

Exploring Our Solar System

A Closer Look at Astronomy

Students are exposed to a lot of information, both fact and fiction, about space. Space exploration and scientific discoveries often show up in the news, and aliens and other sci-fi myths make appearances in countless movies and TV shows. Consequently, students are curious about outer space. The *Exploring Our Solar System* Teacher Guide serves to fuel further exploration of astronomy. By using this guide, you have an opportunity to tap into high student interest while exposing students to broader scientific issues.

Participation in these lessons will lead students to make global connections and understand higher-level concepts, such as Earth's place in the solar system and the composition and characteristics of planets and other objects in outer space. Students will become aware of some of the issues involved in space exploration and classification of space objects. They will begin to realize just how expansive and intricate our universe really is.

The lesson plans in this guide are tailored for grades 4-6 and address various subjects, such as science, language arts, mathematics, and social studies. Each lesson plan is designed to stand alone. As such, they do not need to be presented in sequential order. Helpful reproducible worksheets appear at the end of the guide. The book titles referenced in this guide include:

Galaxies

Space Probes

Gas Giants

Star Spotters

Hot Planets

The Earth

Ice Dwarfs

The Moon

Mars

The Stars

Mighty Megaplanets

The Sun

As students investigate the topics addressed in the guide and become more aware of the characteristics of Earth, our solar system, and the Milky Way galaxy, they will sharpen their critical thinking skills to work towards creative solutions to worldwide problems. We invite you to jump in and ask questions with your class as you have fun learning more about the solar system.



National Standards Correlation

Lesson Plan Title	Correlation to National Standards
Inventing the Night Sky	<p>Language Arts Students read a wide range of literature from many periods in many genres to build an understanding of the many dimensions (e.g., philosophical, ethical, aesthetic) of human experience. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.</p> <p>Science Students should develop an understanding of the history of science. Students should develop an understanding of Earth in the solar system.</p> <p>Social Studies The learner can compare similarities and differences in the ways groups, societies, and cultures meet human needs and concerns.</p>
Creating a Crater	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Mathematics Students should select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles.</p> <p>Science Students should develop an understanding of motions and forces. Students should develop an understanding of structure of the earth system.</p>
Round and Round We Go	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Science Students should develop abilities necessary to do scientific inquiry. Students should develop an understanding of Earth in the solar system.</p> <p>Social Studies Students create elaborate mental maps of locales, regions, and the world that demonstrate understanding of relative location, direction, size, and shape.</p>
Getting Into the Outer Solar System	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Science Students should develop abilities necessary to do scientific inquiry. Students should develop an understanding of Earth in the solar system.</p>

Lesson Plan Title	Correlation to National Standards
<p>Black Holes: Fact and Fiction</p>	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Students 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.</p> <p>Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.</p> <p>Science Students should develop abilities necessary to do scientific inquiry.</p>
<p>A Trip to Mars</p>	<p>Language Arts Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.</p> <p>Students 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.</p> <p>Science Students should develop an understanding of the history of science. Students should develop an understanding about science and technology.</p> <p>Social Studies The learner can interpret, use, and distinguish various representations of the earth, such as maps, globes, and photographs.</p>
<p>What's Inside?</p>	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Science Students should develop an understanding of properties and changes of properties in matter. Students should develop an understanding of Earth in the solar system.</p> <p>Social Studies The learner can interpret, use, and distinguish various representations of the earth, such as maps, globes, and photographs.</p>
<p>A Closer Look</p>	<p>Language Arts Students read a wide range of print and nonprint texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.</p> <p>Science Students should develop abilities of technological design. Students should develop understandings about science and technology.</p>

For state specific educational standards, please visit www.crabtreebooks.com

Overview and Scope of Lesson Plan Activities

Lesson Plan Title	Subject Areas	Major Concepts
Inventing the Night Sky	Language Arts Science Social Studies	<ul style="list-style-type: none"> • constellations • myths and legends
Creating a Crater	Language Arts Math Science	<ul style="list-style-type: none"> • craters • meteor impact
Round and Round We Go	Language Arts Math Science Social Studies	<ul style="list-style-type: none"> • Earth's rotation and revolution • creation of shadows • making predictions and observations
Getting Into the Outer Solar System	Language Arts Science	<ul style="list-style-type: none"> • Trans-Neptunian Objects • meteors and comets
Black Holes: Fact and Fiction	Language Arts Science	<ul style="list-style-type: none"> • black holes • galaxies • writing science fiction
A Trip to Mars	Language Arts Science Social Studies	<ul style="list-style-type: none"> • space probes • Mars • using interactive map tools
What's Inside?	Language Arts Science Social Studies	<ul style="list-style-type: none"> • composition of planets • making models
A Closer Look	Language Arts Science	<ul style="list-style-type: none"> • refractor telescopes • building telescopes

Pacing Chart and Vocabulary

One class period is approximately 40 minutes.

Lesson Plan Title	Pacing	Vocabulary	Assessment
Inventing the Night Sky	1–2 class periods	asterism constellation culture legend	Evaluate student drawings and legends for completeness and creativity, and check student reproducibles for accuracy.
Creating a Crater	1 class period	collide crater impact meteor	Monitor student participation during the activity and evaluate student reproducibles for comprehension of major concepts.
Round and Round We Go	1–2 class periods	axis revolution rotation	Evaluate student reproducibles for understanding of major concepts.
Getting Into the Outer Solar System	1–2 class periods	comet dwarf planet Trans-Neptunian Object	Monitor student pairs for participation and evaluate student reproducibles for completion and accuracy.
Black Holes: Fact and Fiction	1–2 class periods	barred spiral black hole Milky Way galaxy nebula	Evaluate student reproducibles for accuracy and student stories for completion and creativity.
A Trip to Mars	2 class periods	atmosphere landscape space probe	Evaluate student posters and presentations for accuracy and completeness.
What's Inside?	1–2 class periods	composition core crust mantle	Evaluate student models and reproducibles for accuracy.
A Closer Look	2 class periods	eyepiece lens objective lens refractor telescopes	Evaluate student telescopes for functionality and reproducibles for detail and accuracy.

