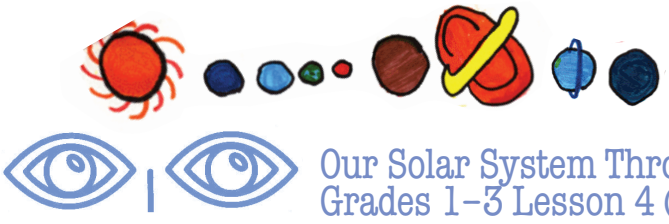


Our Solar System Through the Eyes of Scientists
Grades 1–3 Lesson 4 (Activities 1–5)

LESSON 4

Moons — Many, Many Moons!

Activity 1 — Pre-Assessment

Activity Time
45 minutes

Picture This!

Introduction for Teachers

Do you ever wonder about our Moon? We see it in the sky mostly at night — always moving and changing in predictable ways. The Moon is our closest neighbor in space, and it is Earth's only natural satellite. But do you ever wonder if other planets in our solar system also have moons? They do! Yes! Hundreds of moons orbit other planets in our solar system and throughout the Universe. Meet Dr. Bonnie Buratti, Scientist and Moon Master at NASA's Jet Propulsion Laboratory. Learn about Dr. Buratti and her study of the many moons of the solar system. As she mastered her scientific knowledge of these moons, she learned that every moon in the solar system is different, and new ones are constantly being discovered! Your students can learn about different moons of Jupiter and Saturn. Your students will learn to think like scientists — using notebooks to write and draw their observations about moons and come up with questions of their own.

Come In!

What do you wonder about Earth's moon? Are there moons around other planets? Yes! There are more than 60 known moons orbiting Saturn.

Intended Curriculum

Big Idea

Learning about moons of the solar system through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Science Objectives

Students will:

- Learn that there are many moons in the solar system orbiting planets.
- Learn that moons can differ by size, shape, composition and surface qualities.
- Learn how craters are formed and how they differ.
- Create a crater model to gain scientific information.

Language Arts Objectives

Students will:

- Collect, record and sort data
- Synthesize their scientific findings in writing
- Communicate with their peers to share knowledge of moons

Math Objectives

Students will:

- Use measurement tools to measure craters and weigh the objects that made them.
- Formulate questions that can be answered with collected data.

Materials and Teacher Preparation

Materials

- "Meet the Scientist" segment below
- Colored pencils or crayons
- Pencils
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart
- "What Scientists Do" chart

Teacher Preparation

- Distribute a Science Notebook and Solar System Folder for each student.
- Create evaluation rubrics (see teacher pre-assessment evaluation guidelines).

Meet the Scientist

The Story Begins! Meet Dr. Bonnie Buratti

"I expect to see you on the Moon!" That's what one of Dr. Bonnie Buratti's teachers said to her when she was a young student. Today, Dr. Buratti, a NASA scientist and Moon Master at the Jet Propulsion Laboratory in Pasadena, California, hasn't been to the Moon, but she studies the moons of the solar system.

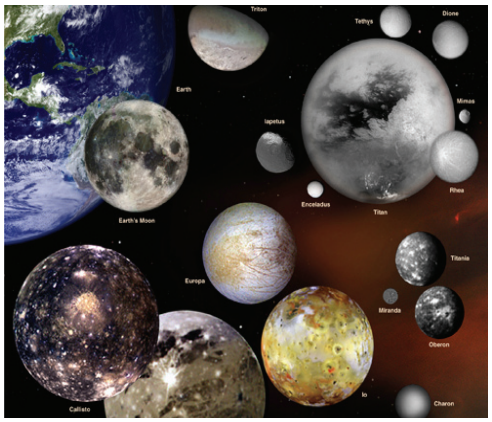
When did Dr. Buratti become so interested in space science? She became interested in science when she was in third grade. One day when she was home sick, she read a book about planets. It was like a spark that ignited her imagination. She could not get enough books about the solar system. She even asked her parents to buy her a small telescope so she could see our Moon and the other planets with her own eyes.

When she became a NASA scientist, she began to wonder about other moons orbiting around other planets. Are they like our Moon? How big are they? What are they made of? She found out every moon in the solar system is different. What do you wonder about moons?

You might wonder how Dr. Buratti can study moons in the solar system that are so far away without ever having to leave Earth. She uses remotely controlled spacecraft and telescopes that send information and images back to Earth. Dr. Buratti knows what information to look for sent from these spacecraft and telescopes and, as a Moon Master, can read the images of the moons as if they were open books. Dr. Buratti believes that in order to achieve dreams and goals of being a part of the great tradition of scientific knowledge and discovery, you need to "start what you finish; if it's worth doing at all it's worth doing well." She now is a Senior Scientist at NASA and not only is a Moon Master, but also is a master of planets, asteroids and other bodies in the solar system.

Many of the moons of our solar system are as interesting as the planets. Our Moon holds clues to how Earth formed. Other moons in the solar system teach us more about the solar system and the Universe as a whole.

Refer to Resource Materials for a full page image showing some of the moons of our solar system:



Discussion Prompt

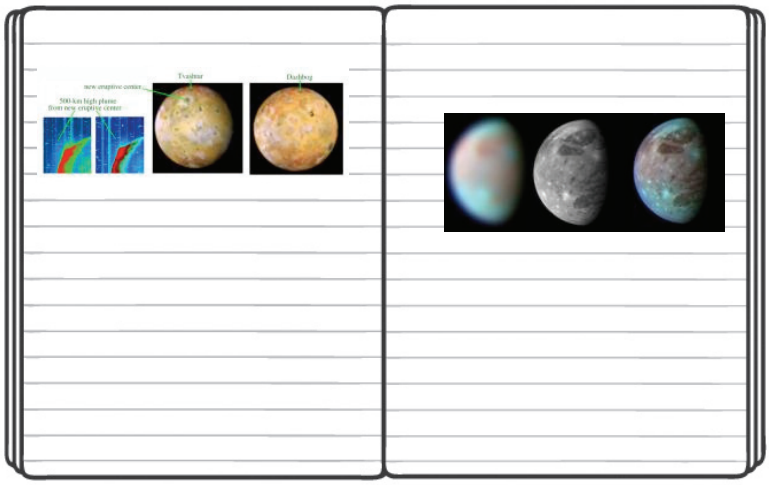
- What do you think of when you look at the Moon in the sky?
- Have you seen the Moon during the daytime? At night? What does it look like?
- What do you think other moons in the solar system look like?
- Did you know that there are many, many moons in the solar system? Saturn and Jupiter each have at least 62 moons orbiting around them.

Science Notebooks

Let's Begin Our Notebook Activity

Science notebooks are important to being a good scientist, because they help you remember what you see and observe, and what you want to know. As you learn new things, you can add them to your notebook.

- When you think about the Moon in the sky, what do you see?
- Now that you know there are other moons in the solar system, what do you think they look like? How big are they? How many do you think there are?
- Think like a scientist and write down what you think you know about the moons of the solar system.
- What do you think a scientist like Dr. Buratti might put in her notebook? Include drawings and illustrations.



Science Word Wall
These are words placed on a blackboard or other wall to get the students to start thinking about these concepts. As they learn more about the solar system, encourage students to add their own.

First Words for the Science Word Wall

scientist, moon, ejecta, depth, deep, shallow, wide, width, weighed, basin, rim, bowl, shaped, exploded, compared, curved, sphere, oval, oblong, diameter, grams, irregular, meteorite, crater, volcano, impact

Making Meaning

What have you learned?

Using the notebooks, ask students to share their words, pictures, ideas, phrases and sentences about moons and what they think they know about the moons in the solar system.

Have students label what they draw in their notebooks.

- What do you think Dr. Buratti might have put in her notebook while she was studying the moons of Saturn or the other planets? What do you think she might write as she receives information from remote telescopes about faraway moons?

