue when they view the images? Have they learned to discuss science ideas in a group setting? If they have, this skill will enrich their experience throughout the unit. If they have not, you will want to emphasize and model partner and group dialogue throughout the unit. Discuss the following strategies: making eye contact, encouraging others to share ideas by asking them what they think, and paraphrasing to make sure you understand what the other person has said.

As you read over the children's work, ask yourself the following questions:

1. Which area of the writing assignment are the students most comfortable with?
2. Have they had solid experiences with observing carefully as demonstrated by their work?
3. Do they understand that what they know has to be supported by evidence?
4. Do they take risks and ask imaginative questions?

Note the strengths that you see. If you notice that the whole class seems less experienced in a particular area, support this skill development by modeling and encouraging your class in this area. For example, if their observations are superficial, you may want to support future observations by modeling your detailed observations of the ceiling of your classroom. If students "know" something, ask how they know it to support the idea of the importance of evidence. If students ask only "safe" questions, model risk-taking with your questions. Once you have established goals for your students based on this exercise, share them with your class in future lessons, and encourage your class to discuss how they did with the goal.

2. What misunderstandings might the students have?

Note ideas that they have about science content that you would like to address in future lessons. Jot these ideas down next to the lesson in the unit in which they would be most appropriately integrated.

Standards

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

All students must have opportunities to:

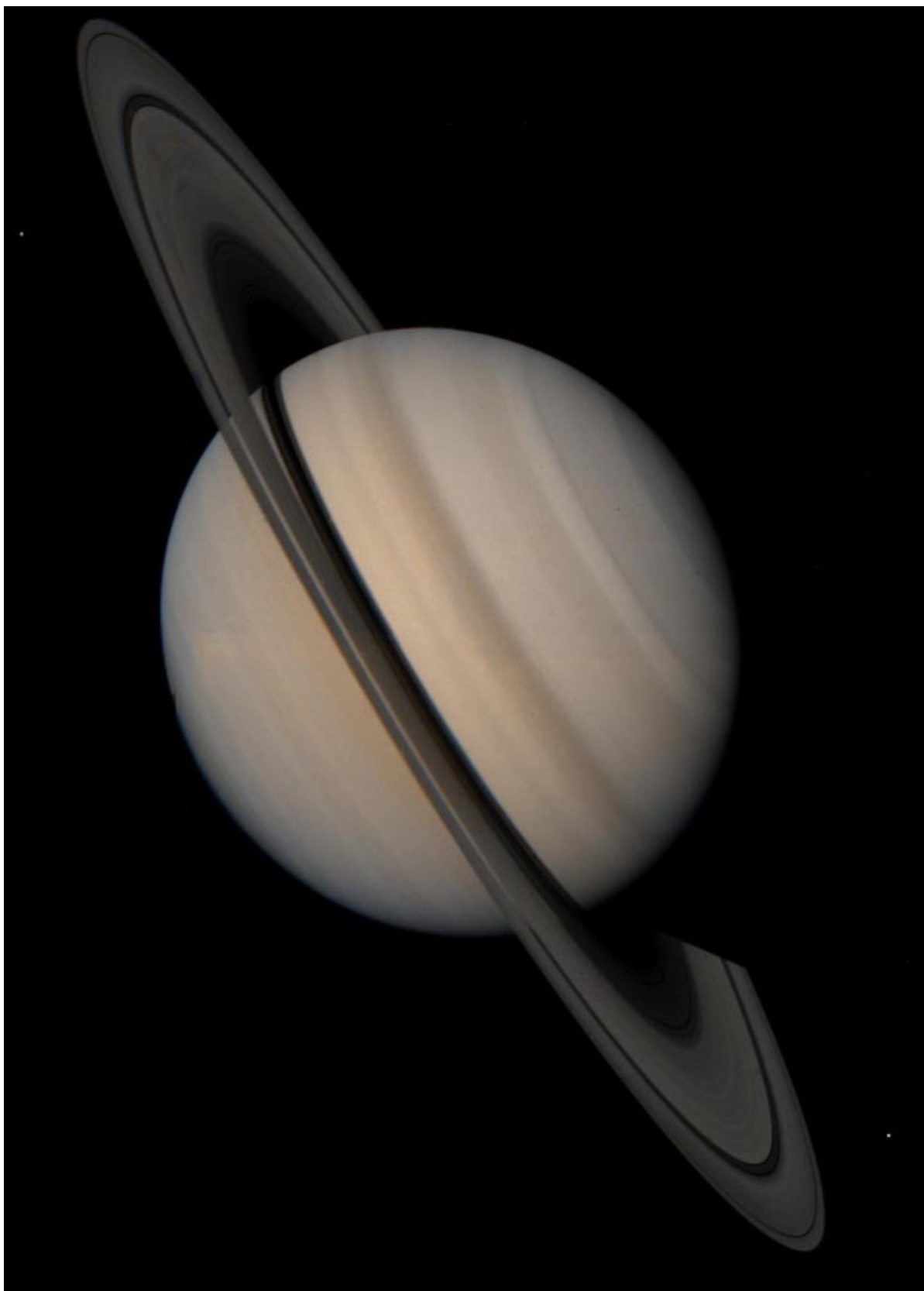
- Participate as knowledgeable, reflective, creative, and critical members of a variety of literacy communities.
- Use spoken, written, and visual language to accomplish their own purposes (e.g., for learning, enjoyment, persuasion, and the exchange of information).

National Science Education Standards

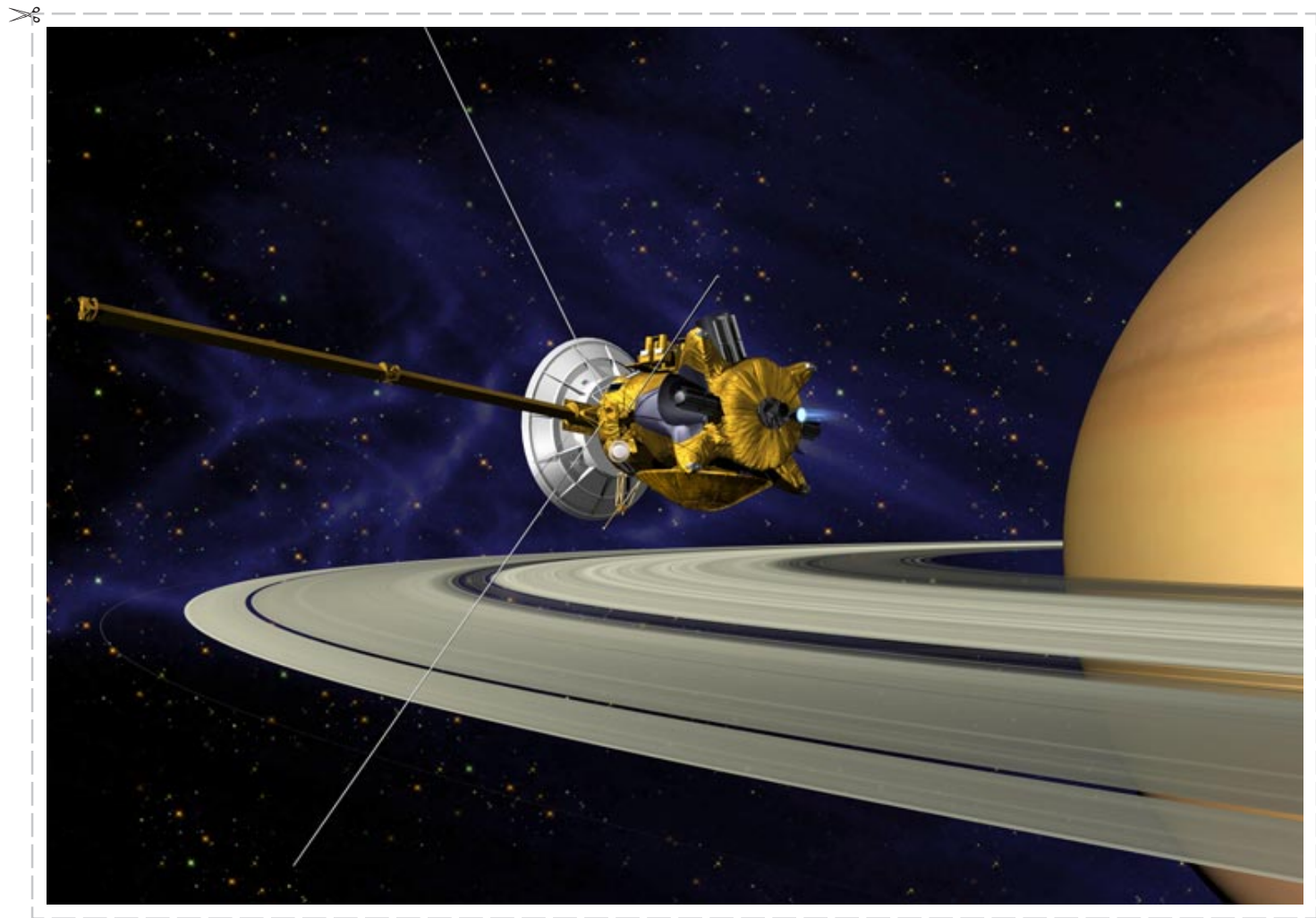
As a result of their activities in grades K–4, all students should develop understanding:

- About scientific inquiry (Science as Inquiry).
- Of objects in the sky (Earth and Space Science).

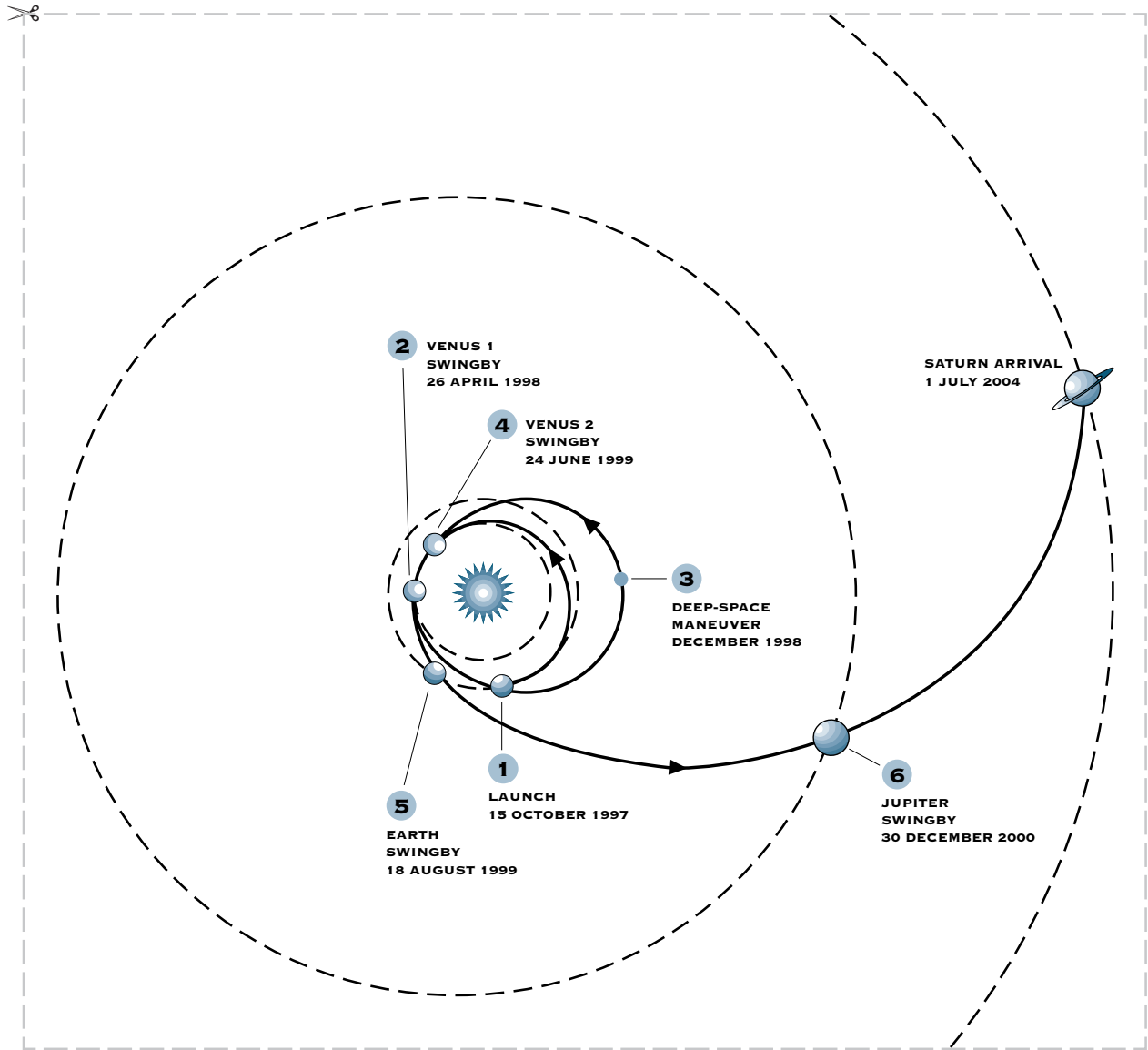


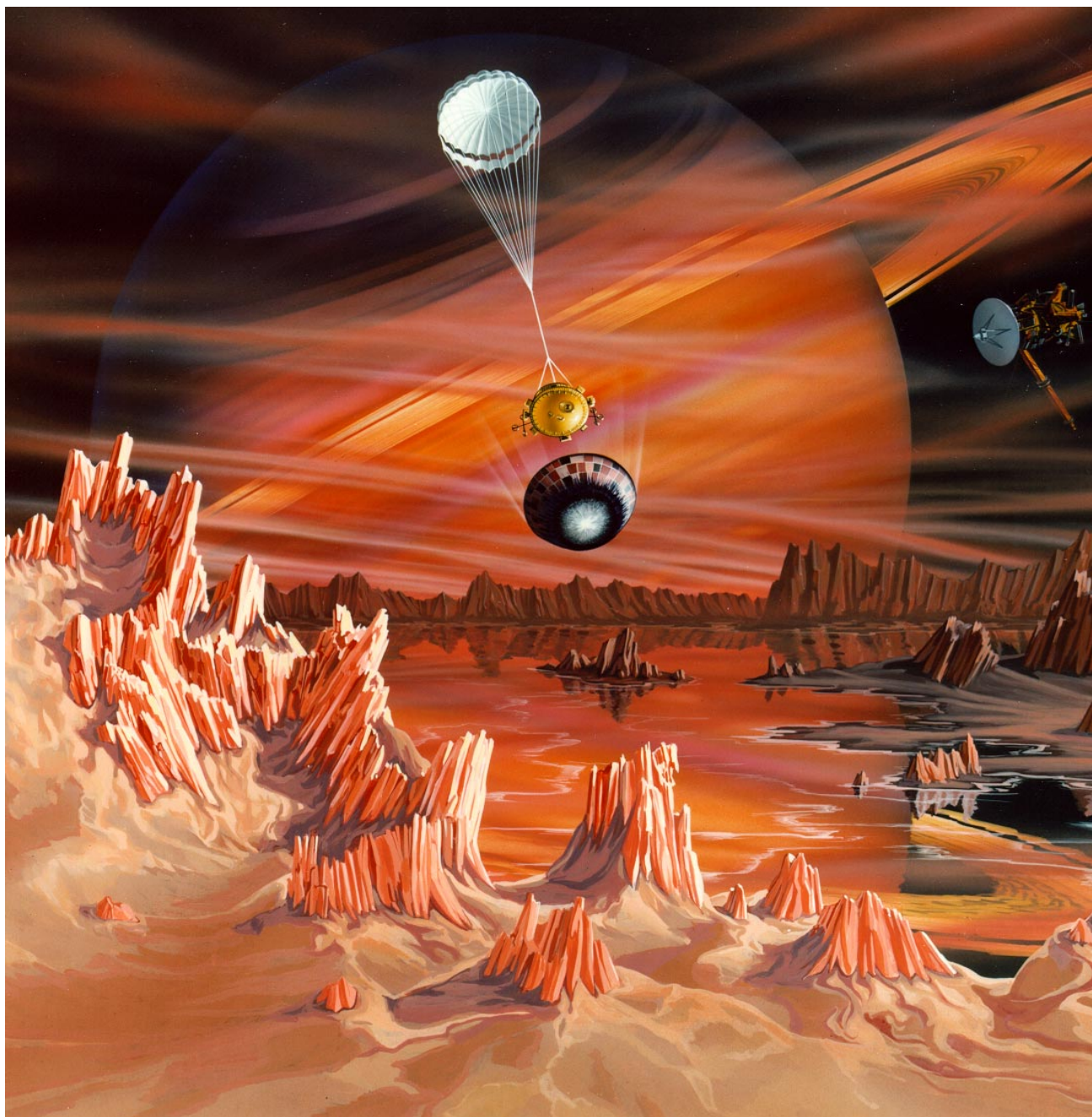








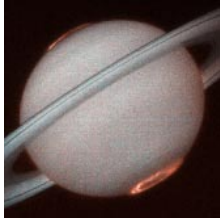






Wondering About Saturn: A Short History

Saturn's polar auroras glow in this ultraviolet view.



LESSON TIME

1 hour

MATERIALS CHECKLIST

For the teacher:

- Copy of reading passage, including marked sample: "Wondering About Saturn: A Short History"

For the students:

- Reading passage: "Wondering About Saturn: A Short History" (one copy for each student)
- Pencils
- Saturn Discovery Log

LESSON NO. 3

• Language Arts Focus

—Nonfiction Writing Practice: Summary

—Nonfiction Comprehension Skills: Visualizing and Wondering

• Science Focus — Reading to Support Inquiry-Based Thinking

OVERVIEW

Humans have been wondering about Saturn for centuries upon centuries. In this lesson, students hear a read-aloud of the history of discoveries that have been made about Saturn. Next, they learn two reading comprehension strategies (visualizing and wondering) to become more powerful readers of nonfiction text. Finally, students share their work with partners and the class.

Saturn, the sixth planet from the Sun, is the farthest planet that is visible without a telescope, and so it has a long history of discoveries associated with it. The National Science Education Standards state that students should understand that science is an ongoing, changing enterprise. It is exciting for students to learn that scientists such as Galileo Galilei were willing to take risks and be mistaken in their quest to make sense of what they observed. The National Science Education Standards state that children should understand the relationship of science and technology. The reading passage in this lesson describes the discoveries that unfold as telescopes become larger and more powerful.

WHY THIS WORKS

Studies have shown that there is a decline in progress in reading in fourth grade (Chall, 1983; Chall, Jacobs, & Baldwin, 1990). This has sometimes been called the "fourth-grade slump." This decline has been attributed to the fact that fourth-grade students are required to process more nonfiction than in previous years, and have been inadequately prepared to do so. This lesson gives children two concrete strategies (visualization and wondering) described in "Mosaic of Thought" (Zimmerman and Keene, 1997) to help them comprehend nonfiction text more effectively.

Objectives

- Teachers will:
 - Gain insight into how students think as they read.
- Students will:
 1. Learn and practice reading comprehension strategies (visualizing and wondering) to help them make sense of nonfiction text.
 2. Learn about the history of discoveries about Saturn.



Teacher Preparation

- For each student plus one copy for yourself to read aloud, print out student handout 1, “Wondering About Saturn: A Short History” (4 pages).
- Print a copy of teacher reference 1, “Wondering About Saturn: A Short History” with the introductory note from the author (to read aloud) and the sample marked page (for modeling).

What to Do

Model Comprehension Strategies — Suggested time 10 minutes

1. Tell the class that you are going to read a summary of the history of discoveries about Saturn. Read aloud to the class “Wondering About Saturn: A Short History,” starting with the introductory paragraph.
2. After you read it aloud once, give each student a copy of the reading passage. Ask the students to write the words “I picture” in the upper left-hand corner of the page. Ask them to write “I wonder” in the upper right-hand corner of the page. Explain that, next to each section, the students will draw what they picture on the left-hand side and write what they wonder on the right-hand side.
3. Model the first section for the class. (Skip the introductory note from the author.) Read the paragraph out loud, and then draw on the board what you picture and write what you wonder. Hold up (or show a transparency of) the sample marked reading passage “Wondering About Saturn: A Short History” as an example of what it will look like on the page.
4. Explain that the students may picture and wonder something different than what you pictured and wondered so they should mark the first section as well (have them skip the note from the author).
5. Explain to the students that they will be sharing what they picture and wonder with a partner at the end of class.

Read to Learn — Suggested time 20 minutes

Give the class time to complete all the sections. Be available if students need help with the passage.

Share with a Partner — Suggested time 10 minutes

Have the students share what they drew and wrote with a partner.

Share with the Class — Suggested time 10 minutes

1. Ask if any students would like to share what they wondered or pictured with the whole class.
2. Ask students to put their name and date on their work, and put it inside their Saturn Discovery Log.



Extensions

- What Our Class Pictured and Wondered

Put the reading passage on a chart. Have students cut out their pictures and what they wondered and paste them next to the reading passage. Look at the pictures and notes from the whole class. Ask children to write what they notice, and why they think it is like that.

- Independent Internet Research Project

1. Have students research how Saturn, Titan, Pioneer, and Voyager got their names, and share this research with the class.
2. Have students research how telescopes are built and how they work, and share this research with class.

- Galileo's Telescope

You may want to have this link to an illustration of one of Galileo's telescopes bookmarked on the computer for the children to explore —

<http://faculty.rmwc.edu/tmichalik/Galileotelescope.htm>

Assessment

As you read over the children's work, ask yourself the following questions:

1. How would I rate this student's comprehension based on the pictures and questions that I see?

Often reading comprehension is assessed by multiple-choice or short-answer questions. Some students have excellent comprehension skills, but struggle with multiple-choice and short-answer formats. This exercise provides another method to gain a sense of how well your students are making sense of what they read.

2. What vocabulary was confusing to the children?

Note vocabulary that you would like to address in future lessons. Jot these ideas down next to the lesson in the unit in which they would be most appropriately integrated.

3. What misunderstandings might the students have?

Note ideas that they have about science content that you would like to address in future lessons. Jot these ideas down next to the lesson in the unit in which they would be most appropriately integrated.



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.
- 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:

- About scientific inquiry (Science as Inquiry).
- Of position and motion of objects (Physical Science).
- Of objects in the sky (Earth and Space Science).
- About science and technology (Science and Technology).
- Of science as a human endeavor (History and Nature of Science).

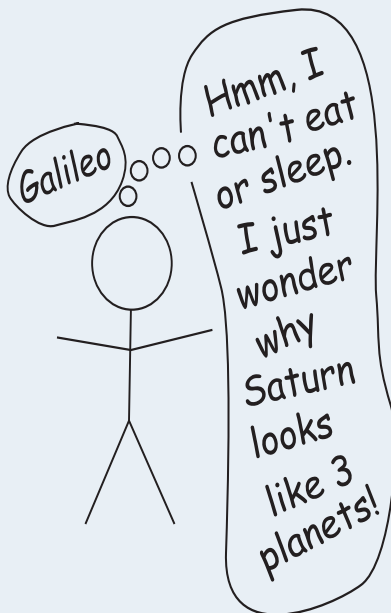


Wondering about Saturn: A Short History

(A Note from the Author — Behind the Scenes of Writing a Summary: Later in the unit, you will be writing summaries. A summary piece of writing includes only important pieces of information. This summary is a history of discoveries about Saturn. Summaries can be difficult to write! When I was researching to write this summary, I found a lot of information about Saturn discoveries. But I only wanted to write a couple of pages about the topic, so that I didn't overwhelm you with information. It was hard to decide what information to include! I decided to put in the information that I thought was the most interesting, and to make sure to show what happened when people invented more and more powerful telescopes. I hope you enjoy hearing and reading this summary!)

Sample

I Picture



A long, long time ago, before the 1600s, when your great, great, great, great, great, great, great, great grandparents looked up into the sky, the farthest planet they could see was Saturn — the sixth planet from the Sun! But they didn't have telescopes yet, so they couldn't see Saturn very well. It looked like a speck.

In 1610, Galileo Galilei spotted Saturn with a telescope that he built. Galileo's telescope was four feet long.

I Wonder

I wonder how well regular people back then knew the difference between planets and stars



Wondering about Saturn: A Short History

A long, long time ago, before the 1600s, when your great, great, great, great, great, great, great, great grandparents looked up into the sky, the farthest planet they could see was Saturn — the sixth planet from the Sun! But they didn't have telescopes yet, so they couldn't see Saturn very well. It looked like a speck.

In 1610, Galileo Galilei spotted Saturn with a telescope that he built. Galileo's telescope was four feet long. The telescope could only magnify distant objects by 20 to 30 times, so Galileo still couldn't see Saturn very clearly. In one of his notebooks, Galileo wrote that he was confused because Saturn almost looked like three planets instead of one. It was a puzzle to him — why would Saturn look like three planets?



In 1655, Christiaan Huygens used a more powerful telescope that he had built, and said, "Saturn isn't three planets. It just has rings!" Huygens also discovered Titan, Saturn's largest moon.

In 1675, Jean-Dominique Cassini studied Saturn using a telescope that was 136 feet long! His telescope was 132 feet longer than Galileo's. He noticed that there was more than one ring around Saturn, and he discovered four more moons.



Hundreds of years passed, and the more astronomers learned about Saturn, the more curious they became about the planet. How did Saturn and its rings form? What were its rings really made of? NASA decided to send a spacecraft to Saturn.

Once NASA decided to send a spacecraft to Saturn, engineers discussed how to build it so that it would be safe on its long journey. (NASA engineers are the people who build spacecraft.)

NASA scientists discussed what the spacecraft would study. (NASA scientists conduct experiments and analyze data.) "Let's land a probe on this moon," one scientist would say. "No, let's land a probe on another moon," another scientist would say.