Inventing the Night Sky

A Lesson on Constellations

Content

Students will learn about constellations. They will identify and make representations of constellations from different traditions and learn the stories behind them. Using this knowledge, students will also create their own constellation and story.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of literature from many periods in many genres to build an understanding of the many dimensions (e.g., philosophical, ethical, aesthetic) of human experience.

Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Science:

Students should develop an understanding of the history of science.

Students should develop an understanding of Earth in the solar system.

Social Studies:

The learner can compare similarities and differences in the ways groups, societies, and cultures meet human needs and concerns.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Linguistic



Visual-Spatial

Prerequisites

Students should read the book *The Stars*, paying special attention to pages 12–13 to familiarize themselves with the definition and characteristics of constellations.

Materials

- *The Stars* books
- large star chart
- student copies of the *Inventing the Night Sky* reproducible
- computers with Internet access, or other research resources
- black construction paper
- white crayons
- glue

Instructional Procedure

Anticipatory Set

Show students the star chart. Ask student volunteers to point out familiar *constellations*, or star patterns, on the chart. Then ask students to name some other constellations they are familiar with. Write their answers on the board. Tell students that many constellations have myths behind them. Explain to students an example of one constellation's *legend*—for example, the constellation Orion looks like the outline of a man. Orion was the son of a poor shepherd, and he was a very strong hunter. One day he offered to kill all the animals on Earth, which upset Gaia, the earth goddess and mother of all animals. She sent a scorpion to attack Orion, and now Orion's figure is just a shape in the stars. Then ask students if they can explain any other myths that are associated with the constellations.

Class Discussion

Ask: *Who named the constellations and invented the myths behind them?* (ancient peoples) Then have students explain why constellations were important to ancient *cultures*. (The night sky acted like a calendar. By keeping track of when constellations appeared in the sky, people knew when to plant seeds and harvest crops.) Explain that while students are likely familiar with some of the constellations named by the ancient Greeks and Romans—such as Orion, Cassiopeia, and Ursa Major and Ursa Minor—other ancient peoples also named constellations and created stories to explain their existence. For example, the Chinese, Indians, and many Native American tribes had constellation legends. People everywhere used stories to explain natural phenomena.

Then explain that some familiar star patterns aren't really constellations. They are called *asterisms*. Have students use their *The Stars* books to describe what asterisms are. (star patterns

Objectives

The student will be able to...

- describe the multicultural origins of constellation myths
- understand the importance of constellations to ancient peoples

that are parts of larger constellations) A famous example is the Big Dipper, which is part of the constellation Ursa Major. Ask a student volunteer to locate the Big Dipper on the star chart.

Activity

Part I: Constellations of Different Cultures

Divide students into small groups. Assign each group a non-Greek/Roman ancient tradition, such as Lakota, Shawnee, or Chinese. Tell students that, using Internet or library resources, they will learn about a constellation legend from another tradition. As a class, brainstorm some ideas for research strategies, including good search terms to use as they investigate their topics. Some search terms students may want to use are: *constellation myths*; *legends*; *myths about the stars*; and the name of students' assigned traditions. As students research, have them complete the *Inventing the Night Sky* reproducible. When they are finished, have volunteers present their findings to the class.

Part II: Do-It-Yourself Constellations

Give each student a piece of black construction paper and a white crayon. Tell students to randomly make 10 dots on the paper. Then have students look at their dots and connect them with lines to make a recognizable shape. Next, have students create a brief legend to explain how their constellation came to be. Remind students to use the legends from other cultures they've learned about as models for creating their own legends. Students should record their legend on a piece of notebook paper and use glue to attach it to the picture. Ask volunteers to present their pictures and stories to the class. Display the pictures in the classroom.

Accommodations and Extensions

For Part I, read the students a story from another culture about a constellation legend and have them fill out the reproducible based on what they heard. For Part II, have students work in pairs to make their drawings and create their legends.

As an extension, have students work in their groups to create a skit based on the constellation legend they research. Have them write a script, rehearse their skit, and then present their skits in front of the class.

Closure

Make sure that students understand that although constellation legends have no basis in scientific fact, they are valuable for what they show us about culture they came from. Ask students to describe the similarities they discovered between the stories they researched and the ones they heard other groups present from different traditions. Then explain that these myths may explain the constellations that ancient people saw, but the constellations may not look like that forever. This is because even though the stars seem like they are standing still, stars are actually always in motion. This means that the appearances of constellations change over time. Have students look at page 13 in *The Stars* for an example.

Assessment

Evaluate student drawings for completeness and creativity, and student reproducibles for accuracy.

Creating a Crater

A Lesson on Meteor Impact and Crater Formation

Content

Students will learn about the characteristics and creation of craters by dropping marbles into sand to represent a meteor impact.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Mathematics

Students should select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles.

Science

Students should develop an understanding of motions and forces.

Students should develop an understanding of structure of the earth system.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Prerequisites

Students should read the books *Hot Planets* and *The Moon*, paying special attention to page 16 of *Hot Planets* and pages 20–21 of *The Moon*.

Materials

- *Hot Planets* and *The Moon* books
- a few small rubber balls
- a few golf balls
- a few small rocks with rough surfaces
- student copies of the *Creating a Crater* reproducible
- small plastic tubs filled with sand (1 per group)
- flour in small cups
- marbles or small balls of different sizes (3 per group)
- rulers (1 per group)

Instructional Procedure

Anticipatory Set

Have students pass the rubber balls around the classroom, and ask them to describe the surface of the rubber balls. (smooth, even, hard) Then pass around the golf balls and have students describe their surfaces. (smooth but covered by small holes that are all the same size) Pass the rocks around, and ask students to describe the surfaces of the rocks. (rough, jagged, uneven) Have students discuss the differences between the surfaces of each object. Then ask students which object they think is most similar to the surface of the Moon. Tell students that the Moon may have been smooth like the rubber balls when it was first formed billions of years ago, but it is now more rough and jagged like the rocks. And although it has holes in the surface, like the golf balls, the holes are of all different shapes and sizes. Tell students these holes are called *craters*, and millions of them cover the surface of the Moon and planets like Mercury and Mars.