Refer to the "What Scientists Do" chart:
- How did this activity help your students think and be like scientists? Compare and contrast the chart with student observations, recording, notebook and discussion activities.

Teacher Pre-Assessment Evaluation

Objectives taught in this lesson may be used to create rubrics for evaluating student writing in notebooks and represent the pre-assessment for this unit.

- There are many moons orbiting the planets in our solar system.
- Earth has one Moon; some other planets (like Jupiter and Saturn) have many moons.
- Moons are very different.
- Moons have different sizes.
- Moons have different shapes.
- Moons have different surface qualities.
- Some moons have a surface that looks like it has fractures or cracks, while other moons have many colors.
- Some moons have lots of craters, some moons have only a few.
- Some moons have craters all over the place, some moons have most of their craters in one area.
- Some moons are covered with ice.
- Some moons have active volcanoes.
- Depending on what caused them, craters are different sizes, depths and shapes.
- Some craters are deep and big, some craters are small and shallow.
- Some craters are even inside other craters!

Standards

National Science Standards

- Physical Science: position and motion of objects
- Physical Science: states of matter
- Earth and Space Science: objects in the sky

National Council of Teachers of English (NCTE) Standards for the English Language Arts

- Students read a wide range of print and nonprint text to build an understanding of nonfiction texts and to acquire new information.
- Students apply a wide range of strategies to comprehend, interpret, evaluate and appreciate texts.
- Students adjust their use of spoken, written and visual language to communicate effectively with a variety of audiences and for different purposes.
- Students employ a wide range of strategies as they write and communicate with different audiences for a variety of purposes.
- Students conduct research by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data to communicate their discoveries.
- Students use spoken, written and visual language to accomplish their own purposes for learning, enjoyment, persuasion and the exchange of information.

Acknowledgments

Dr. Bonnie Buratti, Senior Scientist, NASA's Jet Propulsion Laboratory

Further Exploration

To learn more, please visit these websites:

NASA's Solar System Exploration website —
http://solarsystem.jpl.nasa.gov

This website is a great overview of the solar system and its moons. Cool stuff!
http://solarsystem.nasa.gov/planets/index.cfm

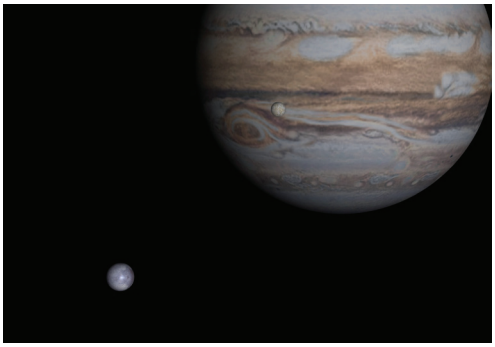
Explore moon images from Saturn taken by the Cassini spacecraft. Cassini continues its mission at Saturn, returning spectacular images. Be sure to go to the Moon menu and browse the images.
http://saturn.jpl.nasa.gov/multimedia/images/images.cfm?categoryID=4

Take a look at Lesson 8 in the Cassini–Huygens curriculum to see another activity on Titan and the other moons of Saturn —
http://saturn.jpl.nasa.gov/education/educationK4Program/educationK4Lit12b/

Download a lithograph of the "Moons of the Solar System" —
http://solarsystem.nasa.gov/multimedia/download-detail.cfm?DL_ID=225

Teacher Background Information (2 pages)

Resource Material **Lesson 4 — Activity 1**



Moons — Many, Many Moons!

The following information is from NASA's "Moons of the Solar System" lithograph series.

Moons come in many shapes, sizes and types. They are generally solid bodies, often with craters, and a few have atmospheres. Most of the moons possibly formed from the discs of gas and dust circulating around planets in the early solar system. Astronomers have found more than 145 moons orbiting planets in our solar system. This number does not include discovered moons that have not yet been officially recognized by the International Astronomical Union (about 20), and it does not include the moons of the "dwarf planets."

Usually the term "moon" brings to mind a spherical object, like Earth's Moon. But the two moons of Mars, Phobos and Deimos, are different. While both have nearly circular orbits and travel close to the plane of the planet's equator, they are lumpy and dark in color. Of the terrestrial (rocky) planets of the inner solar system, neither Mercury nor Venus have any moons at all, Earth has one, and Mars has its two small moons. In the outer solar system, the so-called gas giants (Jupiter, Saturn, Uranus, and Neptune) have many moons. As these planets grew in the early solar system, their large gravitational fields enabled them to capture smaller objects.

Earth's Moon is yet another story. The Moon probably formed when a large body about the size of Mars collided with Earth, ejecting a lot of material from our planet into orbit. Debris from the early Earth and the impacting body accumulated to form the Moon approximately 4.5 billion years ago (the age of the oldest collected lunar rocks). Twelve American astronauts visited the Moon during the Apollo lunar landings (1969–1972) and brought back about 382 kilograms (842 pounds) of lunar rocks for analysis.

Our solar system's largest planet, Jupiter, has 50 confirmed moons and 12 awaiting confirmation, for a total of 62 moons. Many of Jupiter's smallest outer moons have highly elliptical orbits and these small moons orbit "backwards" (opposite to the spin of the planet).

The large moons of Jupiter named Io, Europa, Ganymede and Callisto are distinct worlds. Io is the most volcanically active body in the solar system. Its surface is covered by sulfur in different colorful forms. As Io travels in its orbit, it is caught in a tug-of-war between Jupiter's immense gravity and the gravity of the other three large moons. Tidal heating from friction in Io's interior produces bulges of the solid surface as high as 100 meters (300 feet). The heat that is generated causes Io's intense volcanic activity, driven by hot silicate magma.

Europa's surface is mostly water ice, and there is evidence that it may be covering an ocean of water or slushy ice. Closeup images taken by the Galileo spacecraft of Europa's surface show places where ice has broken up and moved apart, and where liquid may have come from below and frozen smoothly on the surface. The heat needed to melt the ice in a place so far from the Sun is thought to come from inside Europa, resulting from primarily the same type of tidal forces that drive Io's volcanoes. Europa is

thought to have twice as much water as does Earth. This moon intrigues astrobiologists because of its potential for having a "habitable zone." Life forms have been found thriving near subterranean volcanoes and other "extreme" locations on Earth that may be analogues to what may exist on Europa.

Ganymede is the largest moon in the solar system, larger than the planet Mercury, and is the only moon known to have its own internally generated magnetic field. Callisto's surface is heavily cratered and ancient, a record of events from the early history of the solar system. Callisto shows very few small craters, indicating that landslides may be occurring today.

The interiors of Io, Europa and Ganymede have a multilayered structure (as does Earth's interior). Io has a core, and a mantle of at least partially molten rock, topped by a crust of solid rock coated with sulfur compounds. Europa and Ganymede both have a core; a rock envelope around the core; a thick, soft ice layer; and a thin crust of impure water ice. In the case of Europa, the global subsurface water layer probably lies just below the icy crust. Layering at Callisto is less well defined and appears to be mainly a mixture of ice and rock.

Saturn, another moon champion, has 53 officially recognized moons, plus another 9 discovered moons awaiting confirmation. The chunks of ice and rock in Saturn's rings (and the particles in the rings of the other outer planets) are not considered moons, yet embedded in Saturn's rings are distinct, tiny moons. Small "shepherd" moons help keep the particles in the rings in line.

Saturn's moon Titan, the second-largest in the solar system, is the only moon with a thick atmosphere. Titan is so large that it affects the orbits of nearby moons. It hides its surface with a thick, nitrogen-rich atmosphere. This atmosphere is similar to Earth's atmosphere of long ago, before biology took hold on our planet. Hyperion, another of Saturn's moons, has an odd, flattened shape and rotates chaotically, possibly because of a recent collision. Mimas has an enormous crater on one side, the result of an impact that nearly split Mimas apart. Enceladus displays evidence of active ice volcanism: the Cassini spacecraft observed warm fractures where evaporating ice evidently escapes and forms a high cloud of water vapor that feeds one of Saturn's rings.