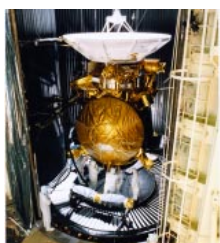
In 1997, after eight years of discussions, coming to agreements, planning, and building, NASA engineers and scientists launched the Cassini spacecraft into space. The engineers and scientists who worked so hard on the spacecraft hoped that Cassini would stay safe during its trip of 800 million miles.

Cassini arrives at Saturn in July 2004, after seven years of flying. Everyone at NASA is excited to see what the spacecraft will learn!



How Far Away Is Saturn?

*The Cassini spacecraft
in JPL test chamber.*



LESSON TIME

One to three class periods

MATERIALS CHECKLIST

For the teacher:

- Copy of “Solar System Background Information”; “Chart of the Size Models for the Walk of Wild Size”
- Copy and overhead of “Taking a Walk of Wild Size”; “Traveling to Saturn: My Predictions and Some Cool Facts”
- Tongue depressors or popsicle sticks, glue, tagboard, tape
- Chart paper, marker, yardstick, yellow highlighter

Per groups of 3 students:

- 18 x 24 inch drawing paper for posters; markers, crayons
- One each “Sun on a stick,” “Earth on a stick,” and “Saturn on a stick”

Per student:

- Saturn Discovery Log
- For extension #2, copy of “Traveling to Saturn: My Predictions and Some Cool Facts”

TO SEE EXAMPLES
OF STUDENT WORK,
CLICK HERE

LESSON NO. 4

• Language Arts Focus

—Nonfiction Writing Practice: Descriptive Paragraph

—Nonfiction Writing Practice: Compare/Contrast Paragraph

• Science Focus — Understanding Size and Distance by Creating Sun/Earth/Saturn Models

OVERVIEW

In this lesson (and extensions), students will be “Thinking and Writing About Scale: Taking a Walk of Wild Size!” We provide invitations and opportunities for students to begin to understand the vastness of the solar system and the size differences between our home — Earth — and our destination, Saturn. Using the “Sun on a stick,” “Saturn on a stick,” and “Earth on a stick” props, students create a scale model for size and distance in our solar system. Because the distances in space are so vast, you and your students will need to take a short hike to complete this model. A special Solar System Fact Sheet provides background information for teachers, and can be used as a lesson extension. We also include an indoor model as an option if teachers have limited time or space. Writing activities engage students in reflecting on experience, and in comparing and contrasting what they thought the trip to Saturn would be like, from the “real” thing!

WHY THIS WORKS

At the beginning of this unit on Saturn, or any astronomy unit, it is useful to give students a sense of the neighborhood we’ll be studying. The sizes and distances that we explore in space are far greater than those we are accustomed to on Earth. Children (and adults) may not easily grasp the vastness of space or the size differences between Earth and the other planets. When students “walk to Saturn,” they discover firsthand that it is very far away from Earth! This early, shared experience becomes a useful “touchstone” throughout the unit, as well as a point of departure for our trip to Saturn. When students write about an experience or activity, they have a chance to learn again. Students clarify ideas, questions, and understandings. This activity provides an authentic context for both descriptive and compare/contrast genres.

Objectives

Students will:

1. Practice descriptive writing.
2. Practice compare/contrast writing.
3. Build an operational understanding of scale — both size and distance — in comparing the Sun, Earth, and Saturn.



4. Increase/enhance their understanding of and interest in Saturn and the Cassini–Huygens mission and spacecraft.
5. Practice the scientific thinking skills of predicting, comparing, and relating.

Teacher Preparation

- Print out and read teacher reference 2: “[Solar System Background Information](#).”
- Print out a copy of teacher reference 3: “[Chart of the Size Models for the Walk of Wild Size](#)” (instructions for making the chart).
- Allow about an hour to gather materials and make stick puppets.
- Print out copies of teacher reference 4: [Sun, Earth, and Saturn image page](#) for the “Sun on a stick,” “Earth on a stick,” and “Saturn on a stick.” Cut out the images and glue (or laminate) them to tagboard. Then tape each object to a large tongue depressor or popsicle stick, so that students can easily hold them. Make enough so that you have enough for students to work in groups of three; make one extra set for the Chart of the Size Models for the Walk of Wild Size.
- Print out and prepare an overhead of teacher reference 5: “[Taking a Walk of Wild Size](#)” (Directions for Pacing the Solar System).
- Make the Chart of the Size Models for the Walk of Wild Size — you will need the three stick models, tape, a large marker to write the titles, a large piece of chart paper, a yard stick, and a highlighter or yellow marker.
- Create a special Saturn envelope that you open upon arrival at Saturn as your class paces the solar system. There could be photos or facts about Saturn written on strips of paper that students could take turns reading aloud.
- Optional (extension activity #2):
 - One copy of teacher reference 6: “[Traveling to Saturn Fact Sheet](#)”
 - Overhead for the teacher, plus print one copy per student, of student handout 1, “[Traveling to Saturn: My Predictions and Some Cool Facts](#).”

Teacher Tips

1. Do the activity yourself before having students do it, so you can find the best location and better anticipate student responses and questions.
2. It is critical to talk with the students about scientific models — particularly how models are alike or different from the objects or phenomena they represent, and why we use models. While this particular model holds true for size and distance comparisons, it is inaccurate or misleading because students may conclude that the Sun, Earth, and Saturn are all lined up in a straight line. Be sure to talk to students about the shortcomings of this model (it works for size and distance but it does not model locations in space). Additionally, since the planets have elliptical rather than circular orbits, their actual distances from the Sun are always changing. Distances suggested here are averages. It is okay if your “line” from the Sun to Saturn is not straight; your line can curve and twist, or go back and forth. What is most amazing to the students (and adults as well) is the relationship of size to distance.



teacher TIP

If your students' responses indicate that they know very little about the solar system, you may want to do a whole-class read aloud. (Suggested title: *Our Solar System* by Seymour Simon)

3. Because much of this activity is done outdoors, you will want to clearly establish behavior expectations, or “signs of success,” with your students beforehand. For example, “stay with the group,” “stay focused on the activity,” and so forth. If your students are used to doing “T” charts for behaviors, this will be helpful (see example below):

“Staying Focused Outside”

Looks Like: Sounds Like:

Before You Begin

- A note on grouping:
 - Triads and Whole Class for outdoor activity
 - Partners or triads for Prior Knowledge posters, and follow-up projects

What to Do

Introduction/Sharing What We Know — Suggested time 30–60 minutes

Optional — if your class is already familiar with the solar system, you may skip this section.

1. Begin with a whole-class discussion of what the students know about the solar system.
2. Have students work in groups of two or three to make charts or posters of the following on 18 by 24 inch paper:
 - What We Know About The Solar System
 - What We Know About Space Travel
 - Questions We Have
3. Have groups share with the class. Keep posters up throughout the unit, so students can compare how their understandings, ideas, and questions are changing.

Understanding Size and Distance — Suggested time 40–60 minutes

1. Tell students that “we are going to begin our journey to Saturn with a scientific model that will help us understand both size and distance.” Explain to the students that the Sun is the largest object in the solar system — it would take 109 Earths to span the Sun’s diameter. Remind students that the Sun is in the center of the solar system and the planets orbit the Sun.
2. Show the students the “Sun on a stick” that is approximately 8 inches in diameter. This is our model Sun. Have students predict: If this is our Sun, how big do you think Earth should be? How big do you think Saturn should be? Have students draw their ideas in their Saturn Discovery Logs.
3. Show the students the “Earth on a stick” and “Saturn on a stick” models. Earth and Saturn will be exaggerated in scale (compared with the 8-inch-diameter Sun) so that they can be seen by everyone in the classroom.



4. Students can make changes to their log drawings, and label “first ideas” and “actual model size.”
5. Display the Chart of the Size Models for the Walk of Wild Size you have made and have the students read it with you. Fourth graders can copy the information into their Saturn Discovery Logs. You may want to have “glue-in” mini-charts for third graders.
6. Ask the students, “Now that we have established the size scale for the Sun, Earth, and Saturn, how much space do you think we need for a scale model of distance between the Sun, Earth and Saturn?” Record predictions on the board.
7. Tell students: The distance between Earth and the Sun is 93 million miles. In the model, this will be 26 yards. Have a student volunteer take 26 paces in the classroom. (Students will see that it will be necessary to go outside to complete the model.)
8. Take the class outside.
9. Take a few minutes to demonstrate, and have students practice, pacing as close to a yard in length as possible. This is another good place to talk about the difference between a model and “real life,” and that our giant-step paces will be almost, but not exactly, the same.
10. Distribute sets of Saturn on a stick, Sun on a stick, and Earth on a stick to student groups of three. Have the oldest student be the Sun, the second oldest be Earth, and the third oldest be Saturn.
11. Ask the students, “How far apart do you think you need to stand in order to model the distance that the Sun, Earth, and Saturn are from one another?” (Give students a few minutes to discuss.)
12. Have the groups model what they think are the scaled distances between the Sun, Earth, and Saturn.
13. Bring students back together and have a brief discussion about what they noticed.

Taking The Walk of Wild Size — Suggested time: 25 minutes to Saturn and back, 45 minutes to pace the entire solar system

1. Collect the Sun, Earth, and Saturn stick models.
2. Have a volunteer Hold ONE Sun stick model. Have the students line up. Begin pacing together (teacher reads directions). Note: the pacing directions tell where the other planets are located. You can call these out as you pass each one. Also, you can continue past Saturn all the way to Pluto, if desired.
3. Stop at Saturn and discuss the model with your students. Prompt them with the questions on the “Taking a Walk of Wild Size: Directions for Pacing the Solar System” sheet. You may want to have students record responses in their Saturn Discovery Logs, especially if they are fourth graders.



teacher TIP

If you are able to secure two adult volunteers for this activity (one to hold the “Sun” and one to hold the “Earth”), then all your students will be able to participate in pacing out the distance from the Sun to Earth to Saturn.

If you have created a special Saturn envelope, it can be opened upon arrival at Saturn. There could be photos of Saturn, or facts about Saturn written on strips of paper that students could take turns reading aloud.

Optional: This would be a good time to do the “Traveling to Saturn” activity (extension activity 2).

4. Return to the classroom and have the students complete their Saturn Discovery Log entries.

Writing About Saturn in Saturn Discovery Logs — Suggested time 30–45 minutes

Options:

- A compare and contrast paragraph about the activity: “My ideas about the distance from Earth to Saturn before and after the activity.”
 - A descriptive paragraph about the activity.
1. Have students talk with a partner before beginning to write. They can share notes from their logs, or discuss one or both of the suggested writing activities.
 2. Talking before writing gives students a chance to rehearse their ideas, to clarify ideas, and to learn from one another. A suggested format is to have students sit facing their partners “knee-to-knee and eye-to-eye.” Give one partner 2 or 3 minutes to talk. The listener can then ask clarifying questions. Have students reverse roles.

Sharing/Closure — Suggested time 10 minutes

1. Students can first discuss with partners and small groups what they learned, what they found most interesting or surprising, and what questions they now have.
2. They can also read their writing to one another, and give feedback on both content and structure. One way would be for partners to tell one another “remembers,” reminders, and questions. Remembers are specific sentences, words, or ideas that the listener/audience remembers from the piece. Reminders are statements where the listener connects to the author and piece of writing. “That reminds me of....” Finally, questions can be about the content, or, about parts of the writing that are unclear. For more ideas about peer response to writing, see Ralph Fletcher’s or Nancy Atwell’s books. After sharing with partners or in small groups, students can be invited to share with the class.

Extensions

1. Send home the directions for pacing the solar system, so students can do the activity again with family and friends.
2. Have students complete the “Traveling to Saturn: My Predictions and Some Cool Facts” worksheet (suggested time 15–20 minutes).
—Display teacher’s copy of “Traveling to Saturn: My Predictions and Some Cool Facts” worksheet on an overhead projector.



—Tell the students: “Most objects in our solar system are really, really big; and really, really far apart. We’re going to focus our attention on getting to Saturn.”

—Ask students: How long do you think it will take to get from Earth to Saturn? Walking? In a racecar? In a jet? In a spacecraft? Students can record responses in their Saturn Discovery Logs, or on their personal copies of the “Traveling to Saturn” worksheet.

—Share the information from the “Traveling to Saturn Fact Sheet” with the students as they respond to each of the questions on their copies of the worksheet.

—Discuss why it is going to take Cassini seven years to get to Saturn.

3. Make other models of the solar system: see the “Solar System Model Builders’ Guide” on the Windows to the Universe website at http://www.windows.ucar.edu/tour/link=/our_solar_system/distances.html&edu=elem

(Includes directions for scaling the solar system when Earth is represented by a marble.)

4. Build a radial model of the solar system. This way, students will understand that the planets are not “all lined up” in a straight line.
5. Indoor Alternative to the “Walk of Wild Size” — Astronomical Unit Scale Model for Distance Only

Overview: Students will create a distance-only scale model of either the Sun, Earth, and Saturn, or the Sun and all nine planets, using their own feet to equal one astronomical unit.

Background: Astronomers have given a special name to the distance from Earth to the Sun. It is called an astronomical unit, abbreviated AU. An AU is 150 million kilometers or 93 million miles. Because distances in space are so vast, astronomers sometimes use astronomical units (or other units such as light-years) for measurement.

Materials for Indoor Alternative:

- Paper cups/marketing pens (3–10 for the whole class, or 3–10 per student or group), or index cards/marketing pens, modeling clay
- Sidewalk chalk
- Envelopes containing the number of steps needed from the Sun to each planet (if you want this to be a surprise for the students), or written directions for each group of how many steps to take.
- Saturn Discovery Logs for recording observations and questions

Directions:

—Discuss with the students that they will be creating a model for the distance from the Sun and Earth to Saturn (or the entire solar system, if you wish). Talk



about ways that models are useful to scientists, and also ways that models are alike and different from “real life.”

—Tell the students that because distances in space are so vast, scientists have come up with some different ways of measuring these distances. One way is to use a unit called an astronomical unit. An astronomical unit is equal to the distance from Earth to the Sun (93 million miles, or 150 million kilometers). For our model, the length of _____’s foot will be one astronomical unit!

—Practice measuring the astronomical units by walking slowly, placing the heel of the foot against the toes of the other foot (some people call these “baby steps” or “heel-toes”).

—Place the Sun cup or card at one end of the classroom, hallway, sidewalk, or schoolyard. (If it is windy at your school, you can place a clay ball or other little weight inside the paper cups)

—Ask students to predict (they can mark their predictions with chalk X’s on the pavement if you do this out-of-doors) where they think Earth and Saturn will be, relative to the placement of the model Sun. They can also predict how many astronomical units (real feet) they think this will be.

—If you are doing this as a whole-group demo, select the student whose feet/steps will be used for the model. Otherwise, distribute written directions (or envelopes) to partners/groups. Remind students of how to measure the astronomical units, walking heel-toe.

—Have your astronomical unit model place her or his heel against the Sun cup, or index card set in a clay ball. Place the planets as follows:

- Mercury: instep
- Venus: big toe joint
- Earth: tip of the big toe
- Mars: 1.5 steps
- Jupiter: 5 steps
- Saturn: 9.5 steps
- Uranus: 19 steps
- Neptune: 30 steps
- Pluto: 39 steps

—Use the “Traveling to Saturn Fact Sheet” to discuss the activity with the students.



Assessment

As you observe your students working, and read the work after the lesson, ask yourself the following questions:

1. Are the students able to stay on task in their groups? If they are able to do this, take notes on what you see the students doing, and share these with your class.
2. Do the students' paragraphs indicate an understanding of paragraph structure, e.g., main idea, details, and examples? Are students able to use transition words? Do descriptive paragraphs give a clear picture to the reader of the model journey to Saturn? Do students accurately describe the distance traveled? Do compare and contrast paragraphs include at least two examples of "what I expected" and "what really happened."

Standards

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

All students must have opportunities to:

- 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).

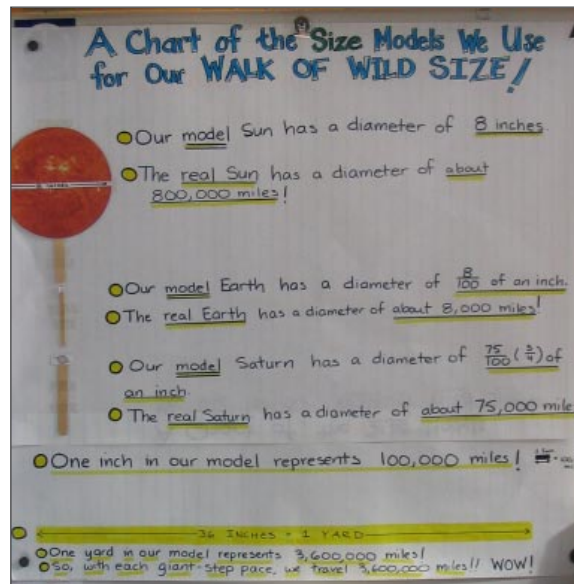
National Science Education Standards

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

- Of objects in the sky (Earth and Space Science).



Examples of Student Work



What I Know about the Solar System

Moon

Rings planets saturn

Mars sun earth Mercury

Jupiter, venus, pluto,

uranus, and neptune

Milky way black hole

astroids comets stars

a orbit astroid belts

as = hydrogen and oxygen

What I know about the Solar System

"Quick Write"

Words, Phrases, or Sentences

The solar system is huge. It has planets and moons. We live on the third planet from the sun. The sun is a star. It gives light to the planets. The far planets are colder and not good for living. The inner planets are warmer, and some are hot. Earth, an inner planet, is just right. There is an asteroid belt separating the inner and outer planets. There is a debate whether Pluto is a planet. There are more planets than we know. Some planets have more than one moon. Jupiter is the largest planet in our solar system. The sun is not a planet. Each planet has an orbit. The planets orbit around the sun.

1" = 100,000 miles

36" = 1 yard = 3,600,000 miles

Taking a Walk of Wild Size

Sun's diameter = 863,890 miles

model Sun's diameter = 8 inches

Earth's diameter = 7,928 miles

model Earth = $\frac{8}{100}$ = $\frac{2}{25}$

Saturn's diameter = 79,413 miles

model Saturn = $\frac{75}{100}$ = $\frac{3}{4}$

Earth I think Earth is one centimeter

Saturn I think Saturn is 3 inches

109 Earths = 1 Sun diameter

11 1/2 Saturns = 1 Sun diameter

9 1/2 Earths = 1 Saturn diameter

I think we would probably need to go outside. Start from the flagpole to about the middle of the field.



Solar System Background Information

Information on Size

Diameter is the length of a straight line through the center of an object — so, the diameter gives us the measurement of how far it is across a planet, moon, or the Sun.

- The Sun's diameter is about 863,890 miles.
- Earth's diameter is about 7,928 miles.
- Saturn's diameter is about 74,913 miles.
- It would take about 109 Earths to span the diameter of the Sun.
- It would take about 11-1/2 Saturns to span the diameter of the Sun.
- It would take about 9-1/2 Earths to span the diameter of Saturn.

Information on Distance

- The Earth is 93,000,000 (93 million) miles from the Sun.
- Astronomers give this distance a special name: an astronomical unit, abbreviated AU.
- Saturn is 890 million miles from the Sun, or 9.5 astronomical units
- So....Saturn is about 800 million miles from Earth.
- Walking at 3 miles per hour, it would take 30,441 years to get to Saturn. (yikes!)
- Driving a race car at 100 miles per hour, it would take 913 years to get from Earth to Saturn. (WOW!)
- Flying to Saturn in a jet plane, traveling at 600 miles per hour, would take 152 years (too long!).
- Flying in a rocket at a constant speed of 17,500 miles per hour, it would take 5 years! (Cassini will spend 7 years on its journey. This is because the spacecraft is too heavy to travel directly to Saturn. It must fly by several other planets to give it the "energy boost" needed to get to Saturn. Cassini's journey covers nearly 3 billion miles).

Information on Converting Miles to Kilometers, or Kilometers to Miles

The metric system is often used in science. As you learn more about astronomy, read different books, and visit different Web sites, you may find information presented in miles, kilometers, or both. Here is an easy way to convert from miles to kilometers, and kilometers to miles —

1 mile = 1.609 kilometers

- To convert from miles to kilometers (km), multiply by 1.609. For example, if the diameter of Saturn is 74,913 miles, multiply 74,913 miles by 1.609 km per mile = 120,535 km.
- To convert from kilometers to miles, divide by 1.609. For example, if the diameter of Saturn is 120,535 km, to find out miles, divide 120,535 km / 1.609 km per mile = 74,913 miles.

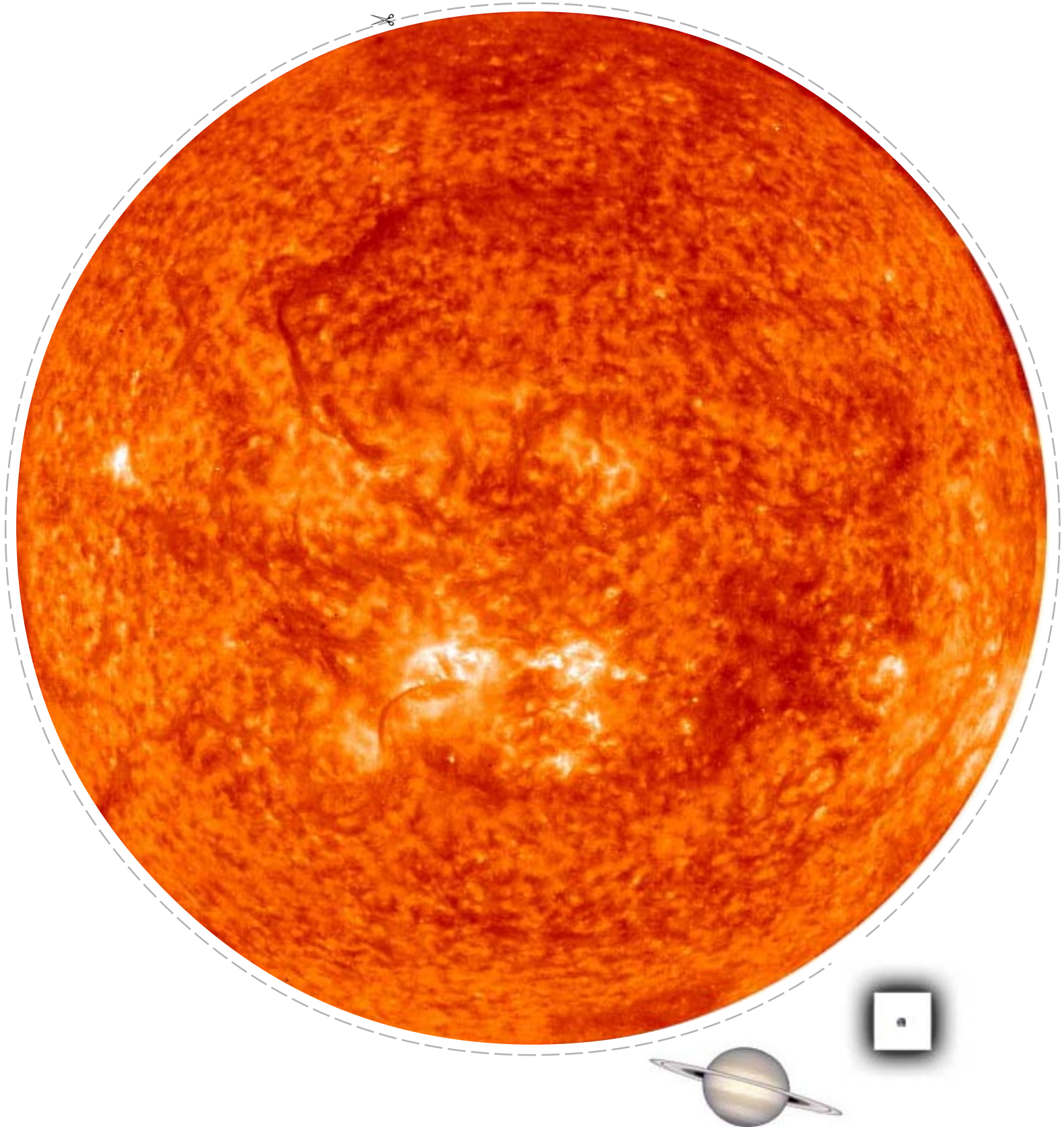


Chart of the Size Models for the Walk of Wild Size

- On a large piece of chart paper, write the title:
“A Chart of the Size Models We Use for Our Walk of Wild Size”
(or “Walk to Saturn”)
- You will be using one set of the “Sun on a stick,” “Earth on a stick,” and “Saturn on a stick.”
- Tape a “Sun on stick” on the left margin.
- Write: Our model Sun has a diameter of 8 inches.
The real Sun has a diameter of about 800,000 miles.
- Tape an “Earth on a stick” below the Sun.
- Write: Our model Earth has a diameter of $\frac{8}{100}$ of an inch (0.08).
The real Earth has a diameter of about 8,000 miles.
- Tape a “Saturn on a stick” below the “Earth.”
- Write: Our model Saturn has a diameter of $\frac{75}{100}$ of an inch ($\frac{3}{4}$ inch or 0.75 inch).
The real Saturn has a diameter of about 75,000 miles.
- Write: One inch in our model represents 100,000 miles (1:100,000).
- Draw a little rectangle, or fat line, that is exactly one inch long, and label it.
- Trace a yard stick, color in with a yellow marker or highlighter, and label it “36 inches or 1 yard.”
- Write: One yard, or 36 inches in our model represents 3,600,000 miles.

So, with each giant-step pace, we will travel 3,600,000 miles!