Class Discussion

Have students refer to their *Hot Planets* and *The Moon* books to describe what the surfaces of Mercury and the Moon look like. (They are gray; some parts of them are smooth but some parts are rocky; there are ditches, holes, and valleys, and sometimes mountains.) Explain to students that these holes and valleys are craters. Have students refer to their books to describe how craters are created. (Meteors hit the surface at high speeds.) Tell students that *meteors* are rocks that fly through space and sometimes *collide* with planets or other things in space. Explain

Objectives

The student will be able to...

- describe the way craters are formed by meteor impact
- understand how the size and speed of a meteor affect the characteristics of a crater
- represent the creation of a crater by making a model

that meteors can be different sizes, which means craters can be different sizes, ranging from a few inches to a few miles. Have students refer to page 16 of their *Hot Planets* books to describe how a meteor *impact* can create a crater. (The meteor falls at a high speed and crashes into the surface of the planet, which blows a hole into the surface and spreads the material from the hole all around the crater.)

Then explain to students that the crater shown on page 16, called the Caloris Basin, has a special shape—it looks like a bulls-eye. Have students describe what gives this crater its special characteristics. (The material from the middle of the crater was blown out by the force of the meteor, but some of that material collected in a circular rim around the edge of the hole. Some of the material bounced back down to the surface after the first blast.) Then explain that some craters have other special features. Have students turn to page 20 of their *The Moon* books, and ask them to describe what rays are. (streaks of lighter-colored materials on the surface that were formed by the material that sprayed out when meteors struck) Tell students that the creation of rays, along with many other characteristics of craters, depend on the size, speed, and distance of the meteors that make them.

Activity

Tell students they are going to create their own craters with marble “meteors.” Distribute the *Creating a Crater* reproducibles. Divide students into groups of three, and give each group a small plastic tub filled with sand, a small cup of flour, three different-sized marbles, and a ruler. Have students sprinkle the flour evenly over the surface of their sand. Then tell students that they are going to create craters by dropping their marbles into the sand. Tell students that they will use different-sized marbles to see how the size of the meteor affects the size of the crater, and they will also test to see how the speed (force used) and distance of the meteor affects the size of the crater. Make sure students take turns dropping the marbles, and ensure that they test each size of marble at each height (6 inches and 18 inches) and at each speed (gently dropping the marble and throwing the marble down more forcefully). After each marble is tested, students should carefully remove their marble from the sand and observe the crater that was formed, using their rulers to measure the width and depth of the craters. Have students describe the craters, including any special features that were formed, such as rims, rays, or basins with bulls-eye appearances. Have students record their results on the reproducibles.

Accommodations and Extensions

Perform the meteor experiment as an entire class. Have student volunteers come to the front of the class to drop each marble into the tub, and then discuss the results as a class. Help students complete their reproducibles as you go.

As an extension, have students create an illustrated explanation of how various craters (a small crater, a large crater, a bulls-eye shaped crater, and a crater surrounded by rays) are formed. Tell students to write out the steps of the creation of a crater and draw a picture for each step. Make sure students include the sizes and speeds of the meteors in each explanation.

Closure

Discuss the results of the experiment as a class. Have volunteers describe how the size of the marbles, the height from which they were dropped, and the force used affected the size and shape of the craters. (The bigger marbles went deeper and spread out more sand and flour than the smaller ones, and they were more likely to make rays. Also, the more force you used to throw down the marble, the deeper the crater and the more likely that it formed rays and bulls-eye shaped craters. This is also true about the height—the greater the height, the bigger and deeper the crater.) Then ask students how this information helps them understand the craters on Mercury and on the Moon. (The craters on the Moon are all different sizes, so that means that meteors of many different sizes created them. It also means that meteors travelling with more force hit the Moon to create rays. Also, craters like the Caloris Basin were probably made by large meteors that were moving very quickly or with a lot of force.) Tell students that most craters on the Moon and on Mercury were formed billions of years ago, but meteors still occasionally strike today.

Assessment

Monitor student participation during the activity and evaluate student reproducibles for comprehension of major concepts.

Round and Round We Go

A Lesson on Earth's Rotation

Content

Students will learn that the Earth rotates once on its axis every 24 hours, causing day and night, and that the position of the Earth relative to the sun changes during its rotation. To gain a more concrete understanding of this, students will measure the shadow of a fixed object throughout the day.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Mathematics

Students should select and apply appropriate standard units and tools to measure length, area, volume, weight, time, temperature, and the size of angles.

Science

Students should develop abilities necessary to do scientific inquiry.

Students should develop an understanding of Earth in the solar system.

Social Studies

Students create elaborate mental maps of locales, regions, and the world that demonstrate understanding of relative location, direction, size, and shape.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Objectives

The student will be able to...

- explain the rotation and revolution of the Earth
- describe the connection between the appearance of a shadow and the location of the sun
- identify how and why shadows change depending on time of day

Prerequisites

Students should read the book *The Earth* to familiarize themselves with how the Earth moves through space.

Materials

- *The Earth* books
- student copies of the *Round and Round We Go* reproducible
- chalkboard and chalk or whiteboard and markers
- coffee cans (1 per 2 students)
- rulers (1 per 2 students)
- yardsticks (1 per 2 students)
- rocks or sand
- pencils

Instructional Procedure

Anticipatory Set

Ask students where the sun appears to be at sunrise, noon, and sunset. (in the east; straight overhead; in the west) Next, ask students what causes day and night. (Students may mention the terms *rotation* and *revolution*.) Show rotation: Ask a student volunteer to stand in place and represent the sun. Ask another student to stand a few feet away from the sun and slowly spin in place to represent the Earth. Explain that this is how the Earth rotates, or turns on its *axis*. Ask students how long it takes for the Earth to make one full rotation. (24 hours) Then ask students how rotation is different from revolution. (Rotation is the Earth spinning on its axis, and revolution is the Earth traveling around the sun.) Ask students how long it takes Earth to revolve around the sun. (one year) To illustrate a revolution, ask the student representing the Earth to walk in a circle around the student representing the sun. Explain that the Earth is always both rotating and revolving. Ask the student representing the Earth to slowly and carefully spin and circle the sun simultaneously.