Uranus has 27 known moons. The inner moons appear to be about half water ice and half rock. Miranda is the most unusual: its chopped-up appearance shows the scars of impacts of large, rocky bodies. Neptune's moon Triton is as big as Pluto, and orbits backwards compared with Neptune's direction of rotation. Neptune has 13 known moons.

The moon numbers change as we discover more moons — check NASA's online solar system information to stay up to date!

For Further Exploration

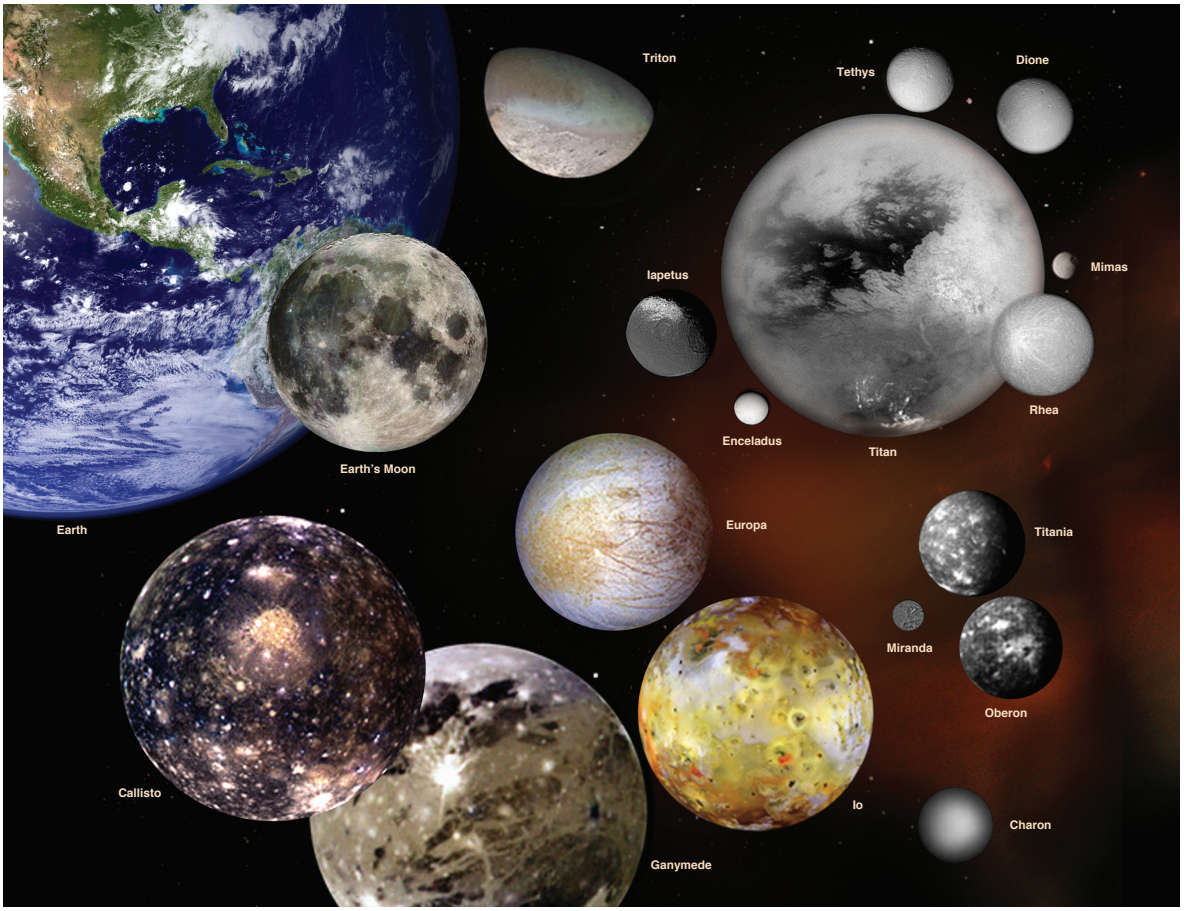
Explore moon images from Saturn taken by the Cassini spacecraft, which continues its mission at Saturn, returning spectacular images. Go to the "About Saturn and Its Moons" menu and browse the images:
http://saturn.jpl.nasa.gov/multimedia/images/images.cfm?categoryID=4

This site is a great overview of the solar system and its moons:
http://solarsystem.nasa.gov/planets/index.cfm

Download a lithograph of "The Moons of the Solar System" from here:
http://solarsystem.nasa.gov/multimedia/download-detail.cfm?DL_ID=225

Earth and some moons of our solar system

1 per student



LESSON 4

Moons — Many, Many Moons!

Activity 2 — Try This!

Activity Time
60 minutes

Create an Impact Crater!

Using Tools to Measure Things Accurately

Our Moon, as well as other moons in our solar system, contains valleys, mountains, volcano sites and many bowl-like holes called craters. Craters are caused by collisions between the Moon and other objects such as asteroids or comets. Explore what happens when objects of different sizes and weights impact on a soft dust-covered surface by creating your own impact crater. Your students will learn about craters and how they affect the surface of moons in our solar system. They will also learn how to accurately measure dimensions like depth and height and learn how to record observations in their notebooks like Dr. Buratti does.

Intended Curriculum

Big Idea

Learning about moons of the solar system through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Science Objectives

Students will:

- Learn how craters are formed and how they differ.
- Learn that there are many moons in the solar system orbiting planets.
- Learn that moons can differ by size, shape, composition, and surface qualities.
- Create a crater model to gain scientific information.

Language Arts Objectives

Students will:

- Collect, record and sort data.
- Synthesize their scientific findings in writing.
- Communicate with their peers to share knowledge of moons.

Math Objectives

Students will:

- Use mathematical tools to measure craters and weigh the objects that made them.
- Formulate questions that can be answered with collected data.

Materials and Teacher Preparation

Materials

- Colored pencils or crayons
- Science Notebooks
- Science Word Wall Chart
- "What Do Scientists Do?" Chart
- Safety goggles (1 pair for each student)
- Low cardboard boxes or plastic tub, one for each of your student groups
- Newspaper for covering desks or floor
- Flour (enough for a 4- to 5-inch layer in each box)
- Cornmeal (enough for ¼-inch layer)
- Cocoa powder (enough for a light sprinkle)
- Yardsticks
- Centimeter rulers, one for each pair of students
- Yardstick
- Ping-pong ball, golf ball and other objects of varying sizes and weights

Teacher Tip

For various objects, consider using marbles, oranges, tennis balls, ping-pong balls, cue balls, grapefruit or other round ball-shaped objects. Also, try using irregular shapes such as small rocks and see what happens.

Teacher Preparation

Instruct students to wear safety goggles and how to put them on. Prepare a pan or box for your crater model, which you will demonstrate for the students. Start with a 4- to 5-inch layer of flour in your pan or box. Next, sprinkle about ¼ inch of cornmeal on the flour. Lastly, sprinkle a light layer of cocoa on the cornmeal. The three layers allow students to see more detail as they create craters. Collect objects of different size and weight and gather other materials listed. Distribute safety goggles to each student to prevent impact dust from getting into eyes.