Taking a Walk Of Wild Size

Directions for Pacing the Solar System

1. Start at the Sun.
2. Take 10 paces. (Remind student that these are “giant steps” and should be as close to a yard in length as possible.) Call out “Mercury.”
3. Take 9 more paces. Call out “Venus.”
4. Take 7 paces. Call out “Earth.”
(At this point, have the students look back at the Sun. Ask, “What do you notice?” “How big does the Sun look from Earth?”)
5. Take 14 paces. Call out “Mars.”
(Ask students if they know which planet they will pass next on their journey to Saturn.)
6. Take 95 paces. Call out “Jupiter.”
(Ask students which planet is next. Have them predict how many more paces it will be to Saturn.)
7. Take 112 paces. Call out “Saturn.”

WOW! Saturn is 247 paces from the Sun, and 221 paces from Earth!

Discussion

Talk about the model with your students, using the following questions to guide the discussion. Students can also write notes in their Saturn Discovery Logs.

- How do you feel?
- What do you notice?
- Can you see the Sun? Can you see Earth?
- What do you notice about how the Sun looks from Saturn compared to how it looked from Earth? (size, brightness)
- Do you think it is colder on Saturn than Earth? Why?
- What problems or challenges do you think a spacecraft will have to overcome in order to travel from Earth to Saturn?
- What kinds of information about Saturn and Titan do you think a spacecraft could gather that we are unable to gather from Earth?
- How did the trip feel?
- What was most surprising?
- What questions do you have? (“I wonder...?” “What if...?”)

To The Outer Planets

If you have time, you can continue to Pluto!

It is 249 paces from Saturn to Uranus.

It is 281 paces from Uranus to Neptune.

It is 242 paces from Neptune to Pluto.



Traveling to Saturn Fact Sheet

- Earth is 93 million miles from the Sun.
- Astronomers give the distance from Earth to the Sun a special name — an astronomical unit.
- Saturn is 890 million miles from the Sun, or 9.5 astronomical units.
- So — Saturn is about 800 million miles from Earth.
- Walking at 3 miles per hour, it would take you 30,441 years to get from Earth to Saturn.
- Driving a race car at 100 miles per hour, it would take you 913 years to get from Earth to Saturn.
- Flying to Saturn in a jet plane, traveling at 600 miles per hour, it would take you 152 years to get to Saturn.
- Flying in a rocket, traveling at 17,500 miles per hour, it would take you 5 years to get to Saturn.

(It takes the Cassini–Huygens spacecraft nearly 7 years to get to Saturn, because it is not traveling at a constant speed.)



Traveling to Saturn: My Predictions and Some Cool Facts!

How Long Would It Take to Travel To Saturn?

Walking at 3 miles per hour?

I predict it would take _____

Actual time _____

My response:

Driving a racecar at 100 miles per hour?

I predict it would take _____

Actual time _____

My response:

Flying a jet airplane at 600 miles per hour?

I predict it would take _____

Actual time _____

My response:

Flying a rocket at a constant speed of 17,500 miles per hour?

I predict it would take _____

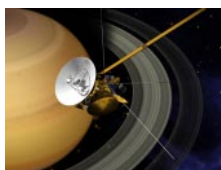
Actual time _____

My response:



Discovering Saturn, The Real “Lord of the Rings”

Cassini–Huygens at Saturn, July 2004.



LESSON TIME

About 3 hours for the Saturn minibooks; 2 hours for the Saturn poster.

MATERIALS CHECKLIST

Per groups of 4 students:

- One set of four “Discovering Saturn” minibooks

Per student:

- Student handouts 1, 2, 3, and 4: “Pre-Reading/Pre-Writing Activity Worksheet”; “Note-Taking for Nonfiction Worksheet”; “Descriptive Writing Tip Sheet”; “Peer Conference Guidelines”
- Pencil, paper, broad-tip markers, paints, 36 x 48 chart paper
- Saturn Discovery Log

For the teacher:

- Optional: overhead transparencies of student handouts; a CD or tape of “The Planets” by Gustav Holst

TO SEE EXAMPLES OF STUDENT WORK, [CLICK HERE](#)

LESSON NO. 5

- Language Arts Focus

—Nonfiction Reading Practice: Saturn Minibooks

—Nonfiction Writing Practice: Descriptive Paragraph

- Science Focus — Understanding the Saturnian System by Building 2-D and 3-D Models of Saturn

OVERVIEW

At this point in our imaginary journey to Saturn with the Cassini–Huygens spacecraft, we have arrived at Saturn! Now students extend and enhance their current understandings about Saturn by reading a series of four Saturn minibooks about the planet, the rings, and the moons. Students take notes as they read for three purposes: first, to collect information that will be used to craft a descriptive paragraph about Saturn; second, to record this information (along with their questions and predictions) in their Saturn Discovery Logs for later comparison with real data collected and transmitted by Cassini; and third, to assist them in writing text for giant-sized Saturn posters. For one extension activity, students build 3-D models of Saturn and its rings.

WHY THIS WORKS

At this point in the unit, students’ curiosity about Saturn is piqued. They are eager to learn more about the special features of Saturn — its rings and moons — and the planet itself. While much is known about Saturn, there are still many mysteries. Students are encouraged to ask questions as they read the Saturn minibooks and learn new information. They are given multiple opportunities to reinforce and apply what they have learned by writing, talking, and creating models.

This lesson gives students practice in both reading and writing for authentic purposes. Students pay close attention as they read in order to write descriptively. They write to a specific and authentic audience. Sharing information about the Cassini–Huygens mission with students at their school contributes to building a community of learners.



Objectives

Students will:

1. Read and write for specific, authentic purposes.
2. Practice expository writing by writing a descriptive paragraph about Saturn.
3. Extend and enhance their understanding and knowledge about Saturn by reading, writing, talking, and building models.
4. Create a giant-size Saturn poster.
5. Build a 3-D model of Saturn and its rings (extension activity).



For background on Saturn — <http://saturn.jpl.nasa.gov> and <http://solarsystem.jpl.nasa.gov>. To get a feel for how the planets orbit — <http://www.fourmilab.ch/cgi-bin/uncgi/Solar>

Teacher Preparation

- Print out and photocopy the four “Discovering Saturn: The Real Lord of the Rings” minibooks. Students can take turns reading them. Make enough copies for your students to work in groups of four; for example, if you have 30 students, you will need 8 sets of the booklets.

The minibooks are:

Booklet One: “Introducing Saturn”

Booklet Two: “Saturn — From the Outside In”

Booklet Three: “Those Amazing Rings!”

Booklet Four: “Saturn’s Moons”

- Print and photocopy (one per student) of student handouts 1, 2, 3, and 4:
 - “Pre-Reading/Pre-Writing Activity Worksheet” (2 pages)
 - “Note-Taking for Nonfiction Worksheet” (2 pages)
 - “Descriptive Writing Tip Sheet”
 - “Peer Conference Guidelines”
- Optional: Make overheads of student handouts rather than individual copies, and have students write in their Saturn Discovery Logs.
- Cut chart paper for students to use for the giant posters (36 by 48 inches). Depending on the age of your students, you may want to trace a large Saturn on the paper and let the students paint or color it.

Extensions:

- For the Connections to Cassini–Huygens Mission extension, prepare an overhead of the teacher reference page “What I Wonder About Saturn.”
- If you are planning to do the hands-on extensions, you will need to get materials for the 3-D Scale Model Saturn and Envelopes and Postcards from Saturn activities. It is recommended that you try out these hands-on activities yourself before doing them with the students.

Before You Begin

You may want to discuss color and scale with your students.

1. *Color.* “False color” is sometimes used to help us see details, artificial divisions, or features that we would otherwise miss. For example, in the illustration of Saturn’s rings on page 2 of booklet three, “Those Amazing Rings,” the artist applied different colors to the various rings to make it easier to distinguish them. In NASA space images, false color is sometimes added during processing to bring out details. Saturn is actually a pale butterscotch color, but adding color to the images brings out atmospheric features and banding. Maps use false colors to identify different cities, states, or countries. Satellite



images of the oceans may use false color to show regions of different temperatures. In images of distant galaxies and nebulae, such as we get from the Hubble Space Telescope, false color is often used to represent wavelengths of light that our eyes can't detect (such as infrared, ultraviolet, or X-ray) or to illustrate the chemicals that predominate in various parts of the object. For more information about false color, visit the following website:

http://chandra.harvard.edu/photo/false_color.html

teacher
TIP

- Students will finish reading the minibooks at different rates; those who finish early could do one of the writing extension activities.

2. *Scale.* Illustrations of space missions often show objects that are not to scale — for example, the picture on page 2 of Saturn booklet four, “Saturn’s Moons,” showing Saturn, the Cassini spacecraft, and part of Titan. (If needed, discuss perspective with your students.) It is clear that the spacecraft is nowhere near as large as it appears to be in the picture. The illustrator uses artistic license so we see the most important objects — Saturn, a moon, and the spacecraft. If the spacecraft were drawn to scale, it would be so tiny that we would not be able to see it.

What to Do

“Discovering Saturn: The Real Lord of the Rings” Minibooks

Reading and Note-Taking — Suggested time 2–3 hours

1. Give students copies of student handout 1, “Pre-Reading/Pre-Writing Activity Worksheet.” Go over the directions with the class and allow time for the students to complete their worksheets.
2. Explain to the students that they will be reading the Saturn minibooks for multiple purposes. First, they will learn new information about Saturn, and second, they will practice note-taking. Finally, they will use the information for two purposes — one, to write a descriptive piece about Saturn, and two, to have this information in a handy place for comparing it with new information we learn about Saturn from the Cassini–Huygens mission.
3. Give students copies of the student handout 2, “Note-Taking for Nonfiction Worksheet.” The first minibook students read will be the one they take notes from and write a paragraph about.
4. Read the directions aloud and model how to use the “Note-Taking Sheet for Nonfiction Worksheet.” Remind students to just take notes on the first booklet they read.
5. Establish with the students how the minibooks will be shared (for example, “pass to the person on your left.”) If students will be reading the books with or to a partner, be sure they are clear about the procedure.
6. Hand out copies of the Saturn minibooks to groups of four students. Read and enjoy!

From Notes to Paragraphs — Suggested time 20–30 minutes

1. Have students read their notes to a partner and share/compare ideas.
2. Review and/or model for students the elements of a descriptive paragraph. Give copies of student handout 3, “Descriptive Writing Tip Sheet,” to students and go over it together.
3. Give students time to write their paragraphs.



Sharing — Suggested time 10 minutes

1. Have students read descriptive pieces to a partner. The writer can tell the listener what to listen for, as well as ask for tips. The listener can help the writer by sharing specific places in the writing that are descriptive: “show not tell,” examples, details, and figurative language. Students can use student handout 4, Peer Conference Guidelines, for this part of the activity.
2. Invite students to read their paragraphs aloud to the class.

Student pieces can be compiled into a class book, used for individual minibooks, or as text for “Postcards from Saturn” to be shared with a buddy class, pen pals, or family/friends.

Giant Saturn Posters

Posters with Illustrated Text — Suggested time 1–2 hours

1. Put students in groups of four.
2. Give each group a large piece of 36 by 48 inch chart paper.
3. Have students create a giant illustration with text for their posters. They can use tempera paints, collage, or any other media to make their Saturns. Be sure they have broad-tip markers for writing the text. If you feel it is necessary, you can trace the Saturn outline on the chart paper first.
4. Tell students to put new information from their “Note-Taking Sheet for Non-fiction Worksheet” onto their posters.
5. Give the groups some time to present their posters to the class.

Extensions

Connections to the Cassini-Huygens Mission

1. Say to the class: “We’ve learned many new and interesting things about Saturn from reading the minibooks, and from talking, writing, and working together. There are still many things we want to know more about.”
2. Listen while I read what the Cassini scientists wonder about Saturn, and think of some questions of your own.
3. Display the “What I Wonder About Saturn” overhead and read the Cassini scientists’ questions aloud.
4. Give students 2 to 3 minutes to “quick write” their own questions.
5. Create a class poster of “Questions We Have.”

Hands-on Activity

3-D Scale Model Saturn — Suggested time 2 hours

This outstanding lesson was developed by Dr. Mary Urquhart. If you have time and access to materials, it is highly recommended. The lesson is geared toward 4th–8th graders, but is easily adaptable for younger students. Students build a three-dimensional model of Saturn using a 3-inch-diameter styrofoam ball for the planet and a circle cut from an overhead transparency for the rings. At this scale, a peppercorn represents the moon Titan. Teachers who piloted this lesson suggested painting the styrofoam balls, rather than coloring them with markers, for a more “realistic” look. Students can write about the process of building the model and

teacher TIP

- The 3-D model can be done as a center activity. Students can go to a designated area in groups of 4 to 6 to paint their “Saturns.”



discuss the ways the model Saturn is similar to and different from the real planet (additional practice with compare and contrast). If you have limited time and resources, or you feel that it is too complex for your students to do independently, you can do this as a demonstration, or build the model in advance and bring it in to share with your students. The lesson description includes the list of required materials. The URL below will take you to the lesson:

http://lyra.colorado.edu/sbo/mary/Cassini/scale_saturn.html

Writing and Art Activities

Saturn Poetry

Descriptive writing lends itself well to various forms of poetry. Students can write haiku, odes to Saturn, and found poems (to name a few). Use your favorite lessons, with Saturn as the theme. A good resource for ideas on poetry is *Awakening the Heart: Exploring Poetry in Elementary and Middle School*, by Georgia Heard.

Envelopes and Postcards From Saturn

Adapted from *Moon Journals: Writing, Art, and Inquiry Through Focused Nature Study*, Gina Rester-Zodrow and Joni Chancer.

Postcards and letters are a fun alternative form for publishing students' descriptive writing about Saturn. Students will need these materials: pencil, scissors, cardstock (or index cards), colored paper, glue sticks, colored pencils, markers, crayons, and stickers. For samples, provide a real postcard, stamp, and envelope.

How to Make Envelopes

1. Carefully open an envelope along all the seams.
2. Use your flattened envelope as a template for tracing and cutting envelopes from colored paper. Decorate, using available materials, and then carefully re-assemble the new envelope. Be careful that the glue stays on the flaps, and does not get into the interior of the envelope.
3. Envelopes can also be made from photocopied pictures of Saturn, recycled wrapping paper, or other decorative papers.
4. Students can design stamps for their envelopes.
5. Put Saturn mail inside envelope, and deliver. Or, you can make a class book of Saturn mail in the style of *The Jolly Postman* books, if desired.

How to Make Postcards

1. Cut cardstock, or use 4 by 6 or 5 by 8 plain index cards.
2. Use a real postcard as a model for deciding where to put text and images.
3. Students can design postage stamps for their postcards.
4. Postcards can be written before Cassini arrives at Saturn, and after (with new descriptive information).
5. Postcards can be sent to a buddy classroom.



Singing Activity

Just for fun, the Cassini Virtual Singers at the Jet Propulsion Laboratory get together occasionally and perform songs they have developed. The singers are scientists, engineers, and others who support the mission. They have a repertoire of about 50 songs, based on familiar melodies but with lyrics about the Cassini mission. Here is a song from the Cassini Virtual Singers:

“The Moon Song” — sung to “Gary, Indiana”

Wordsmithed by Trina Ray; musical arrangement by David Coppedge

Mimas [MY-muss], and Enceladus [n-SELL-uh-duss]

Atlas, and Prometheus [pro-MEE-thee-us]

Oh-please... let us sing 'em once again

Mimas, and Enceladus

Atlas, and Prometheus

Telesto [tell-ESS-toe], Titan, Tethys [TEE-thiss], Rhea [REE-uh] and Pan

If you'd like to have a logical explanation

for the repetition of this lunar system

we can say without a moment of hesitation

We'll sing 'em again, just in case you missed-'EM

Janus [JAY-nus] and Iapetus [eye-AP-eh-tuss].

oh my Epimetheus [epp-ee-MEE-thee-us].

Helene [heh-LEEN], Dione [dy-OH-nee], Pandora, Phoebe [FEE-bee] and Pan

Janus and Iapetus

don't forget Hyperion [hy-PEER-ee-on]

and leaving out Calypso [ka-LIP-so] is a sin

If you'd like to have a logical explanation

For the naming of the moons of Saturn's system

We can say without a moment of hesitation

Old mythology... is what we see

(remember the melody changes here!!)

But Mimas and Enceladus.

Atlas and Prometheus.

Janus and Iapetus

oh my Epimetheus

We'll see 'em all, if we can



Assessment

While children are working, ask yourself the following questions:

1. Are the students able to read the minibooks?
If you have students for whom English is a second language, you may want to have them partner-read, or you may want to pull a small group and read the books aloud to them.
2. Are the students taking notes as they read?
If this is the first time your students have done an activity like this, it will be helpful to read one book to the whole class, and do “think aloud” modeling for the students. You can use the Note-Taking Sheet for Nonfiction handout as an overhead, or do it on the board.
3. As the students work on their posters and 3-D models, are they able to identify and name Saturn’s special features (rings, the Cassini Division, etc.)?
4. Are they able to identify details about the features that they have learned from their reading?

As you read over the children’s work, ask yourself the following questions:

1. Do their descriptive paragraphs indicate an understanding of both science content and writing conventions?
2. Are their paragraphs organized, including a main idea, details, and examples?
3. Are they able to use figurative language to make their descriptions more vivid?
If you have students who are having difficulty writing, you may want to conference with them individually, teach a mini lesson to a small group, or model descriptive paragraph writing by doing a collaborative piece (again, modeling and thinking aloud) with the whole class.

Standards

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

All students must have opportunities to:

- 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).
- Read a wide range of texts to build an understanding of texts and to acquire new information.
- Apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts.

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).
- Of objects in the sky (Earth and Space Science).
- About science and technology (Science and Technology).
- Of science as a human endeavor (History and Nature of Science).



Examples of Student Work**Giant Saturn poster****3-D model of Saturn**

"What I Wonder About Saturn"

by NASA Scientists



The journey to learn more about Saturn is just beginning! We asked two NASA Cassini-Huygens scientists what they wonder about Saturn. Here is what they said:

Jim Fraurnick of Mission Planning wonders:

- I wonder how thick Saturn's rings are.
- I wonder what will happen to the spacecraft as it passes through the rings.
- I wonder what causes storms in Saturn's atmosphere.
- I wonder if we will get some good pictures showing the particles in the rings.
- I wonder what the mission probe will find out about the moon Titan.
- I wonder if there is an ocean on Titan.
- I wonder how fast the winds are on Titan.

Dr. Bonnie Buratti, Investigation Scientist for the Visible and Infrared Mapping Spectrometer (VIMS) instrument wonders:

- I wonder what the rings are made of.
- Saturn has a moon called Iapetus. One side is very bright, almost as bright as fresh snow, and the other side is as dark as soot. I wonder how it got that way.



Pre-Reading/Pre-Writing Activity Worksheet

This reading, thinking, and talking activity will help your brain get ready for the information in the Saturn booklets, and the paragraph you will write after you do your reading.

Because you'll be doing this activity before you read, it's called a "pre-reading activity."

1. Think about what you already know about Saturn. Take 2 minutes to jot down some words, phrases, and sketches in the space below or in your Saturn Discovery Log.

2. Turn to your partner and take turns sharing what you know.



Pre-Reading/Pre-Writing Activity Worksheet contd.

3. What questions do you have about Saturn? Write them below.

4. You will be using information in the Saturn booklets, plus what you know from other activities and research you've done, to write a descriptive paragraph about Saturn. You will be writing your paragraph to share with your buddy.

Think: In what ways can you use the information you've written on this worksheet to help your buddy understand, and picture in her or his mind, information about Saturn?



Note-Taking for Nonfiction Worksheet

1. Preview the Saturn booklet you will be reading. Look at the title, bold-face headings, and illustrations. Think/write about what you already know, questions you have, and predict what you will learn. You can write in your Saturn Discovery Log. You can write more than one response for each question or statement!

What I already know: _____

I think I will learn: _____

I predict: _____

Questions I have right now:

I wonder _____

I wonder _____

I wonder _____

2. Read the booklet. Jot down ideas that are important for the type of writing you are going to do: details if you are writing a description, important big ideas if you are writing a summary, etc. Remember, for taking notes don't write more than 5 words for any one idea!



Descriptive Writing Tip Sheet

Tips when you are reading descriptive writing

- The purpose of descriptive writing is to help readers feel as though they are seeing, hearing, tasting, smelling, or feeling whatever the author is describing.
- Descriptive writing can be used for many different reasons. It can help persuade the reader of something (such as help the reader love polar bears as much as the author loves them). It can be used in an analysis so the reader understands the problem better. For example, if you want the reader to support more funding to clean up oil spills, it may help if they can really picture what the oil spill looks like and how the birds look all covered in oil. It can be used in compare and contrast writing so you can get a clear picture of the two things being compared.

Tips when you are writing descriptive writing

(Adapted from
readwritethink.org)

- Describe from memory — Picture the object in your mind. Take yourself to a specific location. For example, the location of your "Walk of Wild Size," or Saturn's beautiful rings. If you are describing an object, imagine that you are close enough to touch it. Can you feel it? Look at it closely. What do you notice? Write every detail about the object that you can remember.
- Sketch — Draw a picture of your object. Don't worry about not being an artist. This sketch is just for you to help you fully explore the details of the object. Sketching the object also gives you a creative outlet for when you are struggling with putting pen to paper.

Good descriptive writing helps the reader really feel like he or she is there.

Here is an example of poor descriptive writing:

This page has some things on it.

Here is an example of good descriptive writing:

This page has letters on it that are written using the alphabet of the English language. The letters are organized into words. The words are organized into sentences. There are some headings on the page that tell the reader what the sentences are about. The page is written in black and white.



Peer Conference Guidelines

Writer

1. Choose a partner.
2. Tell the partner what kind of help is needed.
3. Read the piece out loud and listen to it.
4. Consider the partner's response.
5. What will you do next?

Partner

1. Find out what kind of help the writer needs.
2. Listen carefully.
3. Start by telling the writer what works ("three plusses" - compliments or positive statements).
4. Make a suggestion ("and a wish").

General Rules

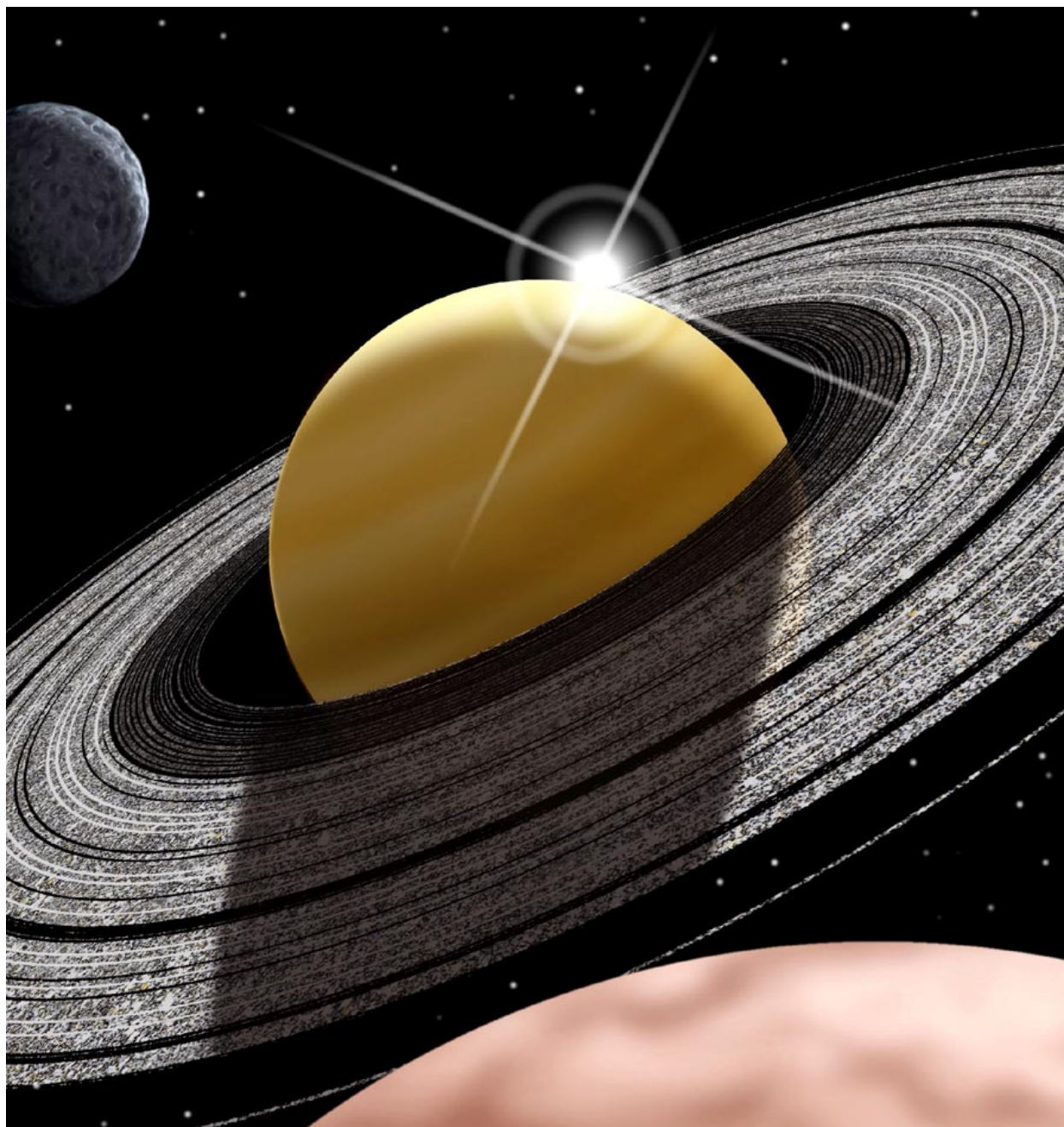
1. Keep your conference short (4 to 5 minutes).
2. Use conference areas.
3. Only one conference per writing period.
4. No back-to-back conferences.
5. Use soft voices.