Class Discussion

Explain to students that during the day, our side of Earth faces the sun, and at night, our side of Earth faces away from the sun. Ask students what causes darkness at night. (When our side of the Earth is facing away from the sun, the Earth's own shadow causes it to be dark.)

Remind students that a shadow occurs when an object gets between the sun and the Earth. As Earth rotates, sunlight shines on the object at different angles. This causes the position and length of the shadow to change. Ask students how time of day might affect shadows. (At different times of day, the sun hits the

Earth at different angles, so that would change the length and position of the shadows.) Remind students to think about where the sun appears in the sky at different points in the day, and ask them how this might affect shadows.

Activity

Distribute the *Round and Round We Go* reproducible to each student, and tell them to fill out Part I. Ask volunteers for their predictions and write them on the board.

Divide students into pairs. Give each pair a ruler, a coffee can, some rocks or sand, and a yardstick. Have students fill the bottom of the can with the rocks or sand and place their ruler into the can so that it stands straight up.

On a sunny morning, go outside to an open area. Remind students not to look directly at sun. Instruct students to place their coffee can in an open area away from buildings, trees, and playground equipment. On their reproducibles, students should note the time of day and describe where the sun is in the sky. Next, tell students to use the yardstick to measure the length of the ruler's shadow. Also have them record the position of the shadow relative to the can. Have students record this data on Part II of their reproducibles.

Student pairs should repeat these measurements around noon and again later in the afternoon, taking turns measuring and recording data. Once students have completed their last measurements, have them complete Part III of the reproducible.

Accommodations and Extensions

Do the activity as an entire class. Discuss predictions as a class. Then set up a coffee can and ruler outside, and have student volunteers take turns measuring the data for the class to record.

As an extension, have students research and create sundials. Try the lessons available at <http://www.sundials.co.uk/projects.htm> find other plans in the library or on the Internet.

Closure

As a class, review students' observations. Ask: *When were the shadows shortest?* (The shadows were shortest at noon.) *Why?* (That is when our spot on Earth rotated so that the sun appears to be highest in the sky.) Compare this answer to students' predictions. Then ask students to describe what happened to the location of the shadows throughout the day. (They moved around the can.) Discuss what caused the shadows to move. (The Earth rotated while the sun remained in the same place.) Ask how the information they learned about shadows could be useful to people. (People could use this knowledge to tell time.) Note that sundials operate on this principle. Revisit the question about the location of the sun every morning and evening. Ask if the sun really moves from the east in the morning to the west in the evening. (No, the Earth moves, not the sun.)

Assessment

Evaluate student reproducibles for understanding of major concepts.

Getting Into the Outer Solar System

A Lesson on Trans-Neptunian Objects, Asteroids, Meteoroids, and Comets

Content

Students will learn about the composition and other characteristics of Trans-Neptunian Objects (TNOs), asteroids, meteoroids, and comets.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Science

Students should develop abilities necessary to do scientific inquiry.

Students should develop an understanding of Earth in the solar system.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Prerequisites

Students should read the book *Ice Dwarfs* to familiarize themselves with the characteristics of TNOs, asteroids, meteoroids, and comets.

Materials

- *Ice Dwarfs* books
- photos of meteor showers (like that shown on page 26 of *Ice Dwarfs*)
- student copies of the *Getting Into the Outer Solar System* reproducible
- index cards (10 per pair)
- pencils

Instructional Procedure

Anticipatory Set

Show students the photos of meteor showers. Ask students what they think these photographs show. (Students may say meteor showers or falling stars.) Explain that these are meteors, which usually are too far away to be seen but can sometimes be seen in “showers” like this when they get close enough to Earth. Ask students to describe some other objects in space that can be seen with bare eyes. (planets, stars, comets) Explain that there are some objects in space that are much too far away to be seen without the use of a strong telescope.

Class Discussion

Ask students how many planets are in our solar system. (8) Then tell students that from the time it was recognized in 1930 until recently, Pluto was classified as the ninth planet in our solar system. But in 2006, the International Astronomical Union defined what a planet is, and Pluto failed to meet the definition. Ask students to describe what they think is the definition of a planet. Then tell students that under the new rules, a planet in our solar system needs to meet three criteria: It has enough mass to be spherical; it orbits the sun; it has control of its own orbit. Explain that because Pluto does not control its own orbit, it was reclassified as a *dwarf planet*. Dwarf planets are just one type of TNO, or *Trans-Neptunian Object*. Ask students to refer to their *Ice Dwarfs* books to explain what Trans-Neptunian means. (beyond the planet Neptune)

Tell students that there are other smaller TNOs, as well as things like *comets* and meteoroids, that travel through deep space. Ask students to refer to their books to describe what deep space is

Objectives

The student will be able to...

- identify objects in our solar system such as dwarf planets, asteroids, meteoroids, and comets
- describe the characteristics of these objects
- contrast dwarf planets and planets

like. (It is very cold and very dark because it is so far away from the sun.) Then have students describe how the temperature of deep space affects the makeup of TNOs. (It is thought that since deep space is so cold, TNOs are made of ice and rock.) Explain to students that even though many strange objects are classified as TNOs, they each have unique characteristics.

Activity

Part I: Compare What's Out There

Distribute the *Getting into the Outer Solar System* reproducible. Have students use the information in their *Ice Dwarfs* books to complete the chart.

Part II: Name that Outer Space Object

Divide the class into pairs. Give each pair ten index cards, and have them write the following terms on the cards (one term per card): *Ceres, Eris, Pluto, Comet, Halley's Comet, Meteoroid, Asteroid, Dwarf Planet, Oort Cloud, Kuiper Belt*. Then have students stack their index cards face-down in a pile. Have the first student choose a card from the deck. That student (Student A) should read the card silently. Student B will then ask Student A yes or no questions to try to figure out what TNO or comet is on the card. Examples of questions are as follows: "Does it have an atmosphere?" and "Does it contain metal?" After several questions, Student B should guess what the TNO or object is. If necessary, students may refer to the *Getting Into the Outer Solar System* reproducible for help.