Lesson Procedure

- Set up a "Craters" transparency to show students how to record data for an impact crater.
- Tell students that you will demonstrate how to make a model of an impact crater and how to record and illustrate the results. Explain that they will be doing the same activity in pairs or small groups later on.
- Ask students to stand where they can see your model. Begin your modeling by deciding with your students if your golf ball is large or small (hint: it's small!) and if it is light or heavy (hint: for its size, it's relatively heavy!).
- Drop the golf ball from about 3 feet into the flour/cocoa/cornmeal mixture. Use a yardstick to indicate a height of 3 feet. Ask students what they see!
- Carefully remove the object, and model how to measure the depth and width of the crater in centimeters using a ruler. Record information on the "Craters" transparency you set up for the demonstration.
- Discuss key terms so your students understand the terms as they relate to the crater model.
- Model how to draw a crater, highlighting the shape of the rim, the size of the crater, how to shade sections to indicate depth, etc. Label your drawing.
- Have students form pairs or small groups and have them take out their notebooks.
- Distribute a golf ball, ping-pong ball and two other objects to students. Have them determine the weight and size of each of the objects and record it in their notebooks
- Tell students to gently drop the objects from about 3 feet.

- Remind students that after each object is dropped, they will measure the width and depth of the craters they have formed, record their findings in their notebooks and draw the crater before moving on to dropping the next object.
- Show selected notebook pages from various students' notebooks. Begin discussion about craters and what they recorded.

Math/Science Enrichment (Optional)

Lesson Time 30 minutes

This enrichment activity allows students the opportunity to predict weights and learn to weigh objects using a balance scale and gram weights.

Materials and Teacher Preparation

Use materials from the activity described above, but also locate:

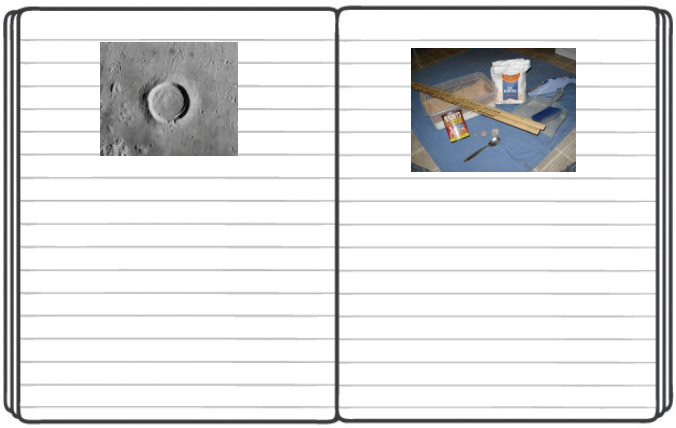
- Balance scale
- Gram weights

Procedure

- Set up a chart labeled "What do our objects really weigh?"
- Set up the balance scale so that the class can observe and participate in the weighing of the materials.
- Pass around a gram weight so students can experience what a gram weight feels like. This can be a medium paper clip.
- Pass around one of the small objects, have students predict the weight, and while the class observes, weigh the object and then record the object's name and its weight on the chart paper.
- Continue procedure with the other spheres, smallest to largest, having the class participate in the actual weighing whenever possible.
- Keep the chart paper posted. As students experiment with their crater models, have students enter into their notebooks the recorded weights for the objects.

Science Notebooks

Let's Begin Our Notebook Activity



Notebooks are really important to being a good scientist, because they help you remember what you see, observe, measure and record.

- What did you learn about craters? What did they weigh?
- What are some things you noticed when dropping objects of different weights into the flour mixture?
- What do the craters you created look like? How are they similar to the ones found on a real moon? How are they different?
- What do you think Dr. Buratti would include in her notebook about craters? Include drawings and illustrations.

Acknowledgments

Dr. Bonnie Buratti, Senior Scientist, NASA's Jet Propulsion Laboratory —
http://science.jpl.nasa.gov/people/Buratti/

Further Exploration

To learn more about moons of the solar system, visit here —
http://solarsystem.nasa.gov/planets/index.cfm

Cratering in your classroom —
http://stardust.jpl.nasa.gov/classroom/activities/1-stardst-ch01.pdf

NASA's moons of the solar system page —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=SolarSys&Display=Moons

LESSON 4

Moons — Many, Many Moons!

Activity 3 — Do This!

Activity Time
30 minutes

Introduction for Teachers

This activity examines scientific images from NASA missions on a "Gallery Walk."

Intended Curriculum

Big Idea

Learning about moons of the solar system through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Science Objectives

Students will:

- Learn that there are many moons orbiting the planets in the solar system.
- Learn that moons can differ by size, shape, composition and surface qualities.
- Learn how craters are formed and how they differ.

Language Arts Objectives

Students will:

- Collect, record and sort data.
- Synthesize their scientific findings in writing.
- Communicate with their peers to share knowledge of moons.

Math Objectives

Students will—

- Formulate questions that can be answered with collected data.

Materials and Teacher Preparation

Teacher Tip

Print comparative moon size chart and moon images and glue on individual sheets of the chart paper for the Gallery Walk.

Materials

- 1 chart showing different sizes of moons in our solar system (See Resource Materials)
- 4 images of other moons (See Resource Materials)
- 9 pieces of chart paper for mounting images

Lesson Procedure

- Post the four mounted images of Earth's Moon on the board and the four images of other moons around the classroom and read the captions to or with your class.
- Explain to students that they will be working in groups. Each group will take a Gallery Walk, view all eight images and add their ideas in writing about each one in their notebooks.

- Begin with Earth's Moon:
  —What are some of the features of the Moon?
  —What are the different phases of our Moon?
  —How big is our Moon compared to (1) Earth and (2) other moons?
- Talk with students about the difference in sizes of the moons. Which is the biggest? Which is the smallest?
- Divide students into four groups and determine who will record ideas for each group.
- Direct students to discuss their ideas after the Gallery Walk and choose one idea that best represents the image they are looking at. Write one idea from each group under the image on the chart paper. After each group has added comments, lead students in a whole-class summary discussion of the images and the comments. Add any new information or ideas from your discussion of the diverse nature of moons in our solar system.
- Post the images and comments in your classroom on the board.

Teacher Tip

You may want to use Post-its to capture student writing and then edit as needed for a final copy of your moon "posters" for display in the classroom.

Discussion Prompt

Family Enrichment Activity

We are fortunate to have our very own Moon visible to us here on Earth. Stepping outside to observe it makes a great way for students to involve their families in their learning. With this in mind, we have attached a letter for you to send home encouraging a shared look into the sky. (Please see a copy of a sample letter in Resource Materials.) Please edit as needed and send home with your students. We know your students will enjoy being the lunar expert in their families!

Assessment

Use your students' writing and discussions to tell you what your students observed and the degree to which they have understood the big ideas about moons. Some key concepts that students need to know are listed below:

Checklist for Student Learning

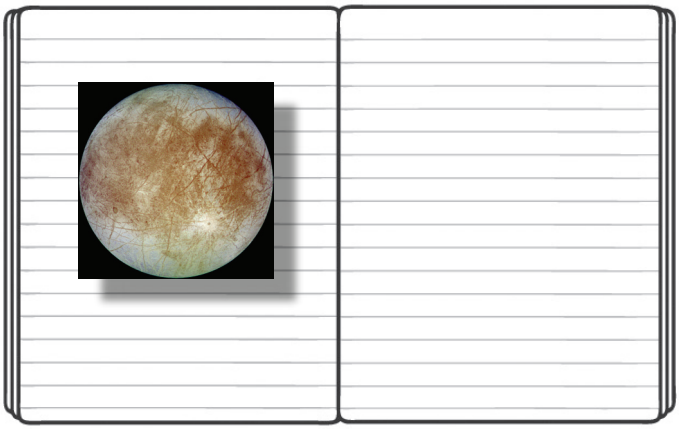
- There are many moons orbiting planets in our solar system.
- Earth has one Moon and some other planets, like Jupiter and Saturn, have many moons.
- Moons are very different.
- Moons have different sizes.
- Moons have different shapes.
- Moons have different surface qualities.
- Some moons have a surface that looks like it has fractures or cracks. Other moons have many colors. Some moons may even have oceans of liquid water beneath their icy surfaces. (See artist's concept of Jupiter's moon Europa at the end of this activity.)
- Some moons have lots of craters, some moons have only a few.
- Some moons have craters all over the place, some moons have most of their craters in one area.
- Some moons are covered with ice.
- Some moons have active volcanoes.
- Depending on what caused them, craters are different sizes, depths and shapes.
- Some craters are deep and big, some craters are small and shallow.
- Some craters are even inside other craters!