Introducing Saturn

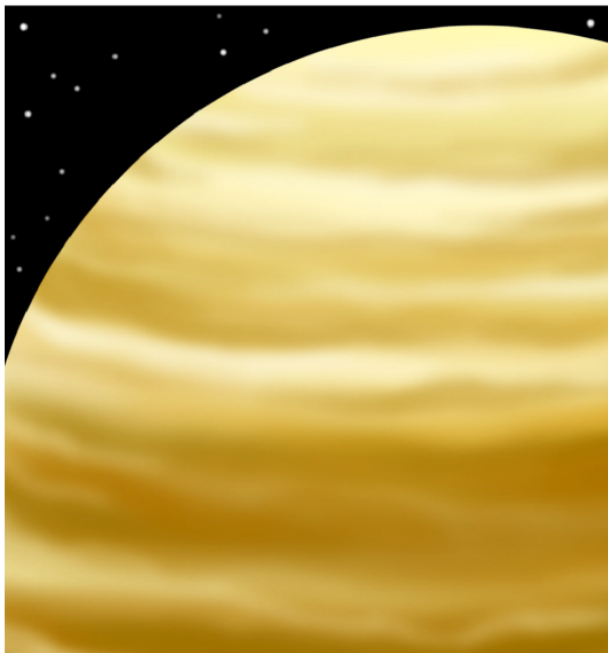
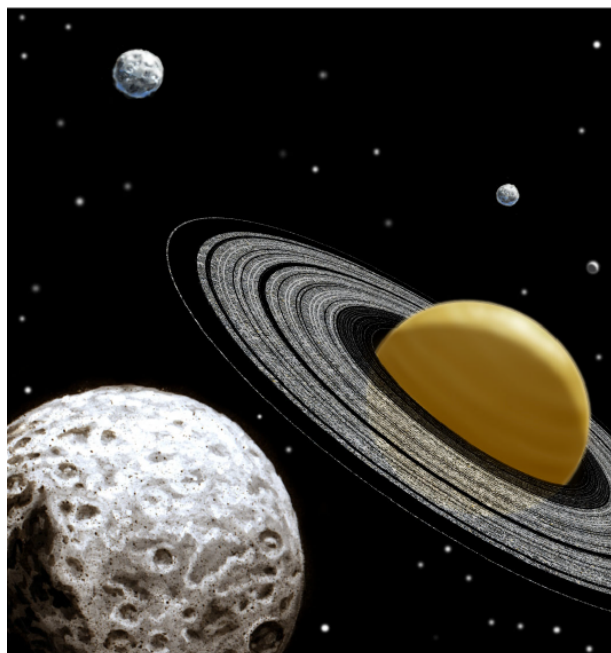
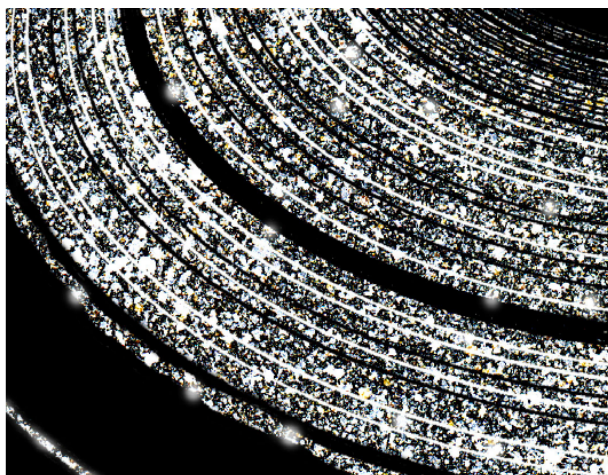
Questions, Answers, and Cool Things to Think About



Discovering Saturn: The Real Lord of the Rings

Mysterious rings, strange and wonderful moons, and bands of gold, brown, and white, in which storm clouds swirl. This is the sixth planet from the Sun, Saturn! Saturn has been called "The Jewel of the Solar System." Look at the pictures on this page. What other nicknames would you give Saturn? Scientists believe that Saturn formed more than four billion years ago from the same giant cloud of gas and dust, whirling around the very young Sun, that formed Earth and the other planets of our solar system. But Saturn is much larger than Earth. Its mass is 95.18 times Earth's mass. In other words, it would take over 95 Earths to equal the mass of Saturn. If

you could weigh the planets on a giant scale, you would need slightly more than 95 Earths to equal the weight of Saturn! Saturn's diameter is about 9.5 Earths across. At that ratio, if Saturn were as big as a baseball, Earth would be about half the size of a regular M&M candy.

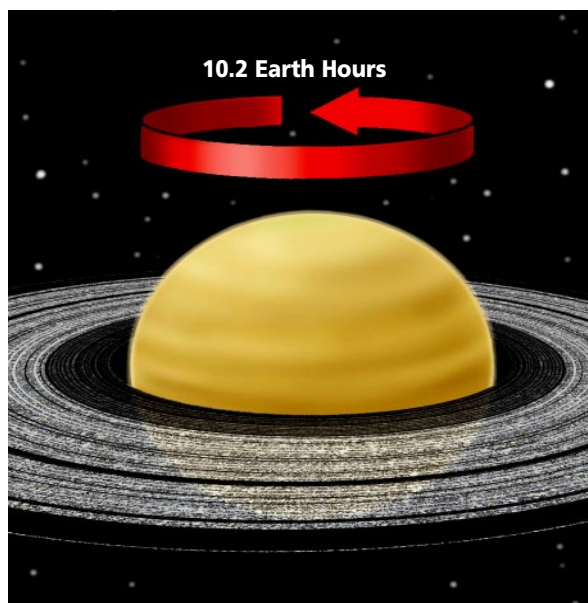


Saturn spins on its axis (rotates) just as our planet Earth spins on its axis. However, its period of rotation, or the time it takes Saturn to spin around one time, is only 10.2 Earth hours. That means that a day on Saturn is just a little more than 10 hours long. So, if you lived on Saturn, you would only have to be in school for a couple hours each day! Because Saturn spins so fast, and its interior is gas, not rock, Saturn is noticeably flattened, top and bottom. Saturn is 10 percent fatter in the middle than at the poles.

Saturn is much farther from the Sun than is Earth. In fact, it gets only about 1/90 the amount of sunlight as does Earth. It takes Saturn almost 29-1/2 years to revolve once around the Sun. Can you figure out how old you are in Saturn years? Like the inner



Galileo



Length of a Saturn Day

planets and Jupiter, Saturn is clearly visible to the naked eye in the night sky, so people have known about it for many thousands of years. The ancient Romans named the planet after their god of agriculture. It wasn't until 1610, however, that anyone saw Saturn's rings. That's when Galileo looked at the planet through one of the world's first telescopes. But his telescope wasn't powerful enough to show the rings clearly, and Galileo thought he was looking at some kind of triple planet.

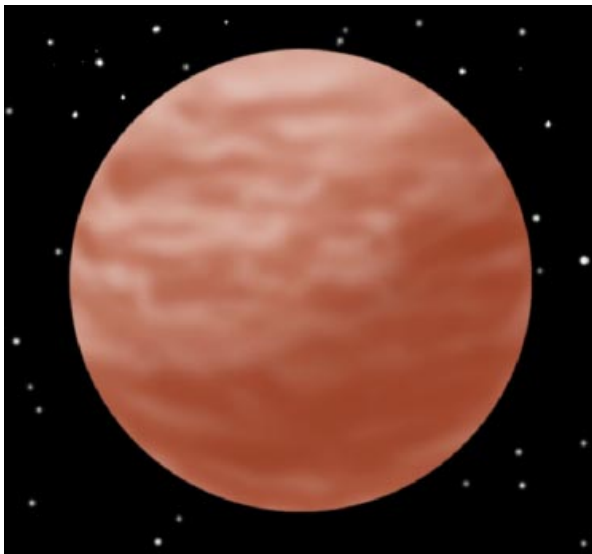
Later, in 1655, a Dutch astronomer named Christiaan Huygens looked at Saturn through a more powerful tele-



**Huygens'
Concept
of Saturn**

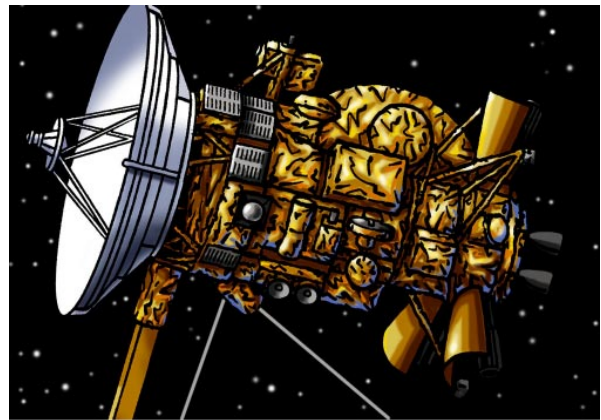
scope, and figured out that the planet is surrounded by a giant flat ring.

Although people have been observing and studying Saturn for thousands of years, first with just their eyes, and then with telescopes and robotic spacecraft, things will get really exciting in July 2004. That is when the Cassini-Huygens spacecraft is scheduled to arrive at Saturn. Cassini-Huygens is really two spacecraft. The Huygens probe (named after the Dutch



Titan

astronomer we mentioned earlier) is riding along with Cassini until they go into orbit around Saturn. Then Huygens will fly off to Saturn's largest moon, Titan. We've never been able to see Titan's surface, because it's hidden under a thick, smoggy atmosphere. But Huygens will parachute down



Cassini-Huygens Spacecraft

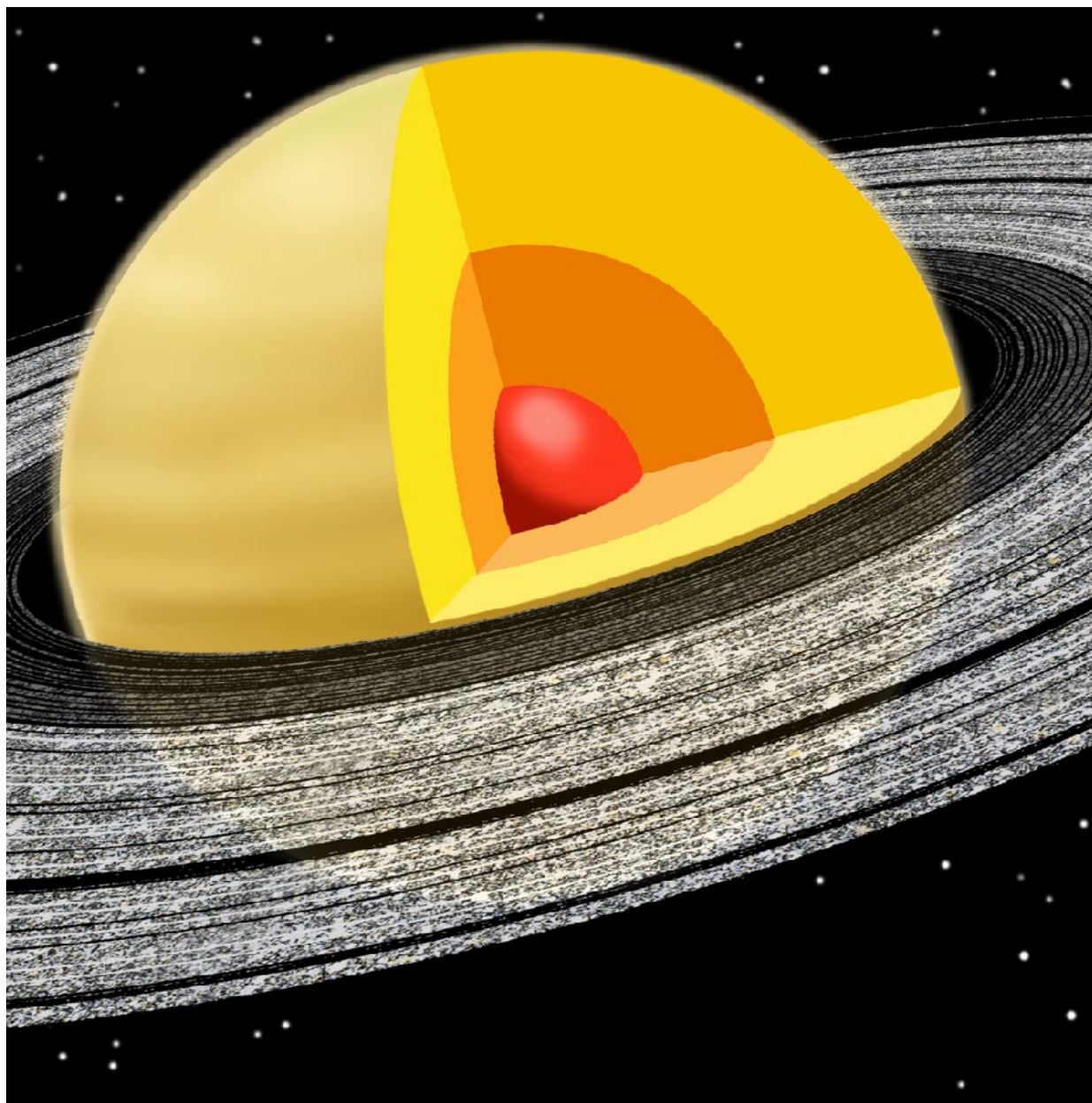
through the atmosphere for 2-1/2 hours and spend up to 60 minutes on Titan's surface before it stops working, sending us pictures and new information about Titan.

Meanwhile, the Cassini spacecraft will continue to orbit Saturn and send us information about its rings, its moons, and the planet itself until the year 2008! What grade will you be in then?



Saturn — From the Outside In

Questions, Answers, and Cool Things to Think About

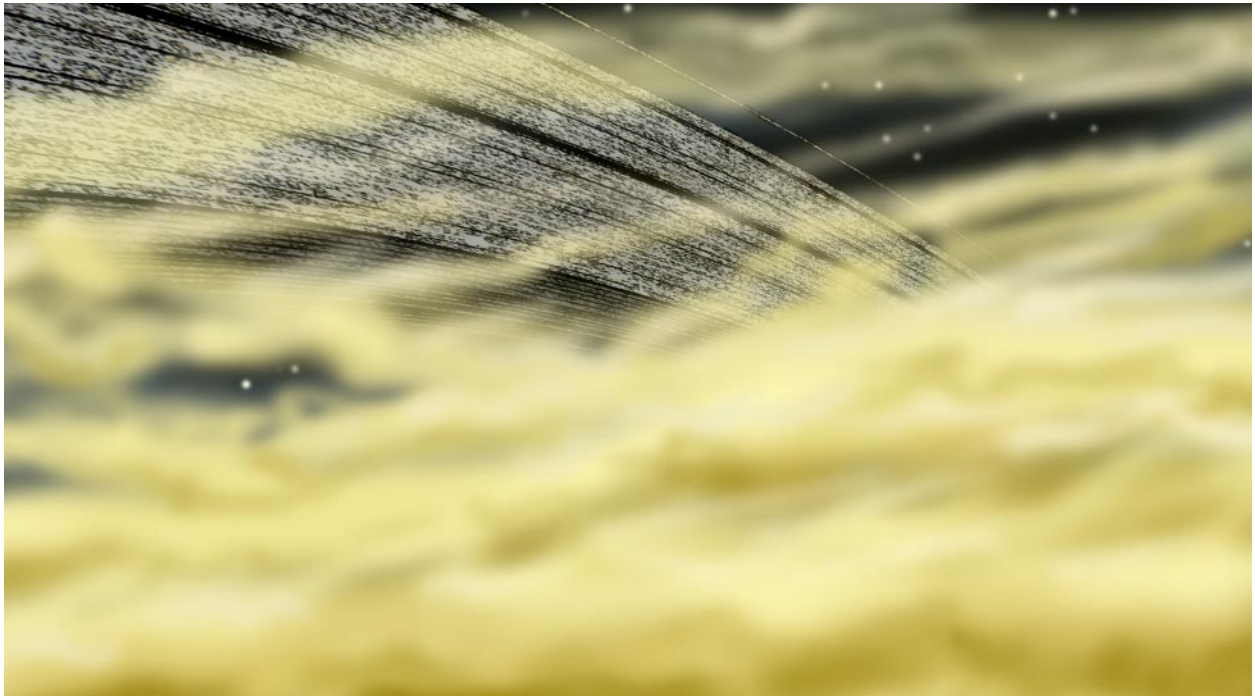


Discovering Saturn: The Real Lord of the Rings

Although no one has ever traveled from Saturn's atmosphere to its core, scientists do have an understanding of what's there, based on their knowledge of natural forces, chemistry, and mathematical models. If you were able to go deep into Saturn, here's what you might find along your journey.

First, you would enter Saturn's upper atmosphere, which has super-fast winds. In fact, winds near Saturn's equator (the fat middle) can reach speeds of 1,100 miles per hour. That is almost four times as fast as the fastest hurricane winds on Earth! These winds get their energy from heat rising from Saturn's

interior. As gases in Saturn's interior warm up, they rise until they reach a level where the temperature is cold enough to freeze them into particles of solid ice. Icy ammonia forms the outermost layer of clouds, which look yellow because ammonia reflects the sunlight. Other chemicals, trapped in the ammonia ice particles, add shades of brown and other colors to the clouds. Methane and water freeze at higher temperatures, so they turn to ice farther down, below the ammonia clouds. Hydrogen and helium rise even higher than the ammonia without freezing at all. They remain gases above the cloud tops.



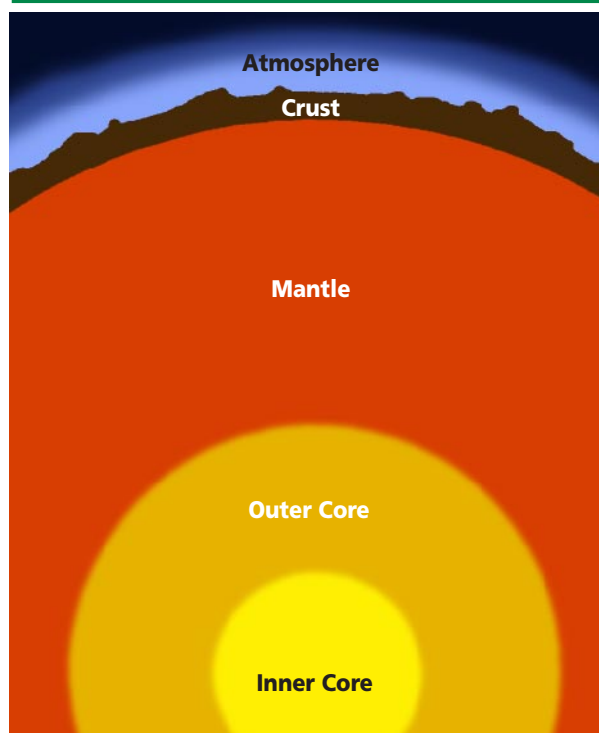
Fierce winds blow clouds of icy ammonia across Saturn's upper atmosphere.

Warm gases are continually rising in Saturn's atmosphere, while icy particles are continually falling back down to the lower depths, where they warm up, turn to gas and rise again. This cycle is called "convection" (kon-VEK-shun). You can see the same kind of thing happen if you watch a big pot of soup boiling on your stove!

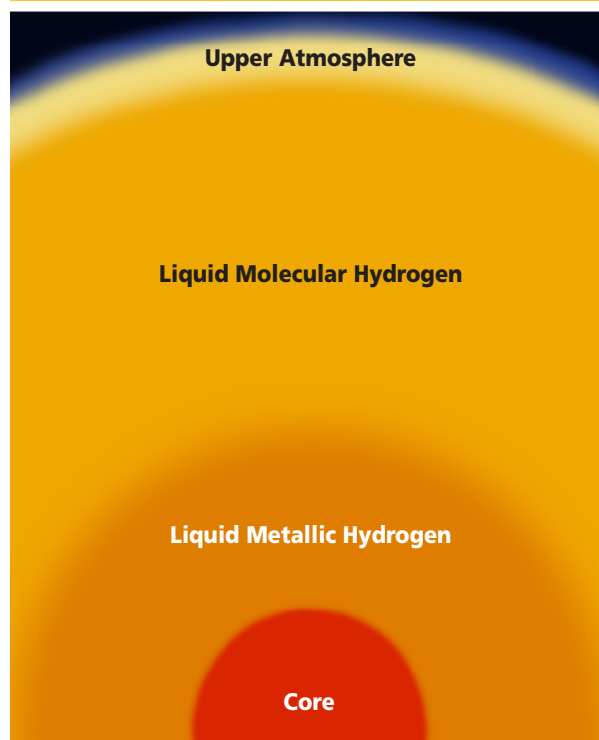
From far away, Saturn may look like a gigantic ringed version of the rocky planets in the inner solar system. However, it is really quite different. Unlike planet Earth, where there is a sudden change from the gases in the atmosphere to the solid crust (land) or liquid (oceans), the layers within Saturn and the other giant planets change from one form to another gradually.

Saturn is made up mainly of hydrogen and helium, in both gas and liquid forms. You couldn't stand on Saturn, because there's no solid surface to stand on. If you tried to "land" on Saturn, you'd sink thousands of miles to depths where the heat and pressure are so high that not even the sturdiest submarine could survive!

Earth's Layers



Saturn's Layers



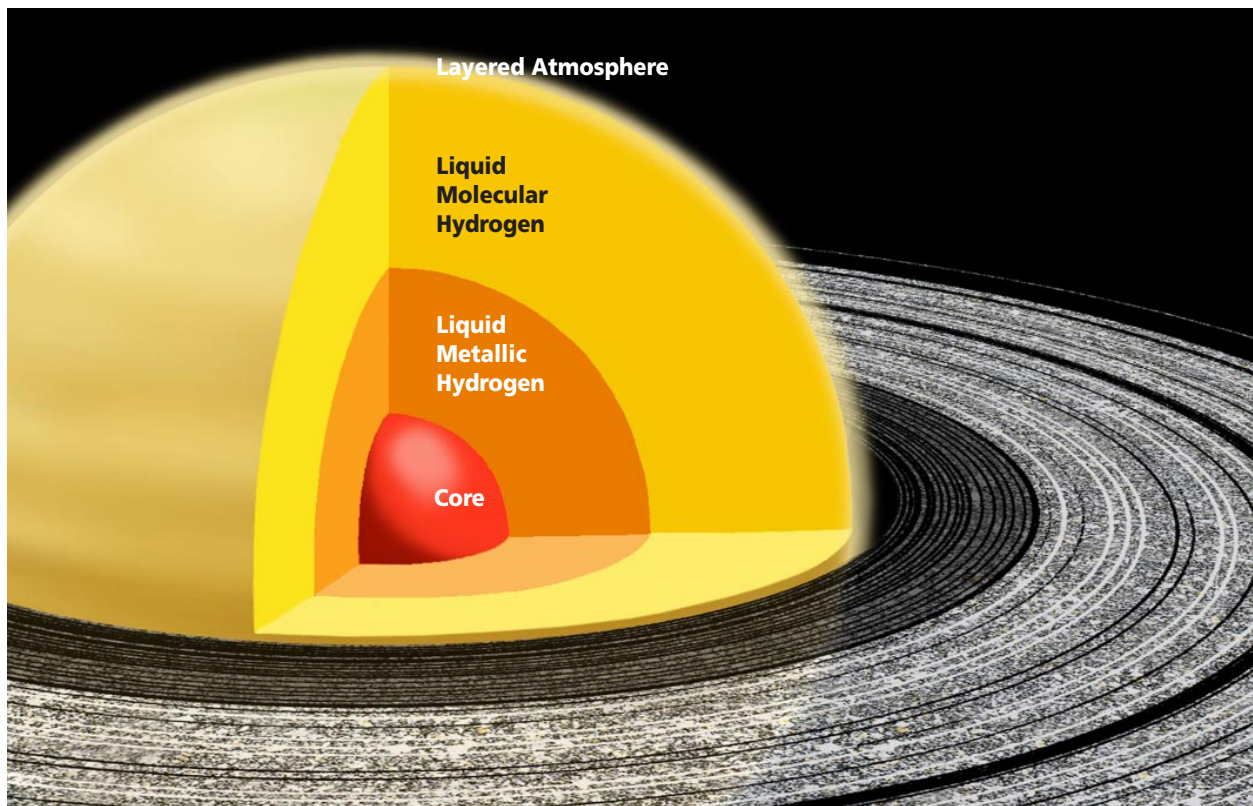
Comparing Earth's Layers to Saturn's Layers

The liquid sections of Saturn form the largest portions of the planet, and are very deep. The first liquid layer inside Saturn, immediately under the atmosphere, is the liquid hydrogen layer. Under the liquid hydrogen layer is a liquid metallic hydrogen layer.

You may be wondering how a gas like hydrogen can also be a liquid. The answer is that most substances can be solid, liquid, or gas, depending on their temperature and pressure. For example, water is liquid at room tempera-

ture, but freezes into a solid when it's very cold and boils into water vapor (a gas) when it's very hot. Also, liquid water can boil into vapor at a lower temperature if you carry it up to a very high mountain, where the pressure in the atmosphere is less than it is at sea level. Bring the water vapor back down to sea level, where the pressure in the atmosphere is higher, and it turns back into a liquid.