Have students switch roles and repeat the process with a new card from the deck. Repeat as time allows.

Accommodations and Extensions

Students can refer to their *Ice Dwarfs* books as they play the *Name that Outer Space Object* game. If students still can't guess the object after four questions, have the student with the card start giving hints about the object.

As an extension, have students turn the *Name that Outer Space Object* game cards into flash cards by writing key facts about the TNO, asteroid, meteoroid, or comet on the blank side of the index card. Have students quiz each other about the objects using the flash cards.

Closure

As a class, review some of the characteristics of each of the objects listed in the chart and the game. Make sure students understand that although scientists know a lot about these celestial objects, there is still much that is unknown. Scientists hope that new space missions will teach us valuable information about TNOs, asteroids, meteoroids, and comets.

Assessment

Monitor student pairs for participation and evaluate student reproducibles for completion and accuracy.

Black Holes: Fact and Fiction

A Lesson on Black Holes

Content

Students will learn about galaxies and identify myths and facts about black holes. They will then write a science fiction story that involves a black hole.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Students 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.

Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Science

Students should develop abilities necessary to do scientific inquiry.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Prerequisites

Students should read the book *Galaxies* to learn about what makes up a galaxy. They should pay particular attention to the sections on black holes.

Materials

- *Galaxies* books
- photocopied pictures of the Milky Way (1 per student)
- transparency sheet and overhead projector
- chalkboard and chalk or whiteboard and markers
- student copies of the *Black Holes: Fact and Fiction* reproducible
- computers with Internet access (if available)
- markers or colored pencils (optional)

Instructional Procedure

Anticipatory Set

Before the lesson, find a clear image of the *Milky Way galaxy* online. Print it out, make a copy for each student, and make a copy on a transparency sheet. Display the image by using an overhead projector, and give each student a copy as well. Tell them that they are looking at an image of the Milky Way galaxy, and ask them to identify its shape. (*barred spiral*) On their pictures, have students label the bar (at the galaxy's core) and the approximate position of our solar system (on the Orion arm). Encourage students to look in their *Galaxies* books for the answers. Have volunteers share their answers by pointing at the appropriate spots on the projected image of the Milky Way.

Class Discussion

Ask students to use their *Galaxies* books to make a list of parts of the Milky Way galaxy, and have them record their list on the back of their Milky Way pictures. When they are finished, have them share their answers. (stars, *nebulas*, a *black hole*, galactic halo, star streams) As students provide their answers, ensure that they have a basic understanding of each part of the Milky Way galaxy by asking the following questions: *What is a galaxy?* (an enormous group of stars) *How big is the Milky Way galaxy?* (average size, with about 200–400 billion stars) *How and where do stars form in the Milky Way?* (in giant clouds of gas and dust, called *nebulas*) *What lies in the core of the Milky Way?* (a black hole) *What is the galactic halo?* (a group of globular clusters outside the main body of the Milky Way) *What are galactic star streams?* (the remains of smaller galaxies and star clusters near the Milky Way that were ripped apart by the Milky Way's gravity)

Objectives

The student will be able to...

- identify myths and untruths about *black holes*
- explain what black holes are and how they work
- write a science fiction story that involves a black hole

Activity

Part I: Finding the Facts

Give each student a copy of the *Black Holes: Fact and Fiction* reproducible. Tell students that black holes, which are thought to be at the center of all galaxies, are the subject of a lot of speculation, myth, and science fiction. Ask students why this might be the case. (Black holes are mysterious, invisible, and very powerful.) Have student volunteers share examples of things they've heard about black holes in books, movies, or elsewhere. (Students may have heard that the sun will turn into a black hole, that a black hole will swallow the universe, that black holes can transport people to other universes, etc.) Write these ideas on the board, and have students list them on the left-hand side of their reproducibles.

Then have students use their *Galaxies* books to create a list of facts about black holes. (They are dense points of matter; their strong gravity prevents light from escaping; the smallest ones have 10 times as much mass as the sun; they are fed by discs of spinning material from stars drawn toward them.) Record these facts on the board, and have students write them on the right-hand side of their reproducibles. If possible, have students use the Internet to find evidence to refute any of the "myths" that they were unable to disprove with information from their *Galaxies* books.

Part II: Writing a Story

Next, ask students to choose one of the myths they wrote down, or make up a new one. Have them use the myth as the basis for a short story that involves a black hole. For example, they might write about what happens on Earth when the sun turns into a black hole, or about the adventure of a young boy or girl who travels through a black hole and emerges in another time or place. The story should be 1–3 pages long, and it should have a beginning, middle, and end. Students may also illustrate their stories with markers or colored pencils if they desire.

Accommodations and Extensions

As a class, brainstorm about what will happen at the beginning, middle, and end of the story. Then have students work in pairs to write their stories based on these ideas.

As an extension, have students do further research on various topics related to black holes, such as event horizons, the Schwarzschild radius, or singularity. Ask students to write a paragraph about their findings and share them with the class.

Closure

Have student volunteers share their stories with the class. After each story, have the listeners identify parts of the story related to black holes that were fact-based and parts that were fictional.

Assessment

Evaluate student reproducibles for accuracy and student stories for completion and creativity.

A Trip to Mars

A Lesson on the Exploration and Features of Mars

Content

Students will learn about the many space probes that have studied Mars, in addition to the information these probes have given us about the planet. They will then use an interactive map tool to conduct further research, and share their findings in the form of posters and presentations.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Students 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.

Science

Students should develop an understanding of the history of science.

Students should develop an understanding about science and technology.

Social Studies

The learner can interpret, use, and distinguish various representations of the earth, such as maps, globes, and photographs.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Objectives

The student will be able to...