Science Notebooks

Let's Begin Our Notebook Activity

Direct students to write about the images they saw on the gallery walk. Include drawings and illustrations. Instruct students to label their findings in their notebooks.

What would Dr. Buratti include in her notebook as she looks at images of moons sent from faraway telescopes?



Science Word Wall Additions

surface, debris, elliptical, orbits, astrobiology, Ganymede, Io, Europa, Enceladus

Making Meaning

Have students refer to their science notebooks.

What have you learned?

- We have many moons orbiting planets in our solar system.
- We on Earth have one Moon and other planets, like Jupiter and Saturn, have many moons.
- Moons are very different.
- Moons have different sizes. (Refer to Resource Material at the end of this lesson for a chart showing comparative sizes of moons in our solar system.)
- Moons have different shapes.
- Moons have different surface qualities.
- Some moons have a surface that looks like it has fractures or cracks. Other moons have many colors. Some moons may even have oceans of liquid water beneath their icy surfaces. (See artist's concept of Jupiter's moon Europa at the end of this activity.)
- Some moons have lots of craters, some moons have only a few.
- Some moons have craters all over their surfaces, while some moons have most of their craters in one area.
- Some moons are covered with ice.

- Some moons have active volcanoes.
- Depending on what caused them, craters are different sizes, depths and shapes.
- Some craters are deep and big, some craters are small and shallow.
- Some craters are even inside other craters!

Acknowledgments

Dr. Bonnie Buratti, Senior Scientist, NASA's Jet Propulsion Laboratory

Further Exploration

The "International Year of Astronomy " site provides references for how to get out and observe the Moon and other bodies in our celestial neighborhood —
http://astronomy2009.nasa.gov/observe_feb.htm

More about Earth's Moon —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Moon

More about Ganymede —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Jup_Ganymede

More about Io —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Jup_Io

More about Europa —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Jup_Europa

More about Enceladus —
http://solarsystem.nasa.gov/planets/profile.cfm?Object=Sat_Enceladus

Sample letter encouraging students to view Earth's Moon.

Dear Parents,

We have been studying the moons in the solar system in our class. We are making models of the craters on moons and learning a lot in math as well as science.

This is a wonderful opportunity for your child to take a better look at our own beautiful Moon during the day and with you in the evening. Together, you might want to step outside to see if you can find the Moon and see what it looks like. Perhaps your child can spot some real craters and he/she can share how they made their crater model and what they have learned about moons so far. Sharing this new information with someone is so valuable in helping young students cement new knowledge.

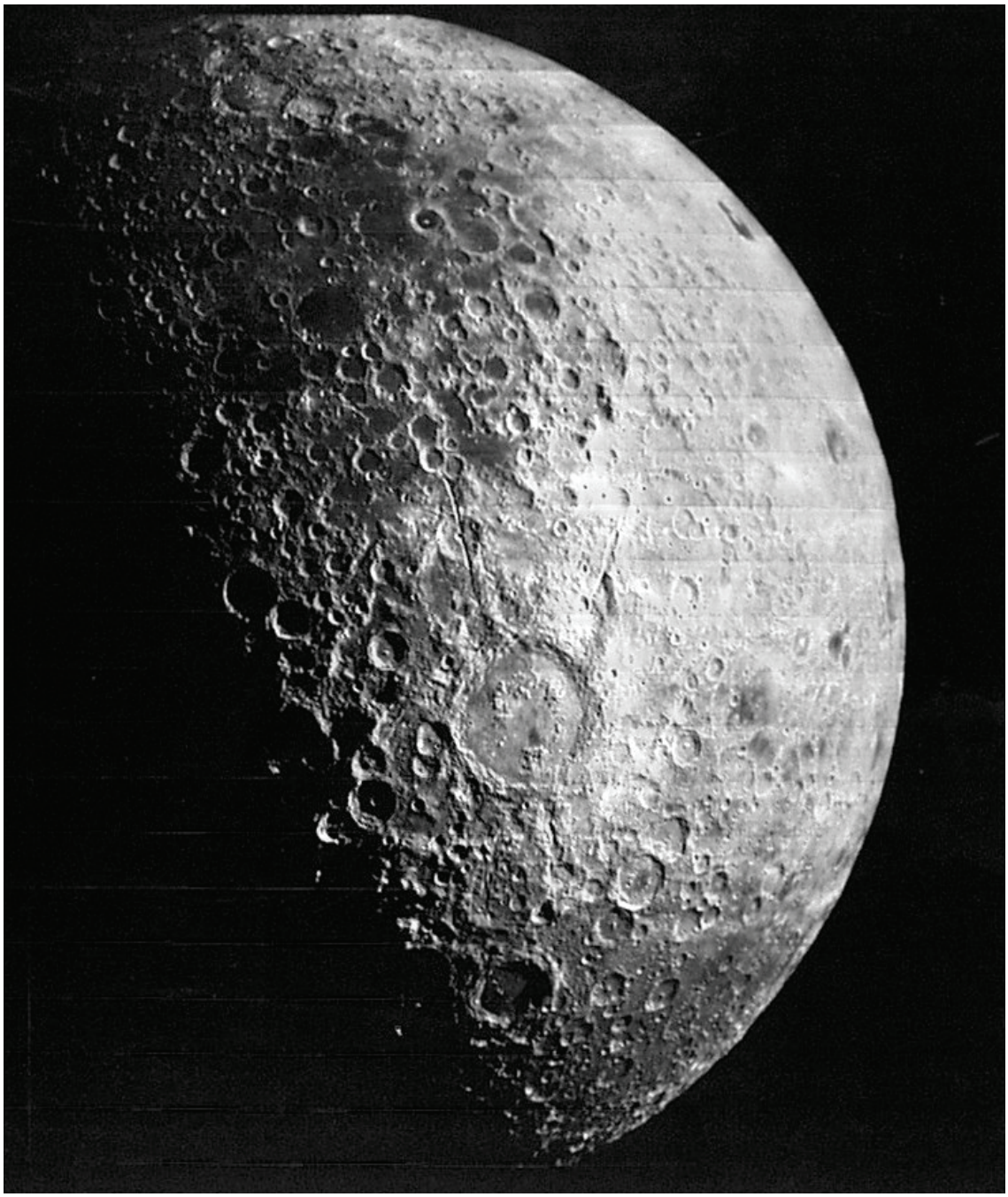
Here's a wonderful website for children to learn more about the solar system and space science — *http://kids.msfc.nasa.gov*

It's a place to have lots of fun while they learn! Enjoy!