Deep within Saturn, the pressure is so enormous that it turns the hydrogen



Inside Saturn

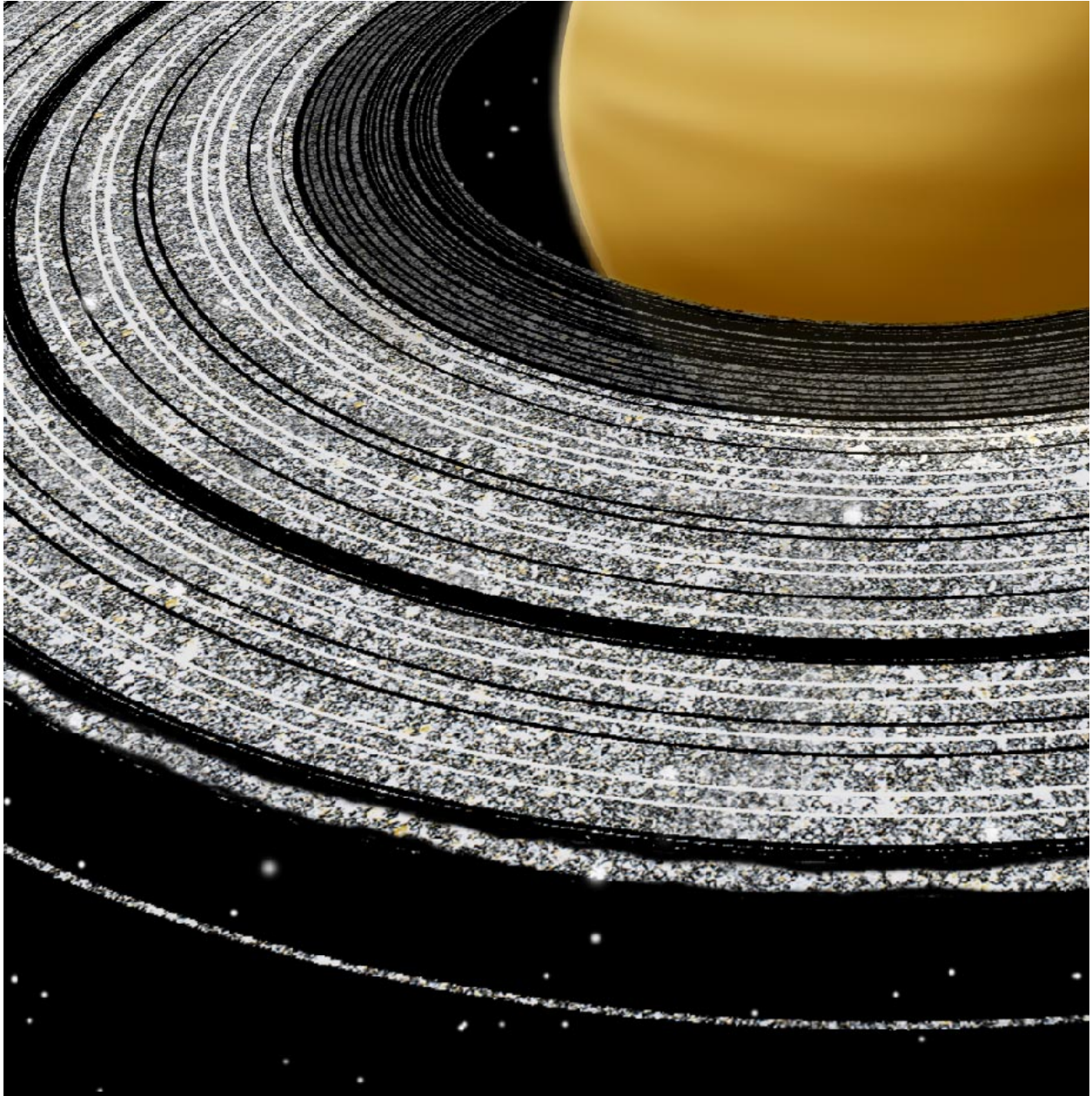
gas into a liquid, even though the temperature is also very high. Still deeper, where the pressure is even greater, the liquid hydrogen acts like a metal and can conduct electricity.

Finally, at Saturn's center is a molten rocky metallic core. Saturn's interior is hot! At the core, the temperature is at least 15,000 degrees Fahrenheit. That's hotter than the surface of the Sun!

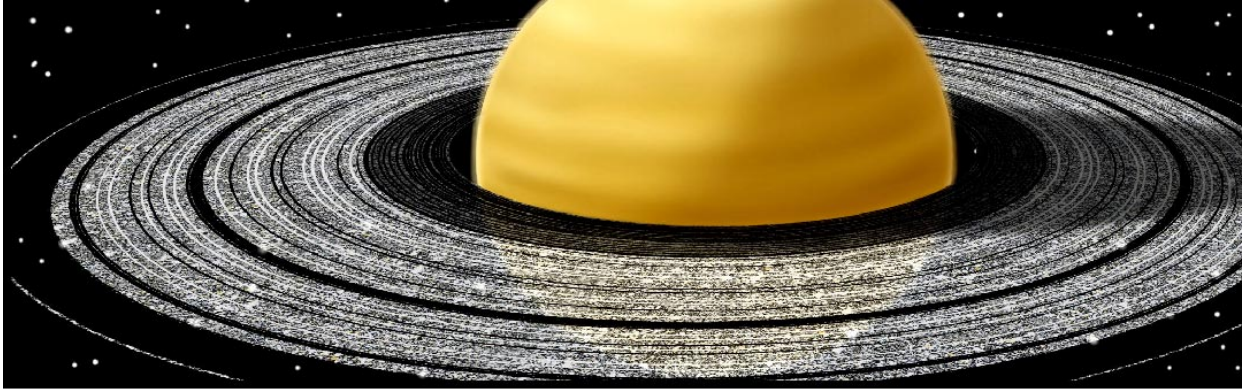


Those Amazing Rings!

Questions, Answers, and Cool Things to Think About



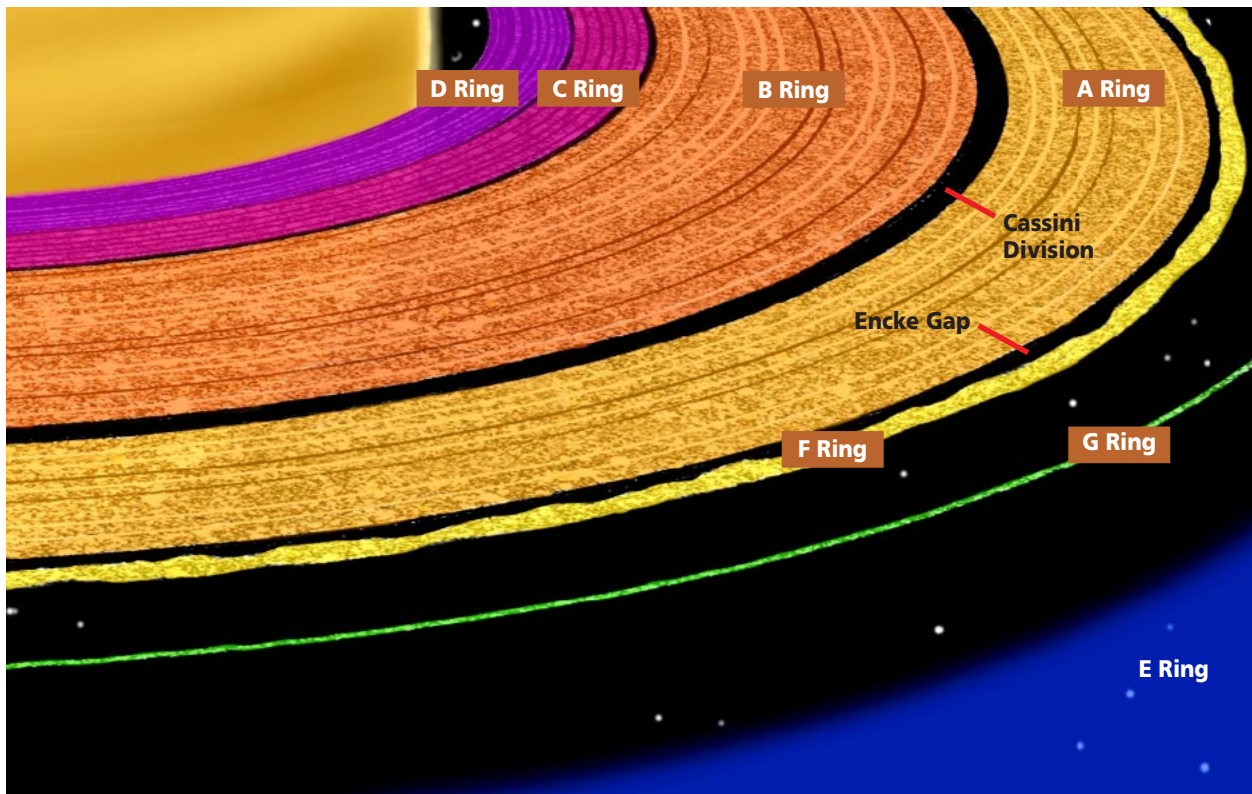
Discovering Saturn: The Real Lord of the Rings



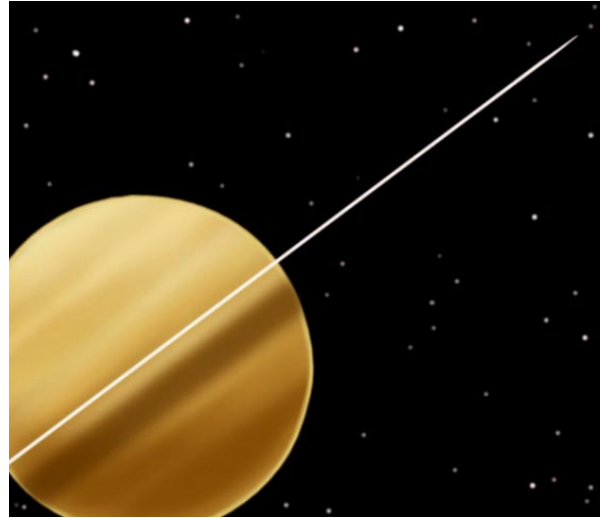
While all the gas giant planets have rings, Saturn's rings are the brightest and most spectacular, although we need a good telescope to see them from Earth. What other adjectives or describing words come to mind when you look at the rings?

The rings are named in order of their discovery, so even though the A ring is not the closest ring to Saturn, it is called "A" because it was discovered first. From the planet outward, they are known as the D, C, B, A, F, G, and E rings. Can you think of a better way to name the rings?

(The colors shown below are not real.)



The rings stretch all around Saturn and are about 170,000 miles in diameter. That is almost the distance from Earth to the Moon! While the rings stretch for hundreds of thousands of miles to circle Saturn, they are less than a kilometer (about half a mile) thick. In fact, scientists have found that in some places they are as little as 10 meters (30 feet) thick.



It is amazing that Saturn's rings can be hundreds of thousands of miles across and yet less than a soccer field in thickness. If you were to use a piece of paper to make a scale model of Saturn's A, B, and C rings, and have the thickness of the paper represent the thickness of the rings, you would need to cut out a circle with a diameter greater than 10,000 feet, or about two miles, across. The rings are really thin!

Long ago, when Jean-Dominique Cassini and Christiaan Huygens were alive, people thought the rings were solid

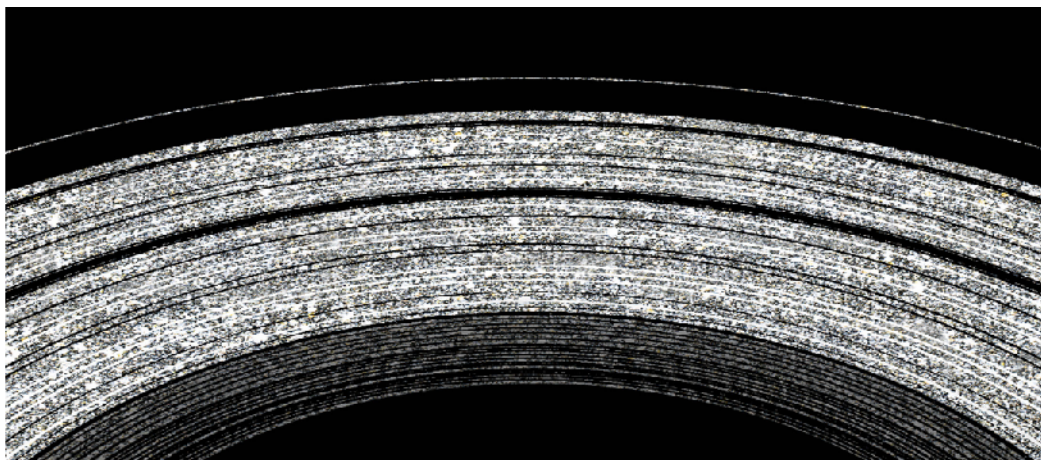
bands. But Saturn's rings only look

like solid bands when seen from far away.



Cassini

Huygens



Kids: Look at this drawing from across the room and see if the rings look solid to you.



The A, B, and C rings are really made up of chunks of water ice and ice-covered rock, ranging in size from a grain of sand to as big as a house! Particles in the D and E rings are even smaller — about the size of particles in smoke. We don't know yet how big the particles are in the F ring.

Where do you think these particles came from? Many scientists think they came from former moons that crashed into each other and smashed into pieces!

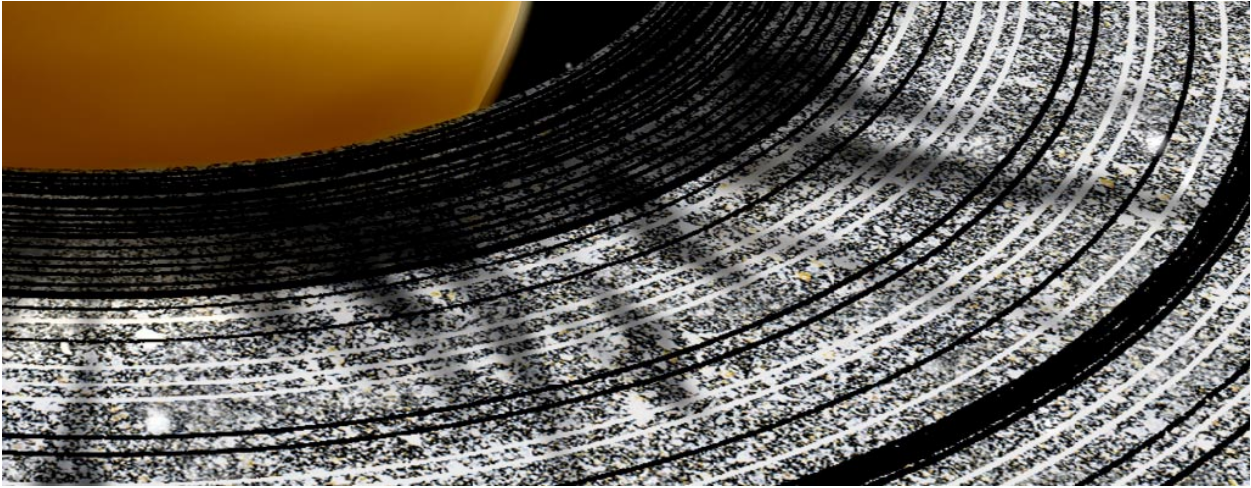
You might expect that all the pieces would eventually float away from each

other and the rings would break up. But some of Saturn's moons act like shepherds herding sheep. Their gravity keeps the icy particles from straying out of the rings. In fact, they're called "shepherd moons."

Shepherd moons are less effective at holding the smallest particles in place, however. Many of these particles gradually fall into Saturn. But they are replaced by new particles that come from the ongoing collisions of large rocks and moons, so the rings are always in the process of being rebuilt.



Shepherd Moons



Spokes

Saturn's rings have gaps between them, though only a few of these gaps were known before space probes visited the planet. The largest of these gaps, located between the A ring and the B ring, is called the Cassini Division, after its discoverer, Jean-Dominique Cassini. It is about 4,800 kilometers wide (about the distance across the United States), although this varies quite a bit around the planet. There is another division between the A ring and the F ring called the Encke Gap. (See diagram on page 2.) The gaps are produced by the gravitational pull of one or more of Saturn's many moons on the particles in the rings.

There are other characteristics about the rings that puzzle scientists. The F ring almost seems to be braided in

places, and there are features that look like spokes that stretch across the rings. What do you think these might be? Scientists are hoping that the Cassini spacecraft will help them to understand Saturn's amazing rings better.



Closeup of the Braided F Ring



Saturn's Moons

Questions, Answers, and Cool Things to Think About



Discovering Saturn: The Real Lord of the Rings

Next time you look up at the Moon in the night sky, imagine what it would be like to live on a world that had 31 moons! That's how many we've found so far orbiting Saturn. There might be even more that we haven't discovered yet.

discover even more as it orbits the planet from 2004 to 2008.

Most of Saturn's moons are much smaller than Earth's Moon. But they are strange and fascinating in many ways.



No one knew that Saturn had any moons until 1655, when a Dutch astronomer named Christiaan Huygens pointed a telescope at the giant planet and saw its largest moon, Titan, for the first time. During the centuries since then, as people built more powerful telescopes and sent robot explorers into space, we discovered more and more moons around Saturn. We've found 31 so far, and it's possible that the Cassini spacecraft will

Some of them help to keep Saturn's famous rings together. The rings are made up of millions of icy stones and specks of dust, and gravity from some of the moons keeps the material from floating away from the rings, much like a shepherd keeps sheep from wandering away from the flock. In fact, those moons are called "shepherd moons."

One moon, called Enceladus (in-CELL-uh-dus), is one of the shiniest objects

in the solar system. It's about as wide as Arizona, and it's covered in ice that reflects sunlight like freshly fallen snow. That makes it extremely cold — about 330 degrees below zero on the Fahrenheit scale! Some scientists think that the icy particles that make up Saturn's E ring came from volcanoes on this moon.

Another moon, Mimas (MY-muss), has a giant crater that is one-third as wide as the moon itself. In the center of the crater is a mountain as tall as some of the biggest mountains on Earth.

Two other moons, Epimetheus (ep-uh-ME-thee-us) and Janus (JAY-nuss), trade orbits with each other every few

years, taking turns being closer to the planet.

Iapetus (eye-A-pe-tus) may be the strangest of Saturn's moons. It looks like a big ball that's chocolate on one side and vanilla on the other side!

Some scientists think a moon called Phoebe (fee-bee) may have started out far beyond Pluto, and wandered billions of miles toward the Sun until it was captured by Saturn's gravity. Titan is by far Saturn's biggest moon. It's the second largest moon in the whole solar system. (The largest one, Ganymede, is in orbit around Jupiter.) Titan is bigger than the planets Mercury and Pluto!



Mimas



Iapetus

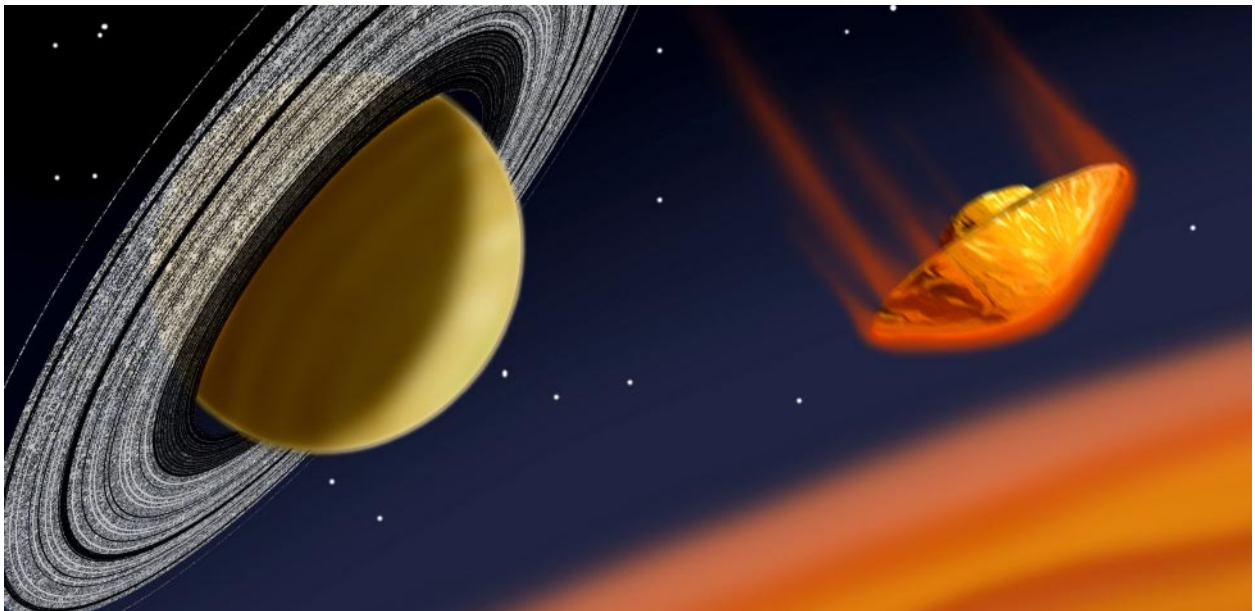
We haven't had a good look at Titan's surface yet, because it is hidden beneath a thick, deep-red haze. But scientists on Earth used the world's most powerful radar system to bounce microwaves off the giant moon — which was about 800 million miles away at the time — and the radar showed that there might be huge lakes or oceans on Titan. But they wouldn't be filled with water. Instead, they might be filled with a liquid that's kind of like alcohol!

The Cassini spacecraft is carrying something that may help us learn much

more about Titan. It's a machine called the Huygens probe, named after the astronomer who discovered Titan.

In January, 2005, the Huygens probe will fly to Titan and drop down through its atmosphere on a parachute, taking pictures and gathering information as it falls to the surface. It will use radio to send the pictures and information to Cassini, and Cassini will send them to us here on Earth.

Which of Saturn's moons would you most like to visit? Why?



Before its parachutes open, Huygens begins to fall through Titan's atmosphere.

My Spacecraft to Saturn

Illustration of Cassini approaching Saturn.



LESSON TIME

1 hour

MATERIALS CHECKLIST

For the teacher:

- Copy of “Summary of Spacecraft Design Problems” to read aloud

For each student:

- Copy of “Designing Your Spacecraft Worksheet”
- Pencil
- Paper
- Saturn Discovery Log

LESSON NO. 6

- *Language Arts Focus*
—Nonfiction Reading and Writing as Tools for Problem-Solving
—Nonfiction Reading Practice: Summary
- *Science Focus* — *Thinking Like an Engineer: Problem-Solving Spacecraft Design*

OVERVIEW

In this lesson, students get the chance to think like engineers as they are presented with problems that the NASA team faced when designing a spacecraft to travel to Saturn. Students work with partners to think of solutions to address those problems, and use these ideas to sketch their spacecraft. In the next lesson, students have the opportunity to compare their ideas to the ideas of the NASA team. This is a unique opportunity for children to gain an insider’s look at the world of engineering.

WHY THIS WORKS

The National Science Education Standards state that children should be able to design solutions to problems. This exposure to design in the younger grades provides the groundwork for more sophisticated work in later grades. Drawing illustrations with accompanying text is a powerful way for children to organize and express their thinking. Nonfiction writers often rely on illustrations with text to explain difficult concepts, so students benefit from repeated exposure to creating and learning from illustrations with text.

Objectives

Students will:

- Practice working with a partner to think of ideas to solve problems.
- Practice communicating solutions clearly.
- Practice communicate ideas using illustrations with text.

Teacher Preparation

Print out a copy of teacher reference 1: “Summary of Spacecraft Design Problems” to read aloud. Make a copy for each student of student handout 1, “Designing Your Spacecraft Worksheet” (4 pages). Decide how to pair students.



What to Do

Model Problem Solving — Suggested time 10 minutes

1. Tell your class that they are going to be working today to design a spacecraft to go to Saturn.
2. Read “Summary of Spacecraft Design Problems” aloud to your class.
3. Ask students to turn to a partner and spend a few minutes brainstorming a way to keep the spacecraft from burning up when it leaves Earth.
4. Collect ideas from the class.
5. Tell your students that they will be put into pairs to work as a design team and will be given a worksheet to complete, and that at the end of the class, each team will choose one or two things from their worksheet to share with the other students.
6. Give each pair of students a copy of the “Designing Your Spacecraft Worksheet.”

Design the Spacecraft — Suggested time 35 minutes

1. Ask the design teams to proceed in designing their spacecraft.
2. Circulate throughout the room to assist the students as they complete their worksheets.

Share with the Class — Suggested time 15 minutes

1. Have students choose a part of their spacecraft designs to share with their classmates, and decide how they will present together (who shares what part).
2. Ask the design team pairs to come up and present something from their worksheets.
3. Have the class share things they like about each other’s work, questions they have, and suggestions for the presented designs.
4. Ask students to put their 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

Write a Descriptive Paragraph

1. Have the students write a paragraph describing everything about their spacecraft.
2. For an extra challenge, you can hang the sketches of spacecraft around the room, and have the class work in pairs to match descriptive paragraphs to the actual sketches.



Assessment

While children are working, ask yourself the following question:

- Are the students able to problem solve successfully with partners?

If they are able to do this, take notes on what you see these pairs doing and saying, and share these with your class. You may want to do this without mentioning names. If students are not, try to notice what is interfering: the way they are sitting, eye contact, etc. and share these observations with your students as well as goals for future partner work.

As you read over the children's work, ask yourself the following question:

- Were the students able to devise creative solutions to design problems?

This is a difficult skill for this age group, and the purpose of this activity is merely to provide beginning exposure to the scientific skill. However, if you notice students that shine in this area, take note of this so that so you can encourage that student's talent.

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.
- 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).