- identify and discuss the *space probes* that have studied Mars
- understand features of Mars's landscape and atmosphere
- use an interactive map tool to explore Mars, and share their findings by making posters and doing presentations

Prerequisites

Students should read the book *Space Probes* to learn about the history of space exploration. They should pay special attention to pages 14–15, which focus on the exploration of Mars. Students should also read the book *Mars* to learn about the planet's landscape, atmosphere, and features.

Materials

- *Space Probes* and *Mars* books
- chalkboard and chalk or whiteboard and markers
- computers with Internet access (1 per 2 students)
- student copies of the *A Trip to Mars* reproducible
- poster board (1 per 2 students)
- colored pencils or markers

Instructional Procedure

Anticipatory Set

In a horizontal line across the top the board, write the following names of spacecraft that have studied Mars: Mariner, Viking, Pathfinder, Sojourner, Spirit, Opportunity, MSL, Mars Space Probe, and Phoenix. Ask students what all of these *space probes* have in common. (They have all studied Mars.) Then ask students to refer to their *Mars* and *Space Probes* books to find a few facts about each space probe. Have volunteers share their answers, and record them on the board under the appropriate names.

Sample answers are as follows:

Mariner U.S. Mariner 4 of 1964–1965 was first successful space probe to Mars; flew past Mars and took pictures; sent pictures to Earth and then moved into deep space

Viking first robot explorer on Mars; two probes landed in 1976; had no wheels; tested atmosphere and soil for life on Mars

Pathfinder 1997 mission was first to land safely using airbags; first to land wheeled rover (the Sojourner) safely

Sojourner first rover to land on Mars (part of 1997 Pathfinder mission); about the size of a microwave; explored for 83 Martian days and then lost contact

Spirit 6-wheeled Rover; has explored parts of Mars since 2004; has taken pictures and rock samples; uses solar panels

Opportunity 6-wheeled Rover; has explored parts of Mars since 2004; has taken pictures and rock samples; uses solar panels; landed on what was once a coastal area

MSL (Mars Surface Laboratory) larger rover than Spirit and Opportunity; uses a power system because solar panels are often covered in Mars's dust

Mars Express Space Probe 2005, took picture of impact crater that has drift of water-ice inside

Phoenix built to explore conditions in polar regions; contains solar panels and robot arm that can dig down to where ice meets soil—where living things might be found

Class Discussion

Tell students that the space probes that have studied Mars have helped us learn a lot about the planet, especially its *landscape* and *atmosphere*. Ask: *How would you describe the surface of Mars?* (smooth on the northern half; lots of craters on the southern half) Have students use their *Mars* books to explain the cause of these features. (Mars was hit by space rocks billions of years ago, which created millions of craters. Then volcanoes in the north spewed out lava, which buried most of the craters in the northern half.) Point out that the surface rocks on Mars are made mostly of basalt, which reveals the planet's history of volcanic eruptions. Ask: *What color is Mars, and why?* (It's red because the iron-rich soil reacts with oxygen to form a coating of rust.) Then ask students what else they know about the landscape or atmosphere of Mars, including features such as craters, sand dunes, dust storms, atmospheric composition, volcanoes, valleys, and poles. Encourage students to refer to their books for details.

Activity

Ask students if they are familiar with Google Earth, the interactive map provided by the search engine company Google. Most students have probably used Google Earth to look at maps, find directions, or see pictures. Tell them that Google also has a tool called Google Mars. This tool allows users to explore and zoom in on a shaded relief map of Mars, and click on topographical features to learn more about them.

Give each student a copy of the *A Trip to Mars* reproducible, divide students into pairs, and make sure each pair has a computer with Internet access. Ask students to go to Google Mars: www.google.com/mars. When everyone is at the site, show students how to use the mouse to move around the map and zoom in and out. Point out the feature at the bottom left that explains the color-coding, and then draw students' attention to the hot links at the top left. Show students that if you click on one of the links, such as *craters*, you will see a list of the craters on Mars, in addition to icons on the map showing the location of each crater. If you highlight an icon, a window pops up with facts about the crater. Some of the windows contain links that you can click to access more background information and images.

Assign each pair one of the features listed as a link: spacecraft, mountains, canyons, dunes, plains, ridges, craters. It's okay if more than one pair is assigned the same feature. Ask students to explore 3 examples of the feature they are assigned, such as 3 craters or 3 canyons. They should find each example on the map, read the information window about each one, and follow any links in the windows. Have them use the *A Trip to Mars* reproducible to take notes on each example. Then, give each

pair poster board and colored pencils or markers, and have them make a poster that includes the following information: a title, interesting facts about the 3 examples; pictures of the 3 examples (hand-drawn or downloaded).

Accommodations and Extensions

Have students work in mixed-ability pairs, and ask them to research 1 or 2 examples of their assigned feature, rather than 3.

As an extension, have students write a short research paper about the feature they are studying. Encourage them to use 3 online sources other than Google Mars to gather information about their feature. Then, have them present their findings in a 1–2 page essay. Review the guidelines for citing sources.

Closure

When students finish making their posters, have them present them to the class. Make sure all students participate in the presentations. Afterward, hang the posters around the room to create a classroom display about Mars.

Assessment

Evaluate student posters and presentations for accuracy and completeness.

What's Inside?

A Lesson on the Composition of Planets

Content

Students will learn about the material composition of rocky planets and gas planets. Using this knowledge, they will build models of both types of planets and compare and contrast characteristics of the two.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Science

Students should develop an understanding of properties and changes of properties in matter.

Students should develop an understanding of Earth in the solar system.

Social Studies

The learner can interpret, use, and distinguish various representations of the earth, such as maps, globes, and photographs.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Prerequisites

Students should read the books in the *Exploring Our Solar System* series to familiarize themselves with the characteristics of rocky planets and gas planets. Students should also have a basic understanding of the states of matter (solid, liquid, gas).