Sincerely,

Illustration showing varying sizes of moons of the solar system

NASA moon images: Earth's Moon

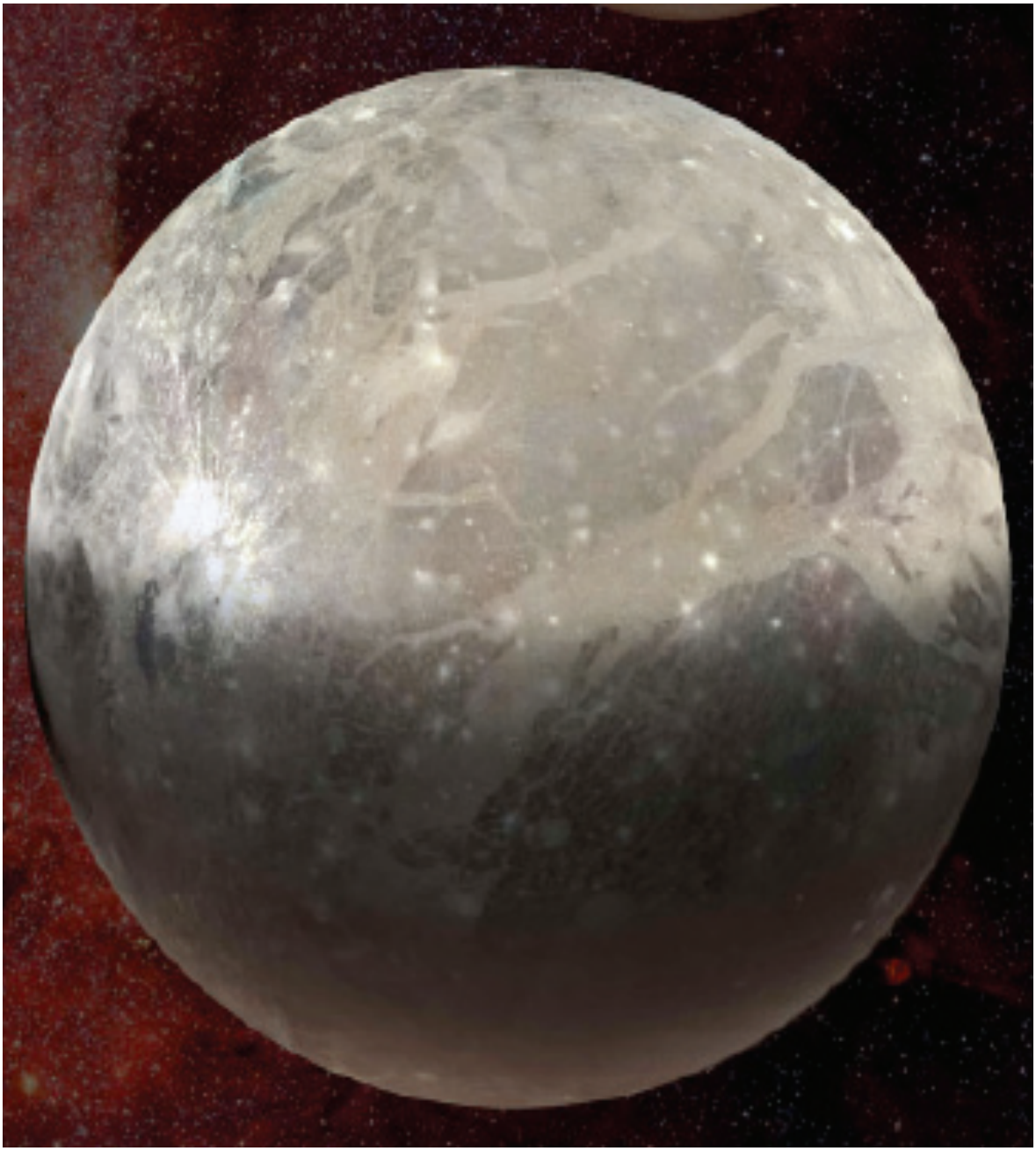


NASA moon images: Earth's Moon

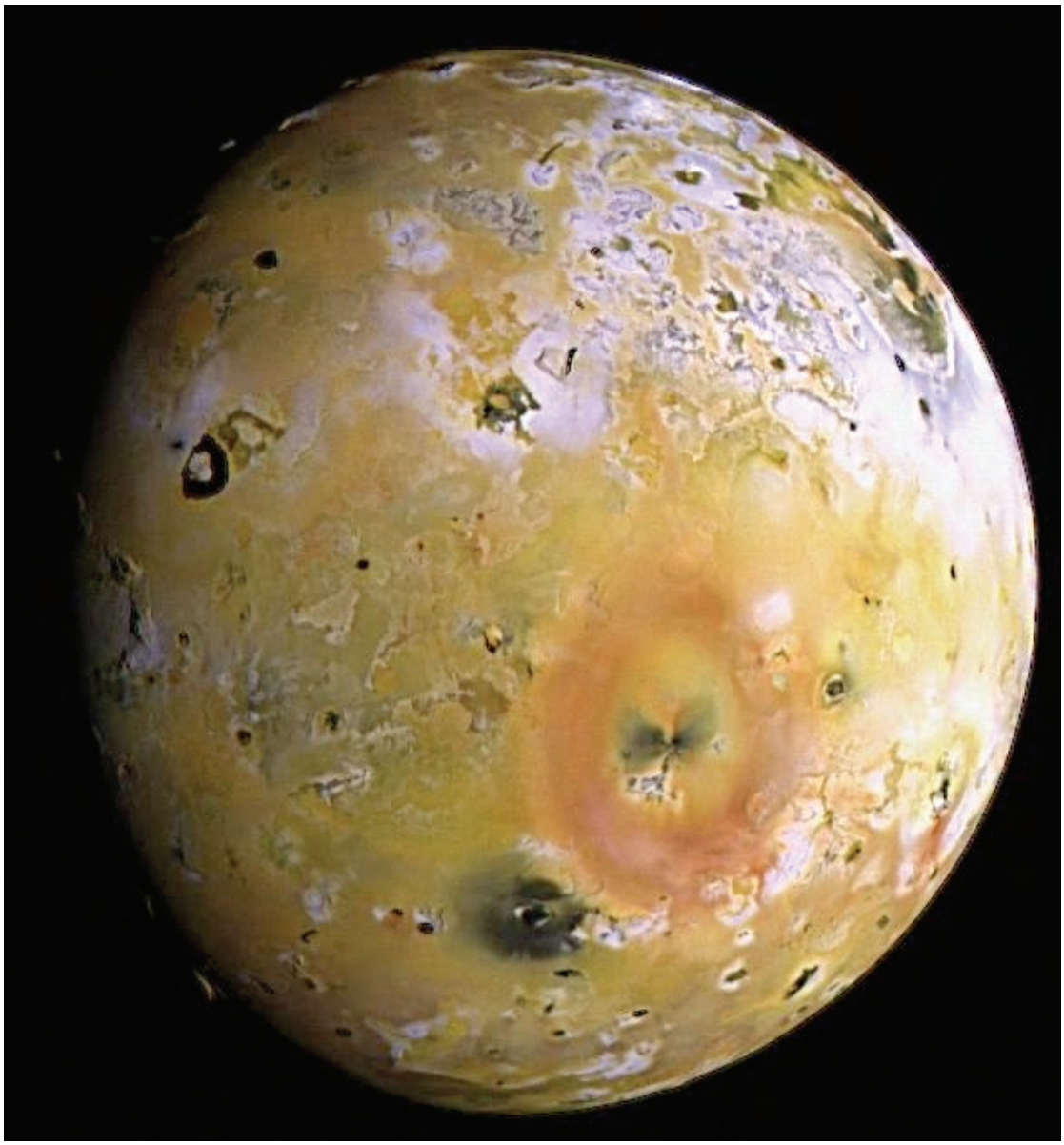
NASA moon images: Earth's Moon

NASA moon images: Earth and its Moon

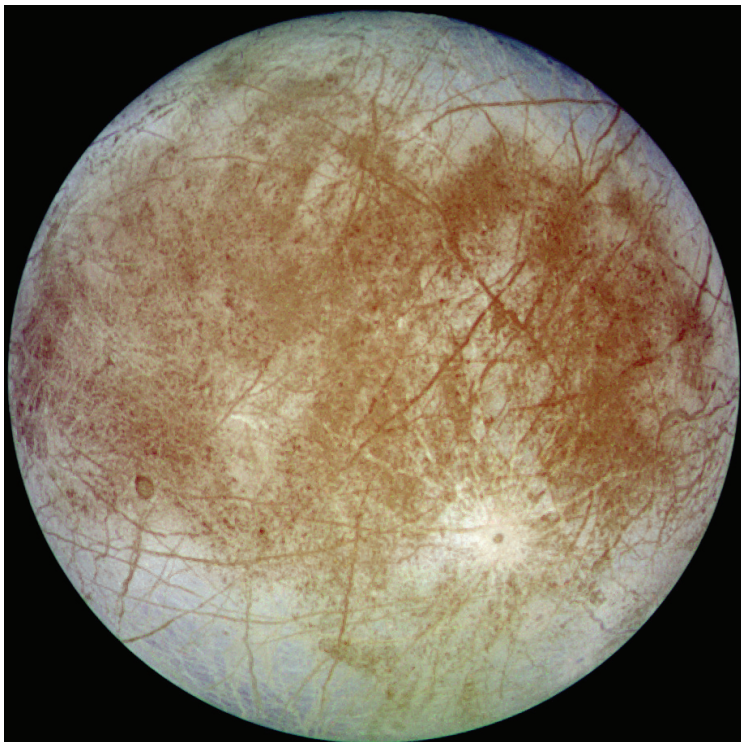
NASA moon images: Ganymede



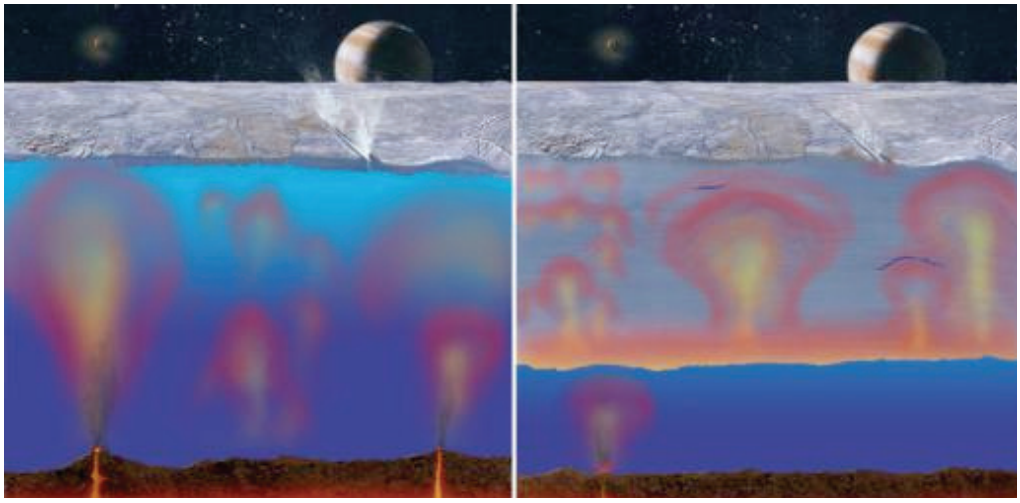
NASA moon images: Io



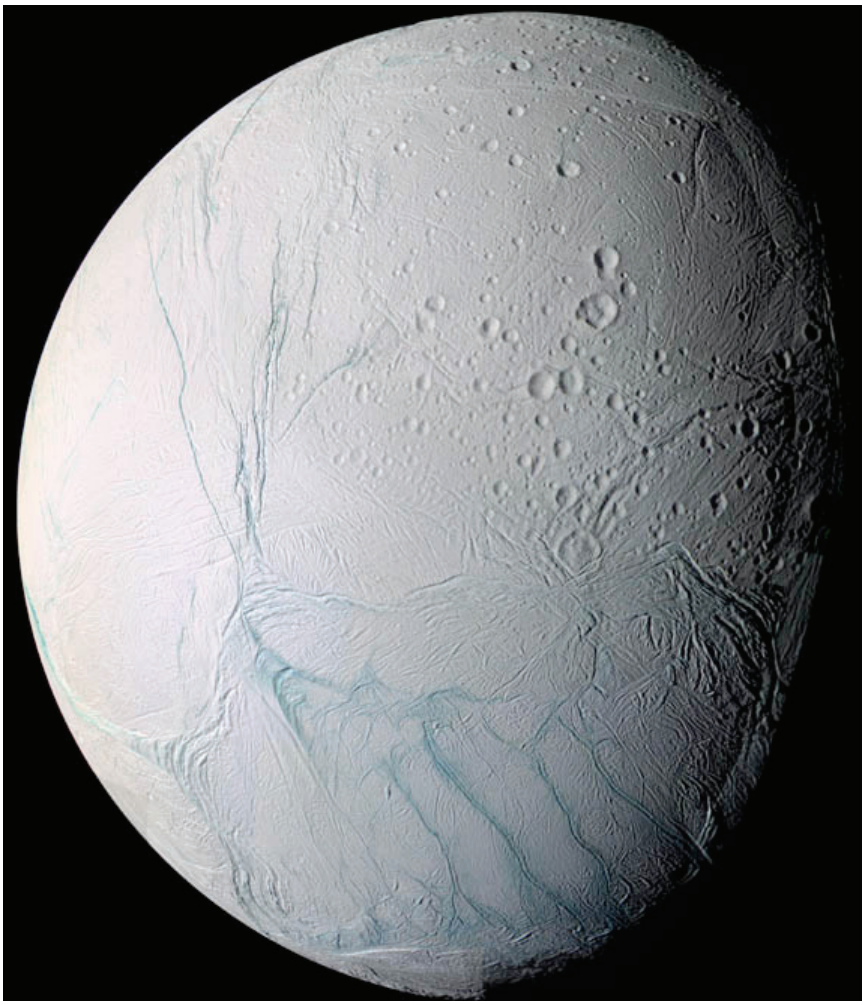
NASA moon images: Europa



Europa's subsurface ocean



NASA moon images: Enceladus



LESSON 4

Moons — Many, Many Moons!

Activity 4 — Read All About It!

Activity Time
30 minutes

Intended Curriculum

Big Idea

Learning about moons of our solar system through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Science Objectives

Students will:

- Learn that there are many moons orbiting planets in the solar system.
- Learn that moons can differ by size, shape, composition and surface qualities.
- Learn how craters are formed and how they differ.

Language Arts Objectives

Students will:

- Collect, record and sort data.
- Synthesize their scientific findings in writing.
- Communicate with their peers to share knowledge of moons.