Summary of Spacecraft Design Problems

Introduction

Behind the Scenes (from a visitor to the Jet Propulsion Laboratory)

In a few minutes, you will hear a summary of the problems that engineers faced when they started designing a spacecraft to go to Saturn. I visited the Jet Propulsion Laboratory in Pasadena and talked to the engineers who built the spacecraft that is going to Saturn. It was cool to visit there! You get to see mission control where they track the progress of lots of different spacecraft, and you can see a room that looks like Mars where they are testing rovers to see how they might work on Mars. The engineers are very excited about their spacecraft. I took 26 pages of notes! Then I needed to decide what to write about, because I don't think you want to hear all 26 pages, do you? I decided to list the most common problems that engineers face when they are building a spacecraft. There are millions of other problems that engineers faced too, but some of them you and I would have no idea how to solve unless we got a degree in engineering. I hope you enjoy hearing this summary.

Designing a Spacecraft

Today you are going to need to think like an engineer. Many of the people who work at NASA are engineers. Engineers at NASA design instruments to help scientists discover things.

Here is your design problem for today. How can you design a spacecraft that will make it all the way to Saturn — 800 million miles away from Earth? To design your spacecraft, you and your partner are going to work together and make decisions about the following things.

- How will you keep the spacecraft from freezing in the icy cold temperature of deep space?
- How will you control and keep in touch with your spacecraft?
- How will you keep the spacecraft safe if it is hit by a space particle (a micrometeoroid, dust particle, or ring particle)?
- What do you want the spacecraft to try to find out at Saturn?
- Do you think you should send humans on the spacecraft? If you think you should send humans, how will they survive?
- What are some things that could go wrong with the spacecraft on the journey to Saturn?
- What will you name your spacecraft?
- Why did you choose that name?

Once you think of possible solutions to these design problems, you and your partner are going to draw a sketch of your Saturn spacecraft!



Designing Your Spacecraft Worksheet



A note to the Design Team Members: Before you start working, read these "words of wisdom" from Marcus Angelo Watkins (Marc), a spacecraft engineer who works at NASA's Jet Propulsion Laboratory. Marc helped develop the antenna system and power and propulsion systems for the Cassini spacecraft.

"Life is about learning, whether it is how to tie your shoe or how to fly an airplane. You learn from listening, observing, and questioning. Take chances!!! Try almost anything as long as it will not hurt you! You are a unique individual and there is only one of you! Develop yourself into whatever you want."

Date of Design: _____

Names of Design Team Members: _____

Directions to the Design Team: Talk about the following questions with your partner, and write down your ideas for solving each problem.

1. How will you keep the spacecraft from freezing in the icy cold temperature of deep space?

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



3. How will you keep the spacecraft safe if it is hit by a space particle (a micrometeoroid, dust particle, or ring particle)?

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

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



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

7. What will you name your spacecraft?

8. Why did you choose that name?

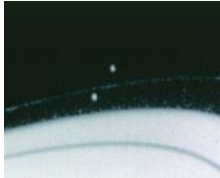


9. Draw the design of your spacecraft. Use arrows and write words to explain what its parts do. Make sure you include your answers from questions 1-8 in your sketch. After you finish your drawing, go back through questions 1-8 and make sure all of your ideas are shown in your sketch.



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.

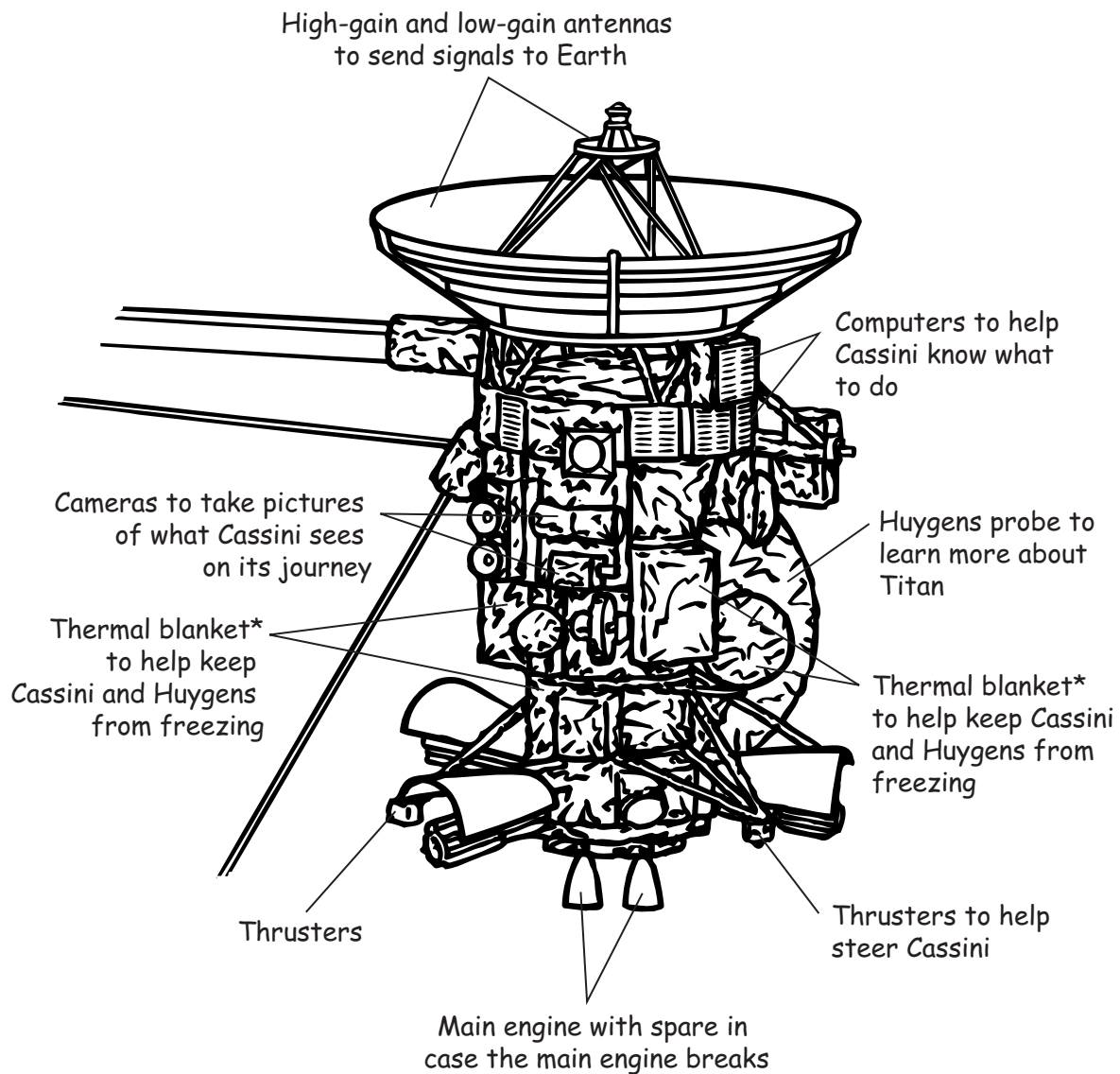
8) Why did you choose that name?

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.



All About Titan and the Huygens Probe

Artist's concept of the Huygens probe at Titan.



LESSON TIME

*1-1/2 hours or two
45-minute sessions*

MATERIALS CHECKLIST

For the teacher:

- Copy of “Memoirs of a Spacecraft” read-aloud passage
- Overhead transparencies — Huygens Probe Components drawing; “Note-Taking for Nonfiction Worksheet”; “All About Titan and the Huygens Probe” article (optional)

For each student:

- Copies of “All About Titan and the Huygens Probe” article; Huygens Probe Components drawing; “Note-Taking for Nonfiction Worksheet”; “Summary Tips Worksheet”
- Pencil, writing paper, drawing paper
- Saturn Discovery Logs

TO SEE EXAMPLES
OF STUDENT WORK,
CLICK HERE

LESSON NO. 8

- Language Arts Focus — Nonfiction Writing Practice: Summary
- Science Focus — Building Mission Background Knowledge

OVERVIEW

This lesson focuses on Saturn’s largest moon, Titan — what we know now and what we hope to discover. Students are introduced to Titan and the Huygens probe in two different ways. First, they listen to a narrative “told” by the Huygens probe entitled “Memoirs of a Spacecraft.” Visualization and drawing are used as motivators to enhance comprehension and to get students thinking about Titan and what we might find there. (Students draw what they envision the surface of Titan might look like.) Next, students will read a factual article entitled “All About Titan and the Huygens Probe” and write a summary.

WHY THIS WORKS

This activity gives students practice in both reading and writing for authentic purposes. When summarizing, students are required to choose the most important information and organize that information. Summarizing helps develop and strengthen comprehension (Rinehart, Stahl, and Erickson, 1986; Taylor, 1982). Good readers are also required to build mental images as they read most texts and in most reading situations. The mental images formed may include visual, auditory, or other sensory associations that the reader may have related to the text. The use of these images helps deepen and enhance the reader’s understanding (Oczkus, 2000).

Objectives

Students will:

- Extend and enhance their understanding and knowledge about Titan and the Huygens probe.
- Read for a specific, authentic purpose.
- Practice writing a summary.



Teacher Preparation

- For yourself: print out one copy of teacher reference 2, the “Memoirs of A Spacecraft — The Huygens Probe Approaches Titan” teacher’s read-aloud passage (3 pages).
- Print out and make a copy of student handouts 1, 2, 3, and 4 for each student:
 - Huygens Probe Components drawing
 - “All About Titan and the Huygens Probe” article (5 pages)
 - “Note-Taking for Nonfiction Worksheet” (2 pages)
 - “Summary Tips Worksheet”
- You might want to make transparencies of the 5 pages of student handout 2, “All About Titan and the Huygens Probe,” and read the pages to or with the whole class.
- Make overhead transparencies of student handouts 1 and 3: the Huygens Probe Components drawing and “Note-Taking for Nonfiction Worksheet” (for modeling).
- If desired for discussion, make for yourself a copy or transparency of student handout 4, “Summary Tips Worksheet.”
- Distribute pencils, writing paper, and drawing paper to the students.

What to Do

Visualizing — Suggested time 15 minutes

1. Say to students: As you know from the booklet about Saturn’s moons you read in Lesson 5, the Cassini spacecraft will drop a special robot spacecraft called the Huygens probe onto the surface of the moon Titan. Scientists are hoping that the probe will collect information that will help answer many questions about Titan, such as “What is the surface like?”
2. Tell students: You are going to be listening to a piece of descriptive writing that is a combination of fiction and nonfiction. It is a story written from the point of view of the Huygens probe. We know that the probe is not alive, so this part of the story is fiction. However, you will also be hearing actual scientific information about the Cassini–Huygens mission and about Titan. As you listen to the story, close your eyes or put your head down on your desk, and imagine what you might be seeing if you were the Huygens probe. After the story is over, you will draw what you think the surface of Titan looks like. We’ll keep our drawings in our Saturn Discovery Logs, and as we learn new information from the Cassini–Huygens mission, we will make changes to our drawings as new data comes in.
3. Read the “Memoirs of a Spacecraft — The Huygens Probe Approaches Saturn” teacher’s read-aloud passage to students once or twice. Direct the students to listen for details and descriptions that will help them with their illustrations.
4. Have them sketch/draw after you read.
5. Give students time to share their drawings with partners and/or the class.
6. Post their drawings, or direct the students to put them in their Saturn Discovery Logs.



Next Session or Next Day

Huygens Probe Teaching Passage — Suggested time 30 to 40 minutes

1. Explain to the students that: We will continue to deepen our understanding of Saturn and the Cassini–Huygens mission by turning our focus to Titan.
2. Tell the students that they will be reading to learn about this fascinating moon and why it was selected as the destination for the Huygens probe. Also, mention that they will be collecting information, or taking notes, in order to write a summary that will help them when they design their own parachuting probes. Pass out copies of the Huygens Probe Components drawing for background.
3. Pass out copies of the “All About Titan and the Huygens Probe” article and preview with the whole class, using the “Note-Taking for Nonfiction Worksheet.”
4. Model by reading aloud the first paragraph of the “All About Titan” article and filling in section 3 of the “Note-Taking for Nonfiction Worksheet”: “What’s Important” and “What’s Interesting” chart.
5. Give students time to complete reading the passage silently, or aloud with a partner, or whole class. Have them fill in the “What’s Important / What’s Interesting” chart on their copies of the worksheet.
6. Have students share their charts with a partner, or, if they have worked with a partner, have pairs share. Circulate while they do this to monitor that the charts have been done accurately.

teacher TIP

Ask students to write down predictions of what they think will happen to the Huygens probe. Save the predictions and compare them with actual data that will come from the mission.

From Notes to Summary — Suggested time 20 minutes

1. Distribute and read the “Summary Tips Worksheet” with the students. Check for understanding.
2. Have students write the writing goal for their summaries on the tops of their papers.
3. Give students time to write. Encourage them to use the notes from their “Note-Taking for Nonfiction Worksheet.”

Sharing — Suggested time 10 minutes

1. Student volunteers can read their summaries aloud.
2. Have the class, or teacher, identify what makes these summaries effective.

Writing Questions in Saturn Discovery Logs — Suggested time 15 minutes

1. It is important for students to understand that scientists change their ideas based on new evidence or data. Also, students need to understand the importance of asking questions.
2. Read the following list of “open issues” about Titan aloud to the students, and have them record any of these, and any of their own questions in



teacher TIP

Students could select one of Saturn's moons that they would like to send a probe to investigate, and then write a persuasive essay to convince a review board to fund their mission.

their logs. Which questions do they think will be answered by the Cassini–Huygens mission?

- Are there liquids on Titan's surface?
- Is the interior still hot?
- Why does Titan have a dense atmosphere while the other large moons do not?

Extensions

1. A Topographical Map of Titan

Unveiling Titan's Surface is a NASA Educational Brief in the “Cassini Science Investigation” family (the identifying number is EB-2001-12-006-JPL). It can be downloaded and printed from <http://saturn.jpl.nasa.gov/education/edu-58-kitchen.cfm> (under “Saturn System Science”). In this hands-on activity, students build a model planetary surface inside a shoebox using green styrofoam. Students make measurements of topographic features and draw maps based on these data. This activity is analogous to the radar measurements and mapping that will be done at Titan. The grade-level range suggested is 5–12, but it can be adapted for younger students by simplifying the mapping activity.

2. Investigate Saturn's Other Satellites

Saturn has over 30 known moons! An excellent activity for comparing the moons can be found in NASA's *Saturn Educator Guide* (EG-1999-12-008-JPL). A PDF can be downloaded from <http://saturn.jpl.nasa.gov/education/edu-58.cfm>. Click on *Saturn Educator Guide*, then “Saturn's Moons” (Lesson 2). The lesson was designed for grades 5–8; here are instructions on how to adapt the “moon card” activity for younger students.

- Print and laminate copies of the moon cards for pairs of students. Have the students group the moon cards in at least three different ways, then ask them to describe the criteria they selected for each of their groupings.
- Have the students observe the cards closely, and write a “show not tell” descriptive paragraph about a moon of their choice. Have students read their paragraphs aloud, and let the class/peers guess which moon they have described.
- Create a class poster or bulletin board using the images of the moons. Have students write “I notice” (observations) and “I wonder?” (questions) on notes and post on the board.
- Students can select a moon that they would like to learn more about. A writing piece might be a short report of information. It could also be a poem. Students could even write fictional autobiographies, and pretend that they are one of the moons.



Assessment

While students are working, ask yourself the following questions:

1. Are they including information from the read-aloud in their drawings, and adding their own ideas as well?
2. Can they clearly explain the different parts of their drawings?

As you read over the students' work, ask yourself the following questions:

1. Do their notes and summaries indicate that they understand the difference between main ideas, details, and examples?
2. Does their writing show evidence that they understand the content of the article? (e.g., are the main features of the probe explained?)

Standards

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

All students must have opportunities to:

- 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).
- Apply knowledge of language structure, language conventions, figurative language, and genre to create, critique, and discuss print and nonprint texts.

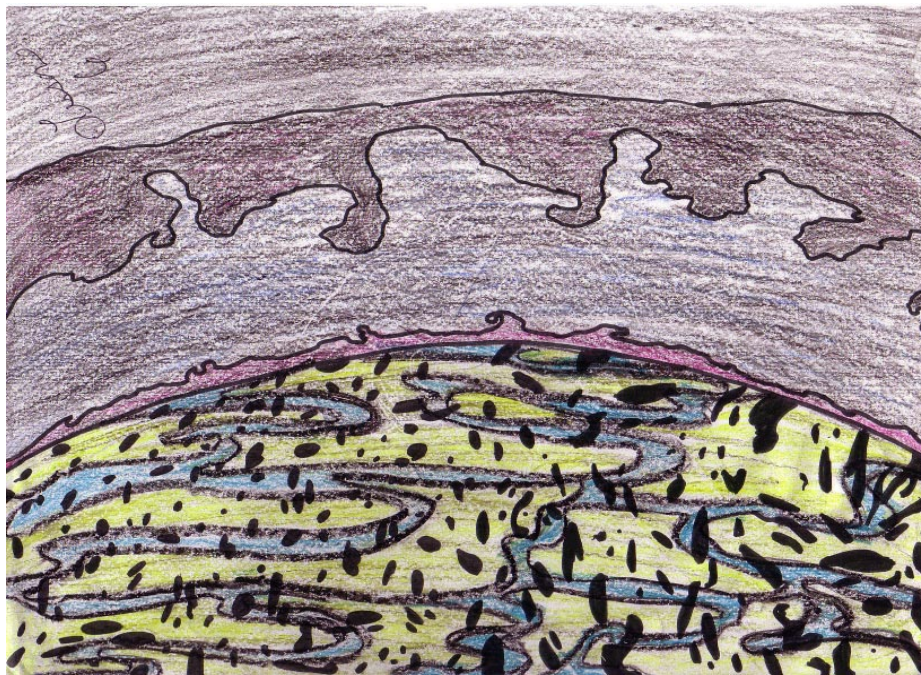
National Science Education Standards

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

- Of objects in the sky (Earth and Space Science).
- About science and technology (Science and Technology).
- Of science as a human endeavor (History and Nature of Science).



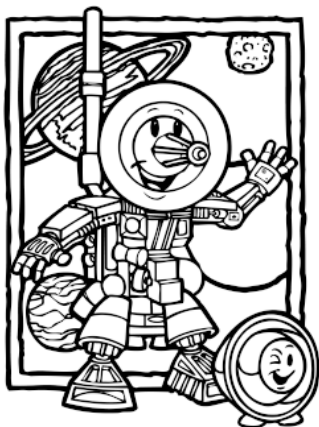
Example of Student Work



Student concept of surface of Titan

Teacher's Read-Aloud Passage**Memoirs of a Spacecraft — The Huygens Probe Approaches Titan**

December 25, 2004



More than seven years and two billion miles ago, spacecraft Cassini and I bid farewell to the powerful rocket that carried us from Earth to outer space.

We're pretty big, Cassini and I — about as big as a school bus — and no rocket is big enough to send us straight to Saturn. So we needed to take a roundabout route, one that would allow us to whip around Venus and Earth and Jupiter on our way, so the gravity of those planets could give us the extra speed we needed. It worked really well, and we got to see some amazing sights along the way. Jupiter was awesome!

By the time we passed by Jupiter, we were traveling at an incredible speed — 50,000 miles per hour! If you could go from San Francisco to New York at that speed, it would only take you three minutes!

We might have zipped right past Saturn if it weren't for our rockets. They were aimed in front of us, to slow us down. It was very tricky! If they slowed us down too much, we would be pulled into the giant planet. If they didn't slow us down enough, we would zoom past Saturn and never be able to come back! So the rockets had to be programmed to switch on at precisely the right moment, with exactly the right amount of power, for just the right amount of time.

The rockets burned for 90 minutes straight, before slowing us down enough for Saturn's gravity to pull us into orbit. That initial jolt when the rockets first fired sure surprised me, even though I knew it was coming. Imagine how you might feel running into a brick wall!

But it didn't amaze me nearly as much as what happened next. As we began to orbit Saturn, we flew right through a gap in the rings, then across to the other side of the planet, and then right through the same gap on the other side of the rings. Now that's fancy maneuvering!

After three orbits around this beautiful ringed planet, my time to say good-bye to Cassini is almost here. I remember talking to Cassini when we first reached Saturn, back in July of 2004 —



“Here we are, Cassini,” I said. “We’re finally at Saturn! Can you see the bands of color — white and yellow and brown— across the globe? They seem to be storm clouds riding and playing on the wind. Now the rings around the equator are shining brighter than ever. For so long they’ve looked like silvery bands, or a halo. But at this close distance, I can see that the rings are not solid bands at all! They’re a dense ribbon of icy pebbles and sand and gravel and boulders lying in a path around the planet’s middle, as if they were racing around Saturn on a gigantic track. Some of the pieces are finer than dust, some are bigger than a house, and others are every size in between! Some of those ice-covered rocks look like chunks of chips and nuts in frozen white cookie dough. I’m thrilled to finally be here, Cassini. But I’m a little sad, too, because in six short months I’ll be leaving you. I’ll continue on by myself to the mysterious world of Titan.”

Well, those six months have passed, and now the time for me to go to Titan is here! I’ll be the first machine from Earth to land on that giant moon. I like the fact that I was named after the astronomer who discovered Titan. His name was Christiaan Huygens, and he lived in the Netherlands. He spotted Titan in 1655 — more than 300 years ago! — using a telescope he had built himself. Now I will uncover some of the mysteries that have puzzled people ever since then. What will I find beneath those thick clouds? Will anything be like it is on Earth? I wonder!

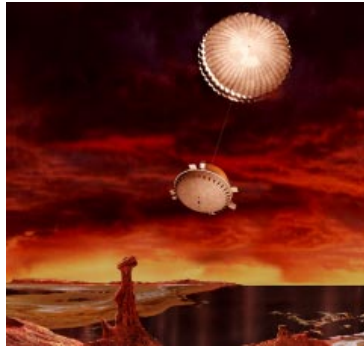
I do know a few of the things I can expect to find. There will be gravity, though not nearly as strong as the gravity on Earth. In fact, I’ll weigh just one-seventh of what I weighed back on my home planet.

My elder cousins, the two Voyager spacecraft, took more than 1,000 photographs of Titan when they paid a short visit to Saturn years ago. Their cameras were not able to see through Titan’s dense atmosphere, but they did learn some very interesting things. Scientists already knew that Titan’s atmosphere is mostly nitrogen, just like Earth’s. But the Voyagers’ infrared and ultraviolet cameras revealed that there is also methane and hydrogen in the atmosphere, as well as many other chemicals.

The Voyagers also measured Titan’s size — it’s 3,200 miles across. That’s less than half as wide as Earth, but much bigger than Earth’s moon. In fact, Titan is the second biggest moon in the entire solar system! The Voyagers also measured Titan’s temperature, and found that it’s about 289 degrees below zero on the Fahrenheit scale. That’s much colder than anyplace on Earth — even the North and South Poles! And the Voyagers also learned that Titan’s atmospheric pressure is 60 percent greater than Earth’s. That’s about as much pressure as a diver back on Earth would feel under 20 feet of water.



To tell you the truth, I'm just a bit nervous about this journey I'm about to take. When Cassini releases me, I'll be on my own for the first time, traveling through space and then down through Titan's atmosphere. But I'm excited, too. It's going to be a great adventure!



My onboard instruments have been carefully programmed, and they were tested numerous times on Earth. Will they still work after seven long years? And when I send my radio messages to Cassini, and Cassini passes them along to my trusted team of engineers and scientists back on Earth, will they arrive? Earth is so very, very far away — the radio signals will be incredibly faint by the time they get there. Well, we're about to find out!

I'm sure thankful for my special heat shield, which will save me from being burned up when I enter Titan's atmosphere. Then my parachutes will open, and — if there is no great and wild wind in that mysterious atmosphere — I'll drift slowly down to the surface.

One of my tasks will be to measure the sunlight that strikes this moon. We're so far from the Sun and Titan's atmosphere is so thick, I wonder what the light will look like on the surface. Perhaps it will be dim all around. Perhaps I should expect something altogether different.