Materials

- *The Earth, Mighty Megaplanets, Gas Giants, and Hot Planets* books
- chalkboard and chalk or whiteboard and markers
- student copies of the *What's Inside?* reproducible
- clay of seven different colors (suggestions: red, orange, yellow, blue, white, black, gray)
- small container of sand
- dental floss

Instructional Procedure

Anticipatory Set

Ask students to name the three states of matter. (solid, liquid, gas) Ask: *What state of matter do you think is most common on the surface of rocky planets?* (solid) *What about gas planets?* (gas) Then have students reread page 5 of *Hot Planets*, page 5 of *Mighty Megaplanets*, and page 6 of *Gas Giants*. Write “Rocky Planets” and “Gas Planets” on the board. Have students classify each of the eight planets in our solar system into those two categories, and list their responses on the board under the two category names.

Class Discussion

Remind students that although we aren't completely sure what's inside the planets, scientists have pretty good ideas about the planets' *composition*, or what they are made of. Have students refer to their *The Earth* books and ask them what is in the center of the Earth. (the *core*, which is a very hot ball of mostly iron) Ask: *What surrounds the core of the Earth?* (the *mantle*, which is a very hot liquid) Have students describe the consistency of the outer mantle. (It is thick, like syrup.) Then ask: *What is the surface of the Earth like?* (It is called the *crust*, and it is a thin solid layer.) Explain that most of the rocky planets have compositions similar to that of Earth. Then ask students how the composition of gas planets is similar to and different from the composition of rocky planets. (Both types have solid cores, but gas planets have layers of liquids and gas instead of liquids and solids; the surfaces of gas planets are not solid so you couldn't walk on them.)

Objectives

The student will be able to...

- describe the material composition of the Earth and other planets
- compare and contrast physical characteristics of rocky planets and gas planets
- represent the composition of Earth and of a gas planet by making models

Activity

Part I: Compare Composition

Distribute the *What's Inside?* reproducible. Have students complete the *Comparing Composition* chart on the top of the page. They should use the information from on page 5 of *Hot Planets*, page 5 of *Mighty Megaplanets*, and page 6 of *Gas Giants* to help them fill in the details.

Part II: Make Models

Once students have completed their charts, give each student a small piece of clay of each color. Tell them that they will be making models of planets to show the layers inside, and that they should use a different color of clay for each layer they make.

Students should first make their model of Earth. Have students start with the core, which should be a small clay ball. Help students as they make each layer (core, mantle, outer mantle) from a different color of clay. Remind students that the layers are not all the same thickness, and that they should try to represent the correct thicknesses of the layers as shown in the diagrams in the books. For the crust, have students roll their balls of clay in sand to coat the outside.

Then have students repeat the process for their next planet, which should be a gas planet of their choice. Tell them to use the diagrams in *Mighty Megaplanets* and *Gas Giants* as a guide to making the layers. Remind them that since the gas planets don't have crusts, they won't need sand for this model.

Tell students that in order to see the layers of their planets, they will need to cut them in half. Guide students as they wrap a piece of dental floss around their models and pull through to cut each sphere neatly in half. Once students can clearly see the layers of each model, have them fill in the color code guide at the bottom of the *What's Inside?* reproducible.

Accommodations and Extensions

Divide students into pairs to complete the chart on the reproducible. Have one student make the model of Earth and the other student make the model of the gas planet. Then have the pairs discuss the similarities and differences between the two models.

As an extension, have students make a model of the Moon, using the *Hot Planets* and *The Moon* books as a reference. Have students explain whether this model is more similar to the model of Earth or the model of the gas planet, and explain their reasoning.

Closure

Make sure students understand that even though they used clay to represent the layers of the gas planet, in reality these layers are made of gases. Then have students discuss the similarities and differences between their two models.

Assessment

Evaluate student models and reproducibles for accuracy.

A Closer Look

A Lesson on How Telescopes Work

Content

Students will learn how refractor telescopes work. Using this knowledge, they will construct a simple telescope and compare objects viewed with and without the telescope.

National Standards

The following standards will be addressed in the lesson:

Language Arts

Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

Science

Students should develop abilities of technological design.

Students should develop understandings about science and technology.

Multiple Intelligences

The following intelligences will be activated throughout the lesson:



Bodily-Kinesthetic



Linguistic



Visual-Spatial

Prerequisites

Students should read the book *Star Spotters* to learn about the history of telescopes and find out how different types of telescopes are used. They should pay special attention to pages 10–13, which focus on optical telescopes.

Materials

- *Star Spotters* books
- pair of binoculars or small telescope
- chalkboard and chalk or whiteboard and markers
- concave eyepiece lens (small and strong, like a magnifying glass) (1 per small group)
- convex objective lens (large and weak, like reading glasses) (1 per small group)
- cardstock (2 sheets per small group)
- tape (1 roll per small group)
- student copies of the *A Closer Look* reproducible

Instructional Procedure

Anticipatory Set

Show students the binoculars or small telescope. Write *objective lens* on the board, and point out that other names for an objective lens are “front lens” and “big lens.” Ask students to refer to page 10 of *Star Spotters*, and have a volunteer point out the objective lens on the binoculars or telescope. Then have another volunteer explain what an objective lens is. (a lens that gathers light from the object being observed) Write the answer on the board. Then write *eyepiece lens* on the board, and have a student point out the eyepiece lens and explain what it is. (a lens that takes the light from the objective lens and makes it bigger, or magnifies it) Write the answer on the board. Point out that all simple *refractor telescopes*, like the one you are showing them, have both an objective lens and an eyepiece lens.

Classroom Discussion

Help students understand how a refractor telescope works. Explain that in order to see objects, our eyes need to gather light from them. We have trouble seeing small objects from far away because our eyes are too small to collect enough light. Ask: *How do you think an objective lens helps to solve this problem?* (The objective lens is larger than our eye, so it can collect more light.) Explain that the objective lens then focuses the light on the eyepiece lens. Ask: *What do you think the eyepiece lens does with the light?* If students need a hint, encourage them to think about a magnifying glass. (It makes the light bigger, or magnifies it. This

Objectives

The student will be able to...

- identify an *objective lens* and an *eyepiece lens*
- explain how a *refractor telescope* works
- create a simple telescope and use it to observe distant objects

makes it take up more room on our eye, so we can see the object better.) Ask students why looking through only one lens would not result in magnifying distant objects like a telescope does. (Both lenses need to work together in order to gather lots of light, focus it, and magnify it.)