Materials and Teacher Preparation

- A copy of "Moons — Many, Many Moons!" reader for each student
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart

Teacher Preparation

- Make copies of the "Moons — Many, Many Moons!" reader for each student.
- Have other materials ready.

Lesson Procedure

- Distribute a reader to each student and read it aloud.
- Explain key terms like orbits, moons, craters, volcanoes (refer to Lesson 5) and satellites, and how Dr. Buratti might define these terms.

Moons — Many, Many Moons! reader (3 pages)

1 per student

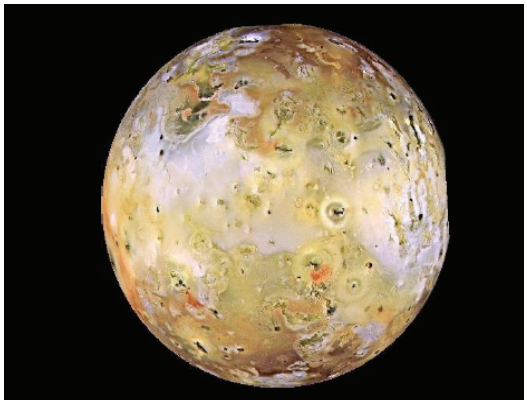
Moons — Many, Many Moons!

Planet Earth has one Moon that we see in the sky. Sometimes it looks like a half moon. Sometimes it looks like a big, beautiful full moon. We see it at night and in the daytime. We see it in different ways because it orbits Earth and reflects light from the Sun. Scientist and Moon Master Dr. Bonnie Buratti was a very young student when she began studying our Moon, and she began to wonder about the moons of other planets in the solar system. How big are they? What are they made of? She discovered that each moon in the solar system is different. Some planets have dozens of moons, while others have none.