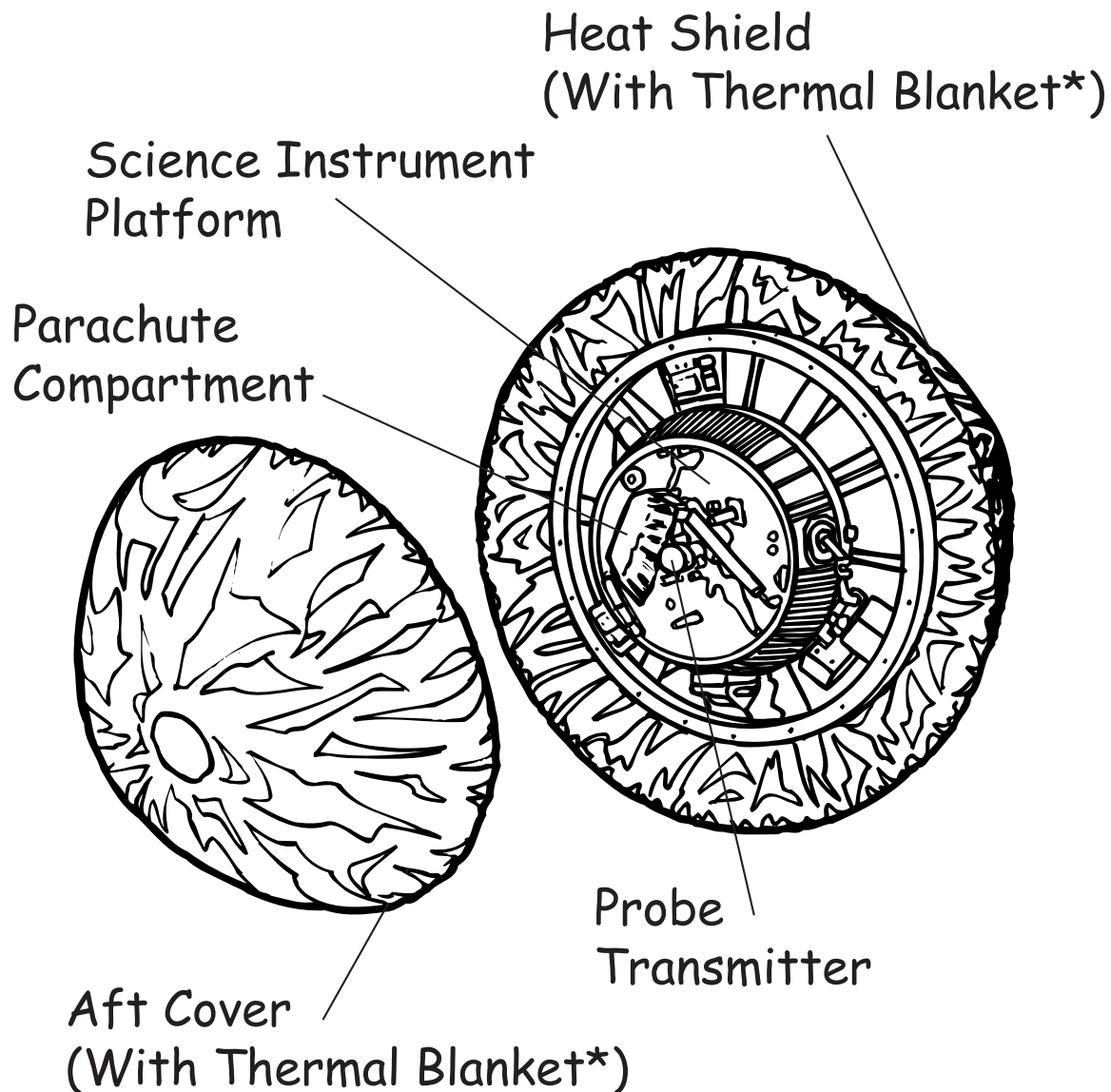
I wonder what Titan's surface will be like? Is a rocky moon hiding under the haze, with mountains and broad valleys, crags and ridges, grand flat plains stretching to the horizon? Or will I fall into a liquid world with swirling wave patterns in a giant sea? Or will the surface be somewhere in between — like slush or mud? Will it swallow me up as soon as I touch down?

I will soon find out. There is Titan now, rising from the edge of the rings as a great ball of light.

Farewell, Cassini. May you learn well. I go to an unknown world.



Huygens Probe Components



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



All About Titan and the Huygens Probe

On January 14, 2005, the Huygens probe will descend to Saturn's largest moon, Titan. The probe will have traveled for seven years, carried on the Cassini spacecraft through millions of miles of space, to complete the work it will do during the next couple of hours.



Huygens is a robot, which means that it's a machine that has been programmed to operate on its own, without the need for a human being to control it. Huygens will take pictures and make measurements of Titan's atmosphere and surface, and send these pictures by radio to the Cassini spacecraft, which will be in orbit around Saturn. Cassini will relay the pictures and scientific measurements to us, here on Earth.

Imagine that you're riding along with Huygens as it cruises to Titan and takes a 2-1/2-hour parachute ride down through the atmosphere! Huygens' descent module (the part of the spacecraft that will actually float down to Titan's surface) is just a little more than four feet across, and it's filled with scientific instruments. But imagine that you could somehow squeeze inside the module and look out through a window. You're about to see sights that no one has ever seen!

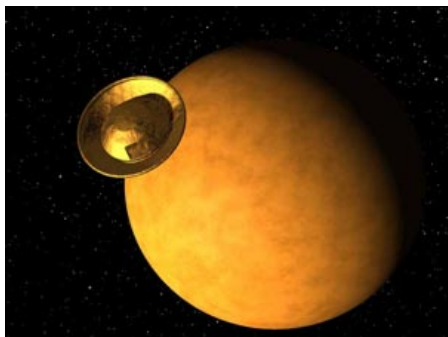
Before you enter Titan's murky, reddish atmosphere, take a last look around at the view from space. The Sun looks much smaller and dimmer than it did from Earth, because it's almost 10 times farther away. The sunlight that reaches you is 90 times weaker than it is back home.

Nearby Saturn is big and beautiful — 12 times bigger than a full Moon appears as seen from Earth! But you're seeing just the edge of its rings, so they don't look as spectacular as they did from a better angle. Some of Saturn's 31 other moons dot the blackness of space.

You're weightless as you coast to Titan. If there were room inside Huygens, you'd be floating around inside.



Titan fills the sky in front of you. It's the second-largest moon in the entire solar system (Jupiter's *Ganymede* is slightly larger), bigger than the planets Mercury and Pluto! If Titan weren't in orbit around a planet (which makes it a "moon"), it would surely be considered a planet.



You blaze into Titan's atmosphere at almost four miles per second! Huygens' heat shield pushes hard against the air as you fall, which is like slamming on the brakes. During the next two minutes, you slow down to "only" a quarter of a mile per second. This sudden change in speed makes you weigh more than 300 pounds!

Then a parachute pops out, the heat shield comes off and falls away, and you begin to float down through Titan's atmosphere. You feel very light again, but not weightless as you were in space.

TITAN'S ATMOSPHERE

Scientists think that Titan's atmosphere may be like the one that Earth had millions of years ago, before life began to form. Studying Titan might

help us learn about the early days of our own planet, and the conditions that led to life developing on Earth.

As the probe descends through the atmosphere, the scientific instruments inside Huygens spring into action! One collects tiny samples of the air, and identifies the gases in it. (We know that Titan's air doesn't have the oxygen you need to breathe. So, on your imaginary journey, you'd better bring some imaginary oxygen tanks!)

Special cameras look up, down, and sideways. Some look at the "regular" light that our eyes can see — called "visible" light. Other cameras look at light that our eyes can't see on their own, called "infrared" (in-fra-RED) light, and these cameras can see it just like you could if you were wearing night-vision goggles.

One camera is pointed toward the distant Sun. Huygens can tell how much dust and vapor is floating around in the air, and how big those particles are, by measuring how the atmosphere affects the sunlight.



The probe is designed to spin as it falls, so its cameras can look all around. Watching the clouds glide by as you turn makes you a little dizzy, so you close your eyes. And then your eyes pop open! Was that a flash of lightning? Do you hear a familiar rumbling sound in the distance? If so, Huygens will tell us about it. It even has a microphone to pick up the sound of thunder.

You can't see the surface yet, but you can tell that you're not falling straight down. A powerful wind — as strong as some of the fastest hurricane winds on Earth — is blowing you to the side as you fall! Don't worry, Huygens' designers expected this. The probe has several instruments to measure this sideways motion, so scientists can figure out which direction the wind is blowing, and how strong it is at different elevations (heights above the ground).

One instrument is called the Doppler Wind Experiment, and it uses something called the "Doppler effect." You've heard the Doppler effect on the street. The sound of a fire engine's siren has a higher pitch when it's coming toward you than when it's moving away. Listen carefully next time you hear a siren to see if you can tell where the fire engine is by the way the siren sounds.

The Doppler effect is useful for science because of what it can tell us about how a radio signal changes and what it means. Huygens is sending a steady radio signal to the Cassini spacecraft. Cassini receives the signal at a higher frequency if Huygens moves a little bit toward Cassini, and a lower frequency if it moves slightly away from Cassini. These tiny changes in the radio signal reveal how the probe is being blown by wind.

You may not have noticed it, but another instrument aboard Huygens can tell that you're not falling as fast as you were a few minutes ago. The atmosphere must be getting denser. That means the molecules that make up the air are packed closer together at this height, so they're a little harder for the probe to fall through.

A DENSITY EXPERIMENT

Try this experiment: Hold a coin just at the top of a glass full of water, and another coin at the top of a glass full of nothing but air. Then let them go at the same time.

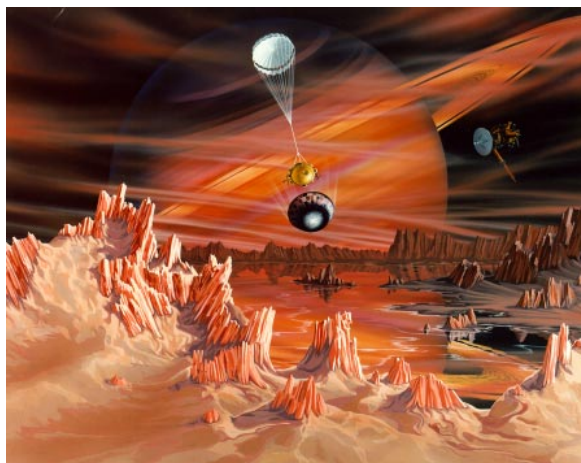
Which takes longer to fall to the bottom of the glass? Denser air will slow Huygens' fall, just as the water, denser than air, slows the coin as it falls.



As you continue to descend, Huygens measures the atmosphere's temperature and pressure, seeing how they change as you get closer and closer to the surface. Another sensor measures how much sunlight is shining down through the hazy atmosphere, and how much bounces back up after hitting the surface.

With only a thousand feet left to go, an infrared lamp switches on to light up the surface for the downward-looking cameras. What do you think you'll find there? Will the surface be solid, liquid, or something in-between? You're about to become the first person in history to find out!

Suddenly you feel a jolt, and you know that you've hit the surface! You're the first person on Titan!



One of Huygens' instruments measures how suddenly you stopped, which tells us how hard or soft the surface is. Are you on dry land, perhaps near a volcano or geyser spewing methane gas into the air? Are you bobbing around in an ocean of liquid methane (kind of like alcohol)?

You notice that you have weight, though not nearly as much as on Earth. If you weigh 70 pounds back home, you weigh less than 10 pounds here on Titan!

If Huygens' instruments still work after the probe has hit the surface, they analyze the surface material. If you splashed down in a lake or ocean, Huygens uses sound waves to measure how deep it is, and it also measures the wind and waves that carry you along.

Huygens' thermometer tells you that it's cold outside — about 300 degrees below zero Fahrenheit! That's far colder than the coldest night at Earth's North Pole!

Now that you're on Titan, looking up at the sky, you're kind of glad you don't have to breathe that air. It's worse than the smoggiest day you've ever seen! This looks nothing like the Earth you know. But you wonder — are you seeing a



STANDING ON TITAN

Titan is the only moon that you could stand on without a space suit. (Although you would need a tank of oxygen to breathe and heated clothing to keep you warm.) You see, our bodies are designed for Earth, which has a big atmosphere. The weight of all that air pushes in on our bodies from every direction. You'd be flattened like a pancake if not for one thing — the inside of your body pushes out exactly the same amount that the outside atmosphere pushes in! As long as the pushing from inside our bodies is just the same as the pushing from outside, we're nice and comfortable.

But what would happen if there were no atmosphere to push in on you (for example, if you were out in space)? There would be nothing to balance the force pushing out, and you'd blow up like a balloon! That's why astronauts need space suits. Space suits replace the pushing (or pressure) of Earth's atmosphere. You could stand on Titan without a space suit because Titan has an atmosphere with about as much pressure as Earth's (actually, a little more!). That's something you couldn't do on any other moon in the solar system — or even on Mars, Mercury, or Pluto.

world that's something like Earth was millions of years ago? Will the information that Huygens is sending to Earth help us learn how life on our planet began?

But now Huygens' batteries run out of electricity, and the little robot stops working. Because it's a machine, it can stay on Titan forever, and never miss being on Earth.

And you? Well, unless you've brought along a whole lot of oxygen, food, water, very warm clothing, and an extra spaceship to bring you back home, you've got a problem!

Maybe it's lucky after all that when Huygens really visits Titan, it will travel alone. But in a way, with this trusty robot serving as our eyes and ears, you and all the other people of Earth will be the first explorers on Titan!



Note-Taking for Nonfiction Worksheet

1. Preview the article you will be reading. Look at the title, headings, and illustrations. Think/write about what you already know, questions you have, and predict what you will learn. You can write in your Saturn Discovery Log. You can write more than one response for each question or statement!

What I already know: _____

I think I will learn: _____

I predict: _____

Questions I have right now:

I wonder _____

I wonder _____

I wonder _____

2. Read the article. Jot down ideas that are important for the type of writing you are going to do: details if you are writing a description, important big ideas if you are writing a summary, etc. Remember, for taking notes don't write more than 5 words for any one idea!



Note-Taking for Nonfiction Worksheet contd.

3. Read through your notes, and scan the article again. Choose ideas for the chart below.

What's Important (Themes, Main Ideas, BIG Ideas)

What's Interesting
(Amazing, cool, fun, weird, surprising,
but NOT the main idea)

[illegible]

Summary Tips Worksheet

1. Tips When You Are Reading a Summary

- The purpose of a written summary is to help the reader, and often also the writer, identify and remember the most important information from a piece of writing.
- Different kinds of writing have different structures or patterns.
- Knowing the structure of the writing you are reading will help you to summarize the information.

2. Tips When You Are Writing a Summary

- A summary will help you to remember the most important parts of what you read.
- Take out the information that is not important for your understanding.
- Replace lists of things or separate details with one word that describes things in that list.
- Write or find a topic sentence.
- A summary reports the information you find in a piece of writing. A summary paragraph should not include your opinion(s) about the topic, nor does it need a conclusion.

3. Try the summary technique yourself!

Write a topic sentence using the following technique, or another that you like:

Article Title	What it Does:	
"All About Huygens and the Titan Probe"	tells.... describes.... explains.... shows....	all about the Huygens probe and its expedition to Titan

Try a couple of different topic sentences using the "What's Important" and "What's Interesting" chart. Pick the one you think is best, and rewrite it.

Now ...

1. Look back at your notes, and create an outline or cluster.
2. Use your outline to write a paragraph.
3. Re-read your paragraph to yourself, and read it out loud to a partner. Be sure it makes sense!



Drop Zone! Design and Test a Probe

The Huygens probe is installed on Cassini.



LESSON TIME

About 6 hours over 4 days; extensions vary

MATERIALS CHECKLIST

For the teacher:

- Stopwatches (2–3); calculators; hula hoop or sidewalk chalk
- Optional: small inflatable wading pool
- Optional overhead transparency: “Saturn Discovery Log Writing Prompts” handout

For the students:

- Parachuting Probe Packets (one per student or per team)
- Lessons 5 and 8 Titan and Huygens material
- Parachute construction materials (see Teacher Preparation)
- “Saturn Discovery Log Writing Prompts” handout
- Saturn Discovery Logs

TO SEE EXAMPLES OF STUDENT WORK, [CLICK HERE](#)

LESSON NO. 9

- Language Arts Focus — Writing to Plan, Problem-Solve, and Analyze
- Science Focus — Designing and Testing a Parachuting Probe

OVERVIEW

Students are invited to participate in a challenge activity. Using the information learned in previous lessons, combined with their own creativity and problem-solving skills, students design and test a parachuting probe that will withstand a fall from a high point, land intact, be able to descend slowly, float in liquid, and cost the least to launch into space. Extensions provide an option if the teacher has limited time, and invite the students to simulate other experiments that will be carried out by the Huygens probe.

WHY THIS WORKS

Using notes, teaching passages, and any other research or data, as well as a materials list, students design, build, and test parachuting probes. Students justify their design decisions and draw a model of the probe they plan to build. In this way, they have the opportunity to engage in problem-solving, spacecraft design, and experimenting — just like real scientists and engineers. Students might work individually, in teams of two or three, or even complete the parachute activity at home as a family project.

At this point, students have sufficient background information about Titan and the Huygens probe to apply this knowledge to their own experiments. It isn't enough for students to read about science; they also need to *do* science. In the book *Classroom Instruction That Works: Research-Based Strategies for Increasing Student Achievement* (Marzano et al.), the authors assert that scientific inquiry is one of the most important skills for students to have. These lessons provide opportunities and invitations for students to integrate reading, writing, and experimenting. Writing provides a vehicle for student learning throughout this lesson.

Objectives

Students will:

- Demonstrate comprehension by including data from reading in experimental design and developing a persuasive writing piece.
- Design, build, and test a 3-dimensional model of a parachuting probe.
- Consider real-world challenges in their probe designs: speed of descent, ability to land upright, ability to hit a target on the ground, and ability to float in liquid.



- Use Saturn Discovery Log writing to help them think through a problem as well as document a process.
- Document their designs using illustration with text.
- Use exposition to write a Report of Findings about their design/experiment.
- Use science inquiry skills: developing investigatable questions, carrying out fair testing, hypothesizing, and drawing conclusions based on evidence.

Teacher Preparation

- Print out and photocopy, one per student or one per team, student handout 1, “Parachuting Probe Packets” (4 pages). Photocopy the pages back-to-back, nest the pages, and fold (check to make sure the pages are in order). Staple into booklets (5-1/2 by 8-1/2 inch) using a long-arm stapler.
- Print out student handout 2, “Saturn Discovery Log Writing Prompts” and make a copy for each student. Optional: make an overhead for class discussion.
- Parachute materials:
 - 14 by 14 inch sheet of sturdy plastic material (cut from garbage bags)
 - Several large sheets of plastic to be cut into various sizes
 - Mylar®
 - Pre-cut set of four 14-inch strings per student or team
 - Plenty of additional (uncut) string for adaptations/variations
 - Masking tape; clear tape; hole punch; self-adhesive, 1/4-inch hole reinforcements
 - Optional: metal washers for weights if you want to do an investigation using parachutes alone either before, or in lieu of, building the probes. Paper napkins or tissue paper can be used for simple parachutes.
- Probe materials (whatever you can scavenge and/or students can bring in):
 - Paper cups/plates of various sizes; cleaned pint-size milk cartons; paper cylinders (e.g., paper towel or toilet paper tubes)
 - Pipe cleaners; foil; corks; straws; tissue paper; Mylar®; popsicle sticks; tape; stapler; nylon stockings/pantyhose
 - Optional: materials for decoration

teacher TIP

Allow sufficient time for copying, compiling, and stapling the probe packets (20 minutes or more) and to set up construction materials for the probes or parachutes. This is a great parent volunteer opportunity.

A Note on Materials Management

The amount and type of materials that you gather will determine whether or not students may have “unlimited” amounts of the available supplies, or if you need to evenly distribute what you have. You can set “prices” on the materials, and give students a budget or limited amount they can spend. You can also provide all students with a basic set of supplies (four pieces of string, a piece of plastic, etc.), and give them a budget with which to purchase any extras.



What to Do

Preliminary (Optional) — Experiment with Simple Parachutes

1. Follow these instructions, or see the parachute lesson in the book *Science on a Shoestring* by Herb Strongin.
2. For the parachute, use tissue paper or paper napkins (approximately 14 inches square). Use a paper punch to make one hole in each of the four corners, and strengthen with a self-adhesive binder paper hole reinforcer (available at office supply stores).
3. Attach 14-inch lengths of kite string to each corner, and tie these to a small washer (inexpensive, readily available in hardware stores).
4. Students need to figure out how to fold and toss the chutes so that they open and how to slow the fall of the washer. Once students have mastered these, they can experiment with different lengths of string, different-size washers, and/or different parachute materials. Be sure they understand that they should only change one variable at a time in order to have a “fair” test!



- Have students experiment with simple parachutes before experimenting with parachuting probes.
- Instead of building the probes during class, have students build their probes as a family project at home and use class time for testing and writing.

Day One

Introduction to the Challenge; Planning Time — Suggested time 1–2 hours

1. Introduce the lesson by telling students that they now have the opportunity to put themselves in the shoes of spacecraft designers and engineers.
2. Distribute the Parachuting Probe Packets and read the text aloud.
3. Ask for questions, and have the students summarize the activity aloud. Record their retelling as a “to do” list on the board or on an overhead transparency.
4. Show the students the materials that will be available for them to use for building the probes.
5. Monitor student progress. Circulate among teams as the students name their probes, complete their plans, and record information in their Parachuting Probe Packets.

Sharing Out — Suggested time 20 minutes

1. Have individuals or teams share their plans with the whole class.
2. Have the students who are not presenting listen for ways that their plans are similar to, and different from, their peers’ plans. Allow time for questions and answers among the students.

Day Two

Constructing the Probes — Suggested time 1–2 hours

1. Have materials available for probe construction. Direct students to select materials and construct probes.
2. Provide time for students to share their designs with one another, and the whole class. Each design team can explain their choices and designs BEFORE testing begins. Students can summarize and justify design decisions, both orally and in writing (in their Saturn Discovery Logs).



Day Three

Testing the Probes — Suggested time 1–2 hours

1. Set up a testing area. Enlist the help of an adult volunteer, such as the school custodian. You will need to get a ladder so your volunteer can climb to the roof, or other high spot (e.g., bleachers) at your location. If your school does not have a suitable “drop zone,” you may want to visit a nearby high school.
2. Draw a “target” on the playground with sidewalk chalk below the drop site, or, if it is not windy, use a hula hoop.
3. If you have access to a small portable wading pool, use this for the landing in liquid test. (Be sure the students understand that there will not be liquid water on Titan’s surface, though there may be liquid of a different type.)
4. Discuss “fair testing” with the students.
5. Decide on a fair way to select who goes first. Try this: print students’ names on ice-cream or popsicle sticks for random selection of names.
6. You will need to figure a baseline time of descent from your drop point. To do this, drop an object that does not have a parachute attached — for example, a clay ball — and record the descent time. Then set a reasonable target time *slower* than the clay ball’s descent time for the students to try to meet. Have students add their test data to their Parachuting Probe Packets.
7. One person (an adult volunteer) should be the “dropper.” The dropper should try to drop the probes in the same manner each time. If possible, have two or three students timing the descent of each probe, and average the times. Also, if possible, there should be three trials for each probe — the test page in the Parachuting Probe Packets is set up for three trials.
8. Have students write their observations of their classmates’ experiments in their Saturn Discovery Logs. This will help them in recalling this information during the whole-class discussion. It also reinforces the idea that the classroom is a community of learners, and that we learn from one another.

Day Four

Discussing Results — Suggested time 45 minutes to 1 hour

1. Begin with a whole-class discussion. Students can share observations, questions, and hypotheses that they have recorded in their Parachuting Probe Packets or their Saturn Discovery Logs.
2. Ask the following questions, and record student responses on the board or on chart paper:
 - Which designs or design elements seemed the most stable, or added stability?
 - Which parachutes seemed to take the longest to land?
 - Which designs or design elements seemed to hit the target, or closest to the target, most often?
 - Is there an optimum weight the probe needs to be in order to land accurately?
 - Is there a relationship between parachute size and probe weight?



Analysis, Re-Design, Re-Test — Suggested time 45 minutes to 1 hour

1. Here is where students refine their designs through analysis and conclusions.
2. Students can make modifications as recorded in their Parachuting Probe Packets.
3. If there is time, students can re-test their modified designs.

Using Writing as a Tool For Reflection — The “Report of Findings”

1. Give a copy of the student handout “Saturn Discovery Log Writing Prompts” to each student. You may wish to use an overhead transparency for class discussion.
2. Have students discuss the questions with their partners or group before writing their responses in their Saturn Discovery Logs.

Extensions

Special thanks to Dr. Jean-Pierre Lebreton and Dr. Ralph Lorenz, Cassini mission scientists, for the extension activities offered here.

1. Parachute Inquiry. If you have limited time, you may want to have students conduct a parachute inquiry only. This is an easy modification, and the questions in the Parachuting Probe Packet can be applied to parachutes rather than probes. You can still design/re-design for landing within a target area, and determine which parachute takes the longest time to descend. Metal washers (available at hardware stores) can be used as weights. It will still be important to discuss “fair testing” with the students. For example, if they change parachute material, string length and washer size/weight should be kept constant. If they change washer size/weight, string length and parachute size/material should be kept constant.
2. Optimization Exercise. Students can experiment with parachuting paper or cardstock cone-shaped “shields.” A broad cone gives more drag (slows you down more); while a narrow cone is more stable, given the same amount of material. Students can first measure the time it takes a washer or ball of clay to fall from a given height (e.g., roof of the building). Parachuting shields earn points based on how much more slowly they fall. They also earn points for stability — specifically for how close they fall to a target drawn on the ground. Points can be “charged” for how much material is used to construct the shields. There should be some optimum where the cone is sharp enough to fall in a stable fashion and to land close to the target, but not so sharp it needs lots of material to have enough drag.
3. Characterizing an Unknown Surface. One of the Huygens probe’s responsibilities is to characterize the surface of Titan from the impact as recorded with onboard accelerometers. You can model this in the classroom by creating different surfaces hidden inside cardboard boxes: for example, sand, gravel, brick, and water. Students can make a hole in the box top, and drop a “probe” (marble) into the hole at the top of the box, and try to guess what the surface is from the sound it makes. If a teacher had a microphone/computer hook up, students could even “look” at the sound.



Assessment

Questions in the Parachuting Probe Packet invite students to reflect and self-assess. Teacher observation of student behavior during the activity, as well as students' written work, can be used to assess understanding of both writing and science.

As you look at the students' writing, ask yourself the following questions:

1. Are the questions they ask investigatable?
2. Is the experimental plan clear and sequential?
3. Has the data been recorded in an organized way?
4. Does the writing show evidence of the student's reasoning from evidence?
5. Does the reflective writing show evidence of critical and creative thought?