Activity

Part I: Building a Telescope

Tell students that they are going to work in small groups to make their own telescopes. Divide students into small groups, and give each group a concave eyepiece lens, a convex objective lens, 2 sheets of cardstock, and tape. Tell students to roll 1 sheet of cardstock into a tube the same width as the smaller lens. They should use tape to hold the tube together and then to attach the lens to one end of the tube. Point out that this will be the eyepiece of their telescope.

Then have students repeat the procedure using the other sheet of cardstock and the larger lens to make a larger tube. They should make sure that the smaller tube can slide easily in and out of the larger one. Explain that the larger lens will be the objective lens of their telescope.

Have students insert the smaller tube into the larger one, forming one long tube with a lens on each side. They have now built a telescope.

Part II: Using a Telescope

Tell students to look through the eyepiece lens (the smaller one) and point the telescope at a faraway object, such as a poster across the classroom. They should then slide the two tubes in and out until the object comes into sharp focus.

Give each student a copy of the *A Closer Look* reproducible. Have them take turns using the telescopes to observe a faraway item with and without the telescope. After each observation, they should record their findings on the reproducible. This exercise can be done indoors or outdoors. In either case, tell students not to use their telescopes to look at the sun, as this can damage their eyes.

Accommodations and Extensions

Build a model telescope in front of the class while students follow along. Then have small groups of students build their own telescopes. Or, have them take turns using your completed telescope to complete the reproducible.

As an extension, have students take turns bringing their telescopes home and observing something in the sky on a clear night. Have them fill out another copy of the *A Closer Look* reproducible to record their findings. When all students have had a chance to bring their telescopes home, discuss what they saw.

Closure

Have students meet again in their small groups to compare their drawings and discuss what they saw. Then, as a whole class, discuss the following questions: *In what ways did the objects look different when viewed through a telescope? Did the telescopes work better or worse than you expected, and why? Do you think these simple telescopes could be used to view objects in the night sky? Why or why not?*

Assessment

Evaluate student telescopes for functionality and reproducibles for detail and accuracy.

Name _____ Date _____

Inventing the Night Sky

Directions: As you research, answer the questions below.

Name of constellation: _____

Culture of origin: _____

Main points of constellation legend:

Draw a picture of the constellation:



Creating a Crater

Directions: Complete the chart as you experiment with each marble. Then write a few sentences describing how your experiment shows how craters were formed on the Moon and on planets.

		Width of Crater	Depth of Crater	Describe the crater. (What happened to the flour? What happened to the sand?)
Marble #1 Describe the marble. (How big is it? How heavy is it?)	Dropped gently, 6 in			
	Dropped gently, 18 in			
	Thrown forcefully, 6 in			
	Thrown forcefully, 18 in			
Marble #2 Describe the marble. (How big is it? How heavy is it?)	Dropped gently, 6 in			
	Dropped gently, 18 in			
	Thrown forcefully, 6 in			
	Thrown forcefully, 18 in			
Marble #3 Describe the marble. (How big is it? How heavy is it?)	Dropped gently, 6 in			
	Dropped gently, 18 in			
	Thrown forcefully, 6 in			
	Thrown forcefully, 18 in			

Write a few sentences that describe what happens on the surface of planets or moons when they are hit by meteors. Include details about how the size and force of the meteor can affect what happens.

Round and Round We Go

Directions: Before you begin the experiment, make predictions in Part I based on what you know about the Earth and the sun. Then record the data from your observations in the chart, and answer the questions at the bottom when you complete your observations.

Part I: Predict

1. What time of day will shadows appear to be shortest? _____

2. Why? _____

3. Will the shadows always be in one place relative to the can? Why or why not?

Part II: Discover

Time of Day	Position of Sun in Sky	Length of Ruler's Shadow	Position of Ruler's Shadow

Part III: Conclude

1. When was the shadow actually the shortest? Was your prediction correct? Why or why not?

2. Did the shadows always stay in one place relative to the can? Was your prediction correct? Why or why not?

Getting Into the Outer Solar System

Directions: Use your *Ice Dwarfs* book to complete the chart below. The first row is completed as an example.

Object	Type of Object	Composition	Location	Distinguishing Features
Ceres	<i>Dwarf Planet</i>	<i>Water-ice, minerals, clays</i>	<i>Between Mars and Jupiter</i>	<i>Ceres is the largest object in the Asteroid Belt.</i>
Eris				
Pluto				
Oort Cloud				
Halley's Comet				
Kuiper Belt				
Asteroid	_____			
Dwarf Planet	_____			
Comet	_____			
Meteoroid	_____			

Name _____ Date _____

Black Holes: Fact and Fiction

Directions: On the left side of the chart, list myths about black holes. On the right, use your *Galaxies* book and other research sources to list facts about black holes.

Fiction	Fact

What's Inside?

Directions: Using the *Hot Planets*, *Gas Giants*, and *Mighty Megaplanets* books for reference, complete the chart below. Then, after you've made your models of the planets, fill in the color codes in the spaces below the chart.

Comparing Composition

	Rocky Planets	Gas Planets
How many planets in our solar system are in this category?		
How many layers do these planets have?		
What is the core made of? How hot is the core?		
What is the layer after the core made of? What is it like?		
What is the next layer made of? What is it like?		
What is the surface like? Could you walk on these planets?		

Making Your Models Color Code Guide

Earth: Core _____
 Mantle _____
 Outer Mantle _____
 Crust _____

Gas Planet (_____): Core _____
 Mantle _____
 Lower atmosphere _____
 Upper atmosphere _____

A Closer Look

Directions: Choose a faraway object to observe. In the top box, draw and describe how it looks when you view it without a telescope. In the bottom box, draw and describe how it looks when you view it with a telescope.

Draw how the object looks when viewed without a telescope.

Describe how the object looks.

Draw how the object looks when viewed with a telescope.

Describe how the object looks. How has it changed?