Half-moon and Earth in day and night.

Different Planets, Different Moons

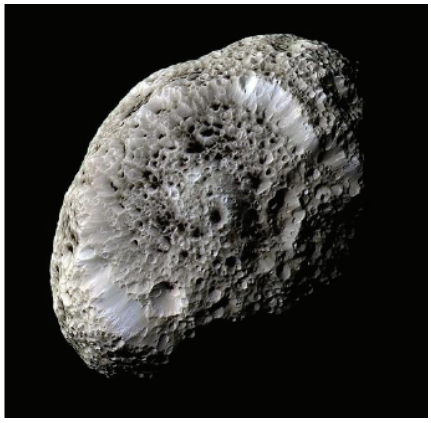
Some moons are like our Moon. Others are very different from our Moon. Can you imagine a moon that is covered with volcanoes? Jupiter's moon Io has hundreds of volcanoes that cover the ground with yellow sulfur. Many moons in the solar system have volcanoes, while others are covered with ice. One of Saturn's moons, Titan, has an atmosphere.



Jupiter's volcanic moon, Io. Jupiter has at least 62 moons.

Moon Shapes

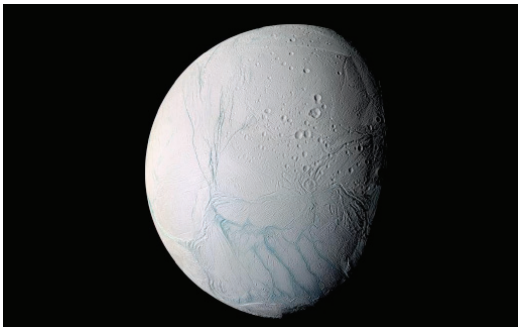
Moons can be round. They can also be odd-shaped, like a potato. Saturn's moon, Hyperion, is one of those moons. Not only is its shape odd, but it's covered in craters. How do you think it got that way? Moons can be big, bigger than the size of Earth, or small, just a few miles across. All moons orbit a planet. And each planet orbits the Sun. Dr. Buratti studies images from Hyperion and many other moons. Each image tells its own story!



Hyperion is a heavily cratered moon.

Volcanoes, Geysers, Ice

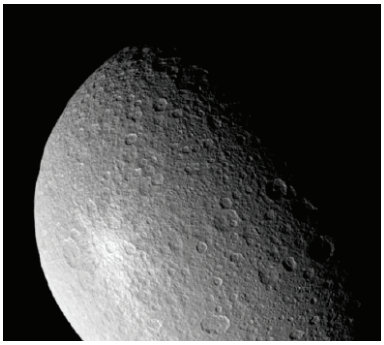
Enceladus is one of Saturn's many moons. It is covered in ice. Near the bottom of the picture to the right, you can see lines that scientists call tiger paws. These lines have geysers. Much like a volcano, these geysers spits out ice into space. The geyser adds ice to one of Saturn's many rings. Could the ice begin as water under the moon's surface?



Enceladus is active, has water ice and adds ice to one of Saturn's many rings.

Lots of Craters

The one thing that moons have in common is craters. Lots and lots of craters. Craters on moons and planets are caused by meteors hitting their surfaces. When it hits, the meteor can send dust, dirt and rocks flying out of the crater. This is called ejecta. Craters can tell scientists about the history of the moon.



Rhea is a cratered moon of Saturn.

Even More Craters

Scientists like Dr. Buratti are very interested in craters… especially the huge crater on Mimas. It is one of the largest craters in the solar system. Can you see it? It is 88 miles wide! There is a huge mountain right in the middle of the crater that is almost as high as Earth's highest mountain, Mt. Everest. Scientists can tell Mimas has had a long history of impact craters.

Can you tell?

Mimas is another moon circling Saturn.

LESSON 4

Moons — Many, Many Moons!

Activity 5 — Amazing Moons

Activity Time
45 minutes

Write the Story!

Introduction for Teachers

What have your students learned about our Moon and other moons of the solar system? Help your students write a compare and contrast essay. What is the most amazing thing your students have learned about moons? Students can use their science notebooks to write about what they now understand about Earth's Moon and many of the other moons in the solar system, based on their own observations and thinking about the different activities from this lesson.

Intended Curriculum

Big Idea

Learning about moons of our solar system through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Science Objectives

Students will:

- Synthesize all the scientific information they have learned about moons through the eyes of Dr. Bonnie Buratti.

Language Arts Objectives

Students will:

- Read and understand information.
- Reflect on and recognize their own learning through notebooks.
- Use accurate language to communicate their scientific understanding orally and in writing.

Materials and Teacher Preparation

Materials

- One copy of the "Moons — Many, Many Moons!" reader for each student
- Science Notebooks
- Solar System Folder for each student
- Science Word Wall Chart

Teacher Preparation

- Make a copy of the "Moons — Many, Many Moons!" reader for each student.

Lesson Procedure

- Hand out a copy of the "Moons — Many, Many Moons!" reader to each student.
- Select students to re-read "Moons — Many, Many Moons!" aloud to the rest of the class.
- Review the Science Word Wall and ask students to refer to their notebooks to help define the words and add new ones.
- Discuss Dr. Buratti's work. (Refer to her biography in the first activity of this lesson.)
- Direct students to write about what they think is the most amazing thing about moons.

- Also, direct students to write one thing they learned about our Moon and the moons around other planets. Encourage them to draw pictures.

Science Notebooks

Let's Begin Our Notebook Activity

Science notebooks are important to being a good scientist, because they help you remember what you see and observe, and what you want to know. As you learn new things, you can add them to your notebook.

Direct students to go back to the first page of their notebooks:

- What did you think about when you saw the Moon in the sky? What did you know and wonder about it?
- Did you know that there are moons orbiting around other planets in the solar system?
- Did you know that some moons have ice and others have volcanoes and craters?

Then direct students to go to the last page of their notebooks:

- What do you know about Dr. Buratti and her work studying moons?
- What are some new things you have learned about moons?
- What are some things you have learned about our Moon compared with other moons in the solar system?

Teacher Post-Assessment Evaluation

Concepts taught in this lesson can be used to create rubrics for evaluating student writing and comprehension through their notebooks.

Use the student writing and discussion to assess the extent to which they accurately observed and understood key concepts about moons through the eyes of Scientist–Moon Master, Dr. Bonnie Buratti.

Key Concepts

- There are many moons orbiting planets in our solar system.
- Earth has one Moon, but some and other planets, like Jupiter and Saturn, have many moons.
- Moons are very different.
- Moons have different sizes.
- Moons have different shapes.
- Moons have different surface qualities.
- Some moons have a surface that looks like it has fractures or cracks. Other moons have many colors. Some moons may even have oceans of liquid water beneath their icy surfaces. (See artist's concept of a possible ocean on Jupiter's moon Europa at the end of Activity 3 in this lesson.)
- Some moons have lots of craters, some moons have only a few.
- Some moons have craters all over the place, some moons have most of their craters in one area.
- Some moons are covered with ice.
- Some moons have active volcanoes.
- Depending on what caused them, craters are different sizes, depths and shapes.
- Some craters are deep and big, some craters are small and shallow.
- Some craters are even inside other craters!

"WHAT SCIENTISTS DO" CHART

What do I do that is like Dr. Bonnie Buratti?

Predictions About What Scientists Do	What Scientists Do	How We Were Like Scientists
Find answers	Often work in groups	Worked in groups
Work in labs	Ask questions	Collected data, wrote in notebooks
Invent things	Read other scientists' work	Used evidence to discuss what we saw
Mix things together	When they disagree, they look for more evidence	Discussed observations and read books by other scientists