Standards

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

All students must have opportunities to:

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

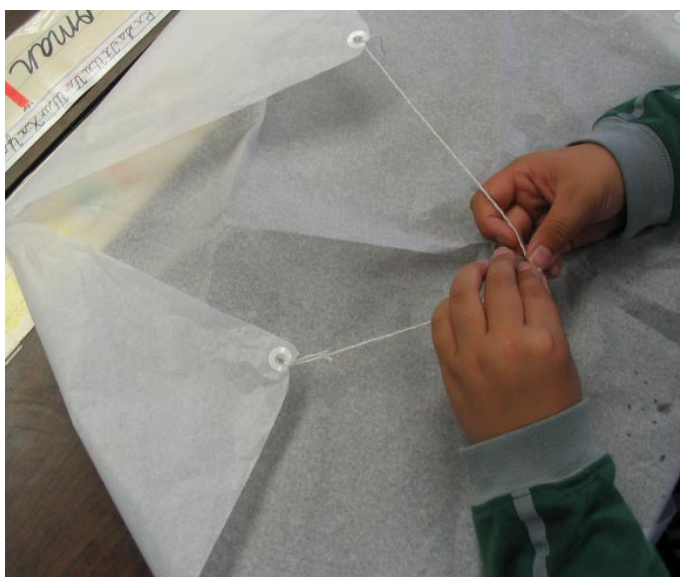
National Science Education Standards

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

- Abilities necessary to do scientific inquiry (Science as Inquiry) and understandings about scientific inquiry (students plan and conduct a simple investigation).
- Abilities of technological design (Science and Technology), and understandings about science and technology (students communicate a problem, design, and solution).



Examples of Student Work



Building parachutes



Saturn Discovery Log Writing Prompts

In what ways did your design meet the criteria?

What were some challenges you encountered, and how did you solve them?

What changes would you like to make in your design? Why?

What are you most proud of?

What questions do you still have?

What do you like best about being a spacecraft engineer?

What do you think are the biggest challenges of being a spacecraft engineer?

What would you like to ask the Cassini-Huygens engineers?

What would you like to ask the Cassini-Huygens scientists?



Questions for the Spacecraft Engineers

1. What did you find most surprising or interesting?
2. What problems did you encounter as you built and/or tested your probe? What changes did you make, and why?
3. Based on your trials, and observations of your classmates' designs and tests, what changes, if any, would you make to your design?
4. What questions do you have now?
5. What questions would you like to ask of the Huygens Design Team?
6. What would you like to try next? Why?

Parachuting Probe Packet

The _____ Probe

Design Team/Spacecraft Engineers



Date _____

Engineering and Design Team Challenge:

Design a parachuting probe that will land upright on both solid and liquid surfaces, remain intact (not break apart), weigh as little as possible (while still meeting the other criteria), and meet the requirements for time of descent (how long it takes the parachute to land after being dropped).

Background information for Design Team:

Spacecraft engineers face many challenges. They design machines that survive the forces of being launched into outer space and operate there with little assistance from Earth.

Once in space, the spacecraft must protect its delicate instruments throughout the journey. We are counting on Cassini to protect Huygens on its seven-year journey from Earth to Saturn.

Any heat absorbed or produced by the spacecraft must be managed to prevent the instruments from overheating or getting too cold. The probe must be strongly anchored to the spacecraft, yet able to separate in a controlled fashion at the right time. Both spacecraft and probe must be protected from dangerous radiation and from high-speed dust particles.

The probe must remain able to operate after many months or even years of inactivity. It must also be able to respond to commands and to radio its data back to Earth as accurately as possible.

Testing the _____ Probe

Trial Number	Condition Upon Landing	Time of Descent	Notes, Observations, Questions
1			
2			
3			

Idea 3 — Final Plan (draw and write):

Weight of Probe:

Your Task:

You will design and build a parachuting probe. Given an assortment of materials commonly found at home or in the classroom, you will construct a parachuting structure that will:

1. Land upright on a solid or liquid surface. (To simulate the requirement for the Huygens instruments — camera and other instruments — to be able to take pictures and measurements)
2. Land undamaged. (To simulate the requirement for the instruments to be able to work — they must not break on impact.)
3. Take as long as possible to land, but land within in a designated area. (Huygens' parachute size will control its descent time. Huygens will be collecting data as it descends.)
4. Weigh as little as possible. (A fourth property to consider is weight. The more a spacecraft weighs, the more it costs to launch it and maneuver it in space. So, you want your probe to be as light as possible.)

Imagine the possibilities! Wonder! Create!

Helpful Science Hints

Scientists use the word "impulse" to describe an impact.

Impulse is the force of impact multiplied by the amount of time the force is exerted. There are two types of impulse: hard and fast, and soft and slow. Hard and fast is usually not the way you would like to experience a change in speed. That's when you run into a brick wall at full speed, going from fast to stopped in a fraction of a second. The great amount of force you experience over the short amount of time can result in broken bones, or worse. So, soft and slow is the way to go.

If the wall you run into is padded like a mattress, you will enjoy the result more than if you run into bricks. To give your probe the best chance for survival, you need to think about how to give it the soft and slow type of impulse. Anything you can do to increase the amount of time the probe spends slowing down before hitting the ground will increase its chances of landing intact.

Your parachute will be central in this endeavor. You may want to do some initial experimenting with parachutes. Think about these questions:

- What happens if you change the size of the parachute?
- What happens if you change the length of the strings that attach the parachute to its load?
- What happens if the parachute is attached in different places?

Idea 1 (draw and write):

Idea 2 (draw and write):

What Do I See Now When I Picture Saturn?

Cassini's view from 35 million miles away.



LESSON TIME

1 hour

MATERIALS CHECKLIST

- Crayons
- Colored pencils
- Pencils
- Saturn Discovery Logs

LESSON NO. 10

- *Language Arts Focus — Nonfiction Writing Practice: Illustrations with Text; Compare and Contrast*
- *Science Focus — Post-Assessment of Scientific Ideas and Understanding*

OVERVIEW

Students are coming to the end of their journey of discovery about Saturn, Cassini, and nonfiction. To reflect on what they have learned, students repeat the exercise that they did at the beginning of the unit in Lesson 1. They draw everything they picture when they hear the words Saturn and Cassini, and add labels and captions to their drawing. Students look back at their first exercise and compare the two. They end the lesson by sharing their work with a partner.

WHY THIS WORKS

While teachers are often the main observers of student growth, giving students the opportunity to observe their own development is a powerful tool. This lesson provides students with the opportunity to reflect on their learning.

Objectives

Teachers will:

- Learn how students' understanding of Saturn and Cassini has changed throughout the unit.

Students will:

- Learn how their understanding of Saturn and Cassini has changed throughout the unit.

Teacher Preparation

- Make sure students have their Saturn Discovery Log entries from the first lesson so they can compare their "before" and "after" work.
- Write this prompt on the board where students can see it: "Draw everything that you picture when you hear the words Saturn and Cassini. Add labels to your drawing."



What to Do

Introduce the Activity — Suggested time 5 minutes

1. Draw the students' attention to the writing prompt you have written on the board: "Draw everything that you picture when you hear the words Saturn and Cassini. Add labels to your drawing."
2. Explain to the class that they are going to spend 20 minutes drawing everything they picture when they hear these two words — "Saturn" and "Cassini."
3. Explain that they are going to add labels or captions to the drawing.
4. Tell the students that they will be comparing this illustration with text to the one they did on the first day of the unit.

Draw and Write in Saturn Discovery Log — Suggested time 20 minutes

1. Circulate and ask students to tell you more about what they are drawing.
2. Encourage them to add what they say to the captions.

Compare "Before and After" Drawings — Suggested time 15 minutes

1. Ask the students to refer back to their first log entry.
2. Tell the students you would like them to study the two entries and compare them.
3. Have students write what they noticed when they compared the two illustrations with text.

Share with a Partner — Suggested time 10 minutes

1. Have students share their illustrated text and comparison with a partner.
2. Have the partners take turns sharing one thing they liked about their partners' work.

Share with the Class — Suggested time 10 minutes

1. Ask if any students would like to share what they noticed about the "before and after" work with the class.
2. Ask students to write their names and dates on their work and put it inside their Saturn Discovery Logs.

Extension

Another "Before and After" Exercise

You may also have students repeat Lesson 2 of the unit (look at images and write "I notice, know, and wonder") and then write a comparison of the differences that they notice in the class response.



Assessment

As you review the students' work, ask yourself the following questions:

1. Where do I see growth in the student's understanding of Saturn and Cassini?

Look at the two illustrations with text, and read over each student's observations of the "before and after." Write notes on the comparison to support the child's observations, and add any other observations that you might have.

2. Are there any misunderstandings that I would like to address?

If so, at this point since the unit is almost complete, you may want to have a one-on-one conversation with the child, if it seems like a misunderstanding or lack of knowledge that the child is ready to learn more about.

Standards

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

All students must have opportunities to:

- 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.
- 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 an understanding:

- Of objects in the sky (Earth and Space Science).

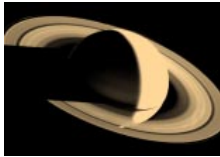


- The Before and After illustrations with text are useful to share with parents at conferences to provide visual evidence of the child's learning.
- You may want to note how the child performs on this type of assessment vs. other types of assessments to gain a better sense of his or her strengths.



Pulling It All Together

*Saturn as seen by
Voyager 1.*



LESSON TIME

1 hour

MATERIALS CHECKLIST

For each student:

- Copy of “Notes for Final Writing Project Worksheet”
- Saturn Discovery Log

LESSON NO. 11

- Language Arts Focus — Nonfiction Writing Practice: Descriptive; Compare and Contrast; Summary
- Science Focus — Synthesis of Information and Reflection

OVERVIEW

Students now have a working knowledge of Saturn and Cassini, as well as their Saturn Discovery Logs full of notes and observations. Students will organize notes to prepare to write one of the following types of nonfiction for their final piece: descriptive (poetry), compare and contrast, or summary.

WHY THIS WORKS

Shepardson and Britsch (1997) state that, “In science, journals and logs are seldom used as a means of communicating and sharing information with others. Instead, the science journal functions as a tool scientists use to create other products, such as oral presentations or journal articles that are then used to communicate findings and other information to other members of the community.” The Saturn Discovery Log serves the purpose that a real journal does for scientists. It is a springboard to a final project.

Objectives

Students will:

- Consolidate learning that has taken place during the unit.
- Organize and synthesize notes for a final nonfiction writing project.

Teacher Preparation

Print out and make a copy of student handout 1, “Notes for Final Writing Project Worksheet” (5 pages) for each student.

What to Do

Introduce the Activity — Suggested time 5 minutes

1. Tell the students that they have almost finished the unit on Saturn, Cassini, and nonfiction. Tell them that they are going to prepare to write a final piece about what they learned to share with others.
2. Give each student a copy of the “Notes for Final Writing Project Worksheet.”
3. Tell the students that they are going to collect ideas for their final writing piece.



Brainstorm — Suggested time 25 minutes

1. Read the prompt on each page of the “Notes for Final Writing Project Worksheet.”
2. Allow the students 5 minutes to write their ideas on the page related to the prompt.

Organize Information from Saturn Discovery Logs — Suggested time 25 minutes

1. Have students go through all the work in their individual Saturn Discovery Logs, and to use the Saturn Discovery Log to add notes to each page of the worksheet.
2. Tell the students that they will have the opportunity to share their notes with a partner and the class.

Share with a Partner — Suggested time 5 minutes

1. Have the children choose one or two things from their worksheet to share with a partner.
2. Have the partners take turns sharing one thing they liked about their partners’ work.
3. Make sure students to put their names and the date on their work, and put it the Saturn Discovery Log, so they have their notes to write their final piece.

Assessment

As you review the students’ work, ask yourself the following question:

- Was the student able to organize notes for each prompt?
If not, have a conversation with the student to find out more about why this was difficult for him or her, and try to think of a strategy for helping the student improve in this area.

Standards

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

All students must have opportunities to:

- Adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- 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.
- 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 an understanding:

- Of position and motion of objects (Physical Science).
- Of objects in the sky (Earth and Space Science).
- About science and technology (Science and Technology).
- Of science as a human endeavor (History and Nature of Science).



Notes for Final Writing Project Worksheet contd.

- Cassini Descriptive Writing Notes

Write down words that describe (tell about) Cassini.

This image shows a single sheet of white paper with horizontal ruling lines. The lines are evenly spaced and run across the width of the page. There are no margins, text, or other markings on the paper.

Notes for Final Writing Project Worksheet contd.

- Cassini Compare and Contrast

- 1) Think of something to compare Cassini to.
- 2) Write all the ways that Cassini is like that thing.
- 3) Write all of the ways that Cassini is NOT like that thing.

Keep on repeating steps 1 through 3 until you run out of time.

[illegible]

Notes for Final Writing Project Worksheet contd.

3. SUMMARY WRITING NOTES

Pretend you are talking to someone at recess and that person says, "Hey, I heard there is a spacecraft named Cassini going to Saturn. Do you know anything about Saturn and Cassini?" What would you say? The recess bell is going to ring in 10 minutes, so you can only tell them the most interesting and important things.

[illegible]

Celebrating Saturn and Cassini

A Cassini approach view of Saturn.



LESSON TIME

About 2 hours total

MATERIALS CHECKLIST

For each student:

- Completed “Notes for Final Writing Project Worksheet” from Lesson 11
- A copy of “Saturn and Cassini Final Writing Choices Directions”
- Paper
- Pencil
- Saturn Discovery Log

TO SEE EXAMPLES
OF STUDENT WORK,
CLICK HERE

LESSON NO. 12

- *Language Arts Focus — Final Nonfiction Writing Practice: Descriptive; Compare and Contrast; Summary*
- *Science Focus — Sharing New Knowledge with Peers*

OVERVIEW

Though this unit on Saturn is coming to a close, students will be beginning a lifelong journey of learning about the mysteries of space and challenges of space travel. For the final lesson, students will use pre-writing notes to write a nonfiction piece about Saturn or Cassini. These final projects provide a way for children with varying learning styles to consolidate and share their learning.

WHY THIS WORKS

For the final project, students are given a choice about the type of writing they will use. Providing this choice helps students become more invested in their writing. Descriptive writing/poetry is emphasized, because being able to “paint a picture” is critical to all types of fiction and nonfiction writing. Compare and contrast writing is a popular nonfiction writing type that will be called for throughout students’ careers. Comparing and contrasting is a high-level thinking skill, and offers students the opportunity to provide an original perspective on the facts and understanding they have obtained. Summary writing is also frequently called for in and out of school. The writing assignment tasks provides students with explicit ways to plan and revise their work.

Objectives

Teachers will:

- Learn how well students have internalized knowledge about Saturn and Cassini.
- Learn how well students are able to meet nonfiction writing goals for a particular type of nonfiction writing.

Students will:

- Learn how to organize their knowledge of science to meet the requirements of a type of nonfiction writing.
- Learn how to communicate this knowledge to others.



Teacher Preparation

- Make sure students have available their completed “Notes for Final Writing Project Worksheets” from Lesson 11.
- Print out and make a copy for each student of student handout 1, “**Saturn and Cassini Final Writing Choices Directions**” (3 pages), and make a copy for yourself for discussion.

What to Do

Describe Final Writing Project Choices — Suggested time 15 minutes

1. Tell the students that they will be choosing one type of nonfiction for a final writing project.
2. Give each student a copy of “Saturn and Cassini Final Writing Choices Directions.”
3. Read through the directions with the students. If your class has had experiences writing poetry, then you may want to encourage students to write the descriptive piece as a poem.
4. Ask the class to brainstorm people or organizations that students could share their work with (for example, students in another classroom, families, NASA).
5. Record the students’ ideas on the board.
6. Allow the students time to choose which type of nonfiction writing they would like to do for their final writing project.
7. Remind students to follow the step-by-step directions for the final writing project. (They will need to do the final step — sharing with people outside of the classroom — later.)
8. Let the students know that everyone will have an opportunity to share their final project with the class.
9. Remind the class that each type of writing has a writing goal that should be written at the top of the paper. A partner will be looking at the work to see if the goal was met, and you will be looking at the work as well to see if the writing goal was met.

Write, Edit, and Revise — Suggested time 45 minutes

1. Circulate and assist the students while they write, peer edit, and revise.
2. Encourage them to remember the writing goal for their piece, and to keep in mind the person(s) they will be sharing their pieces with.



teacher TIP

Sharing work with the rest of the class could be done at another time in the day or week, especially if students need more time to revise their writing.

Revise Based on Teacher Notes — Suggested time 15 minutes

1. Using the “Saturn and Cassini Final Writing Directions” handout, evaluate whether the writing goal was met and provide revision notes.
2. Have the students revise their pieces based on your notes. This does not necessarily mean that the children need to rewrite the pieces. They may be able to insert information or make changes without rewriting the whole thing. If students are going to send their writing to an organization, they may wish to take the time to rewrite or word-process a clean copy after they have made their final revisions.

Share with the Class — Suggested time 30 minutes

1. Have the students share their pieces with the class.
2. Have the students share things they like about the piece and questions and suggestions.

Discuss Sharing Outside of the Classroom — Suggested time 10 minutes

- Encourage students to share their writing piece with three other people or organizations that they listed on their project.

Extensions

Multimedia Presentation

Have the students adapt their final writing projects to HyperStudio projects, and present the projects to each other or invited guests.

Class Book

Compile the final writing projects into a class book, and have students read from it to other classrooms, to a community organization, or invite the parents in for a reading.

Publish!

You may want to encourage students to share their final projects with a local newspaper or science museum, or with the Cassini project at NASA/JPL.

Where Is Cassini Now?

Children can visit the following website to track Cassini’s progress and discoveries, and give summary updates to the class — <http://saturn.jpl.nasa.gov/>



Assessment

As you review the students' work, ask yourself the following questions:

1. Did the child meet the writing goal specific to each type of nonfiction writing? (The writing goal should be written on the top of each student's paper.)

Either share your thinking in a conference with the child or by writing notes next to the writing goal. If you don't think the child met the writing goal, go through the same steps that the children did when doing the peer assessment, and give specific revision suggestions that would help the child meet the goal. This can guide the child's second revision of the piece. You may want to allow class time for this, or give the second revision as a homework assignment.

2. Are there any misunderstandings that I would like to address?

If so, at this point, since the unit is almost complete, you may want to have a one-on-one conversation with the student, if it seems that he or she is ready to learn more about the misunderstanding or lack of knowledge.

Standards

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

All students must have opportunities to:

- Adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.
- 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).

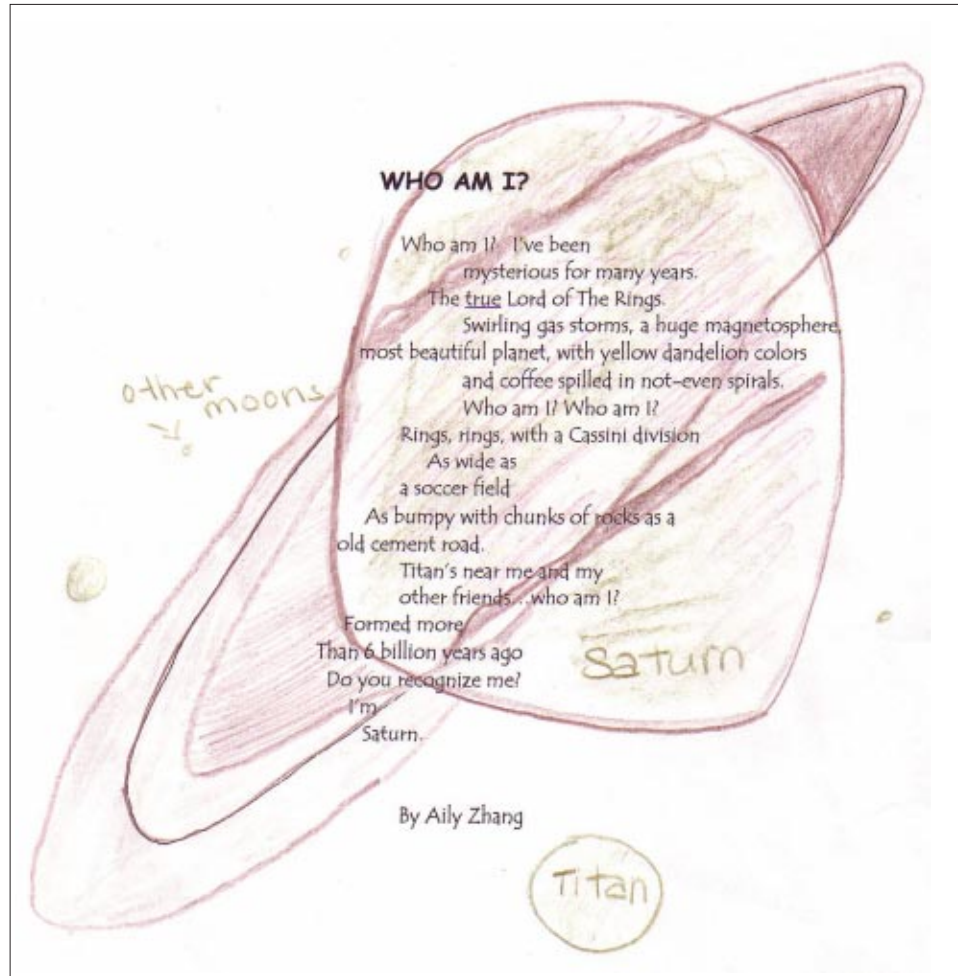
National Science Education Standards

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

- Of position and motion of objects (Physical Science).
- Of objects in the sky (Earth and Space Science).
- About science and technology (Science and Technology).
- Of science as a human endeavor (History and Nature of Science).



Example of Student Work



Saturn and Cassini Final Writing Choices

Directions

Below you will find a choice of three nonfiction writing projects. Read through them and choose the one that you would like to do. Then follow the directions carefully for the project that you choose.

1. DESCRIPTIVE WRITING

You will use your descriptive writing notes to describe Saturn or Cassini.

WRITING TIPS

The purpose of descriptive writing is to help the reader really picture what you are describing.

WRITING GOAL

The reader can picture Saturn or Cassini and know what makes it special.

WHAT TO DO

1. Get a piece of paper for your writing project.
2. Write the Writing Goal at the top of the paper. This will be your main goal to keep in mind as you write.
3. Beneath the Writing Goal, write your name, the date, and the title you have chosen for your piece of writing.
4. List three people or organizations that you would like to share your writing with in the margin of your paper at the top.
5. Using your "Descriptive Writing Notes" from the "Notes for Final Writing Project" worksheet, write a piece of writing that describes Saturn or Cassini. You can write about both if you would like to.
6. Have a partner read your piece and draw a shaded-in circle at all the spots that they can really picture Saturn or Cassini. Have your partner draw a blank circle at all the spots where they think you could add details to help them picture it better.
7. Reread your piece, and any time you see a blank circle, add more details to help the reader picture it better, and know why it is special.
8. Illustrate your writing when you are finished.
9. Share your writing with the three people or organizations that you listed above. Ask them to write one thing they like about your piece at the top, and to underline their favorite sentence or phrase.



Saturn and Cassini Final Writing Choices Directions contd.

2. COMPARE AND CONTRAST WRITING

You will use your compare and contrast writing notes to compare Saturn or Cassini to anything you choose.

WRITING TIPS

The point of compare and contrast writing is to show how two things are similar and different.

You may want to use the following words in your compare and contrast writing:

different
alike

differences
in common

differ
similar

unlike
the same

WRITING GOAL

Choose the five most interesting similarities and five most interesting differences for your paragraphs.

WHAT TO DO

1. Write the Writing Goal at the top of your paper. This will be your main goal to keep in mind as you write.
2. Beneath the Writing Goal, write your name, the date, and the title you have chosen for your piece of writing.
3. List three people or organizations that you would like to share your writing with in the margin of your paper at the top.
4. Using your "Compare and Contrast Writing Notes" from the "Notes for Final Writing Project" worksheet, compare Saturn or Cassini to something. Your first paragraph should show five ways that the two things are similar, and the second paragraph should show five ways that the two things are different.
5. Have a partner read your piece and look at your notes. See if your partner agrees or disagrees that you choose the most interesting similarities or differences.
6. Reread your piece, and make changes based on your partner discussion.
7. Illustrate your writing when you are finished.
8. Share your writing with the three people or organizations you listed above. If possible, ask them to write one thing they like about your piece at the top, or underline their favorite sentence.



Saturn and Cassini Final Writing Choices Directions contd.

3. SUMMARY WRITING

You will use your summary writing notes to write the most important and interesting things that you have learned about Saturn and Cassini.

WRITING TIPS

The purpose of a summary is to help people learn about something when they don't have much time. A summary contains only the most important or interesting information.

WRITING GOAL

For every sentence you write, you should be able to say why you think it is important or interesting enough to include in this summary.

WHAT TO DO

1. Write the Writing Goal at the top of your paper. This will be your main goal to keep in mind as you write.
2. Beneath the Writing Goal, write your name, the date, and the title you have chosen for your piece of writing.
3. List three people or organizations that you would like to share your writing with in the margin of your paper at the top.
4. Using your "Summary Writing Notes" from the "Notes for Final Writing Project" worksheet, pretend you were talking to someone at recess and that person said, "Hey, I heard there is a spacecraft named Cassini going to Saturn. Do you know anything about Saturn and Cassini?" What would you say? The recess bell is going to ring in 10 minutes, so you can only tell them the most interesting and important things.
5. For your last sentence, write: "If I could only tell a person one thing about Saturn and Cassini, it would be that . . ."
6. Have a partner read your piece and draw a circle next to any sentences that they think are not interesting or important enough to include in your summary. Have a discussion with them to try to agree about whether or not to include it. Ask your partner if he or she thinks that there is any other information that should be included.
7. Reread your piece, and delete information if you decided it was not important enough to include, or add information if you and your partner agreed it should be there.
8. Illustrate your writing when you are finished.
9. Share your writing with each of the three people or organizations you listed above. If possible, ask them to underline the most interesting part of your summary.

