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LESSON PLAN

1

3-Dimensional Solar System Model

Grade 1–2

Skills: compare and contrast size, measure distance, sort and classify, color

Materials: 11 balls of various sizes (see chart), several large pieces of yellow paper or posterboard; measuring tape; tape; string; scissors; poster paint and brushes; photos or renderings of the 9 planets, the moon, and the sun

Tip: Foam balls, available in craft stores, can be whittled to custom size.

Preparation: Clear the materials off the wall in a corner of your classroom. You can re-post materials over the sun after the activity is complete. Measure and cut a length of string 10-1/2 feet (3.2m) long; tape one end to the floor and the other to a pencil. Lay the yellow paper on the floor and tape it together. Use the string as a guide to trace an arc. You will only be able to represent a small portion of the sun. Cut out the arc and attach it to the wall.

Resources: _The Magic School Bus: Lost in the Solar System,_ created by Joanna Cole; _The Planets in Our Solar System_ by Franklyn Mansfield Branley

Objective: Students will create a 3-D scale model of the sun and the nine planets. They will also use the sun and planets to get a sense of how far Earth is from the sun.

Introduction: Review how many planets are in the solar system, their order, and their relative sizes. Display the photos of the various planets of the solar system. Have students identify Earth. Ask students how big they think Earth is compared to other planets. Hold up the baseball and point to the sun on the wall. Tell students that if Earth were the size of the baseball, the sun would be as big as the yellow half-circle.

Procedure: Gather the following balls:

Sun	21	feet	6.4	meters	(paper)
Mercury	1	inch	2.54	cm	"Shooter" marble
Venus	2.25	inches	5.7	cm	Tennis ball
Earth	2.35	inches	6	cm	Baseball
Moon	.6	inches	1.5	cm	Large regular marble
Mars	1.25	inches	3.2	cm	Ping-pong ball
Jupiter	2.2	feet	67	cm	Pilates exercise ball
Saturn	1.8	feet	55	cm	Beach ball
Uranus	9.5	inches	24	cm	Basketball
Neptune	9.12	inches	23	cm	Size 5 soccer ball
Pluto	.4	inches	1	cm	Small regular marble

1. Help students plot and paint the colors and features of each planet on the balls. You can use leftover scrap paper from the sun to form Saturn's rings. After the planets have dried, have students arrange them in the correct order on the floor. Have them put the moon to one side of Earth. Students may also use paint to color sunspots.
2. Have students identify the largest planet, then the smallest. Then have students divide the planets into two groups: the small planets (Mercury, Venus, Earth, Mars, Pluto) and the largest planets (Jupiter, Saturn, Neptune, Uranus). Inform students that the large planets are made of gas, while the small planets are rocky.
3. In which group does Earth belong? What size is Earth compared to the other small planets? How big is it compared to the largest planet?
4. If this model were to scale in distance as well as size, how far would Earth be from the sun? Mercury, the closest planet, would be 892 feet away (about 272 m). If possible, have students carry the Mercury ball the equivalent of three football fields away. The earth would be 2,312 feet away (705 m). This is just under half a mile! It probably will not be practical to take students this distance. Tell them of a familiar landmark or building that is about this far away.

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LESSON PLAN

2

Identifying Space Objects: Field Trip

Grade 1–2

Skills: observation, classification, cooperation

Preparation: Choose a relatively dark area near the school. Obtain parents' permission for a short, local, nighttime field trip. Arrange chaperones. Reproduce enough *Sky Finder* worksheets for each group of 3 or 4 students.

Materials: Telescope or binoculars, if available; blankets suitable for lying on the ground; star map; Sky Finder worksheet

Resources: *Stargazing for Beginners: A User-Friendly Guide…* by John Mosley; *Night Sky* by Carole Stott

Funsheets: *Fact Files 016, 013; Grade 1: Language 001, 018; Science 014, 020; Grade 2: Science 015, 018, 020*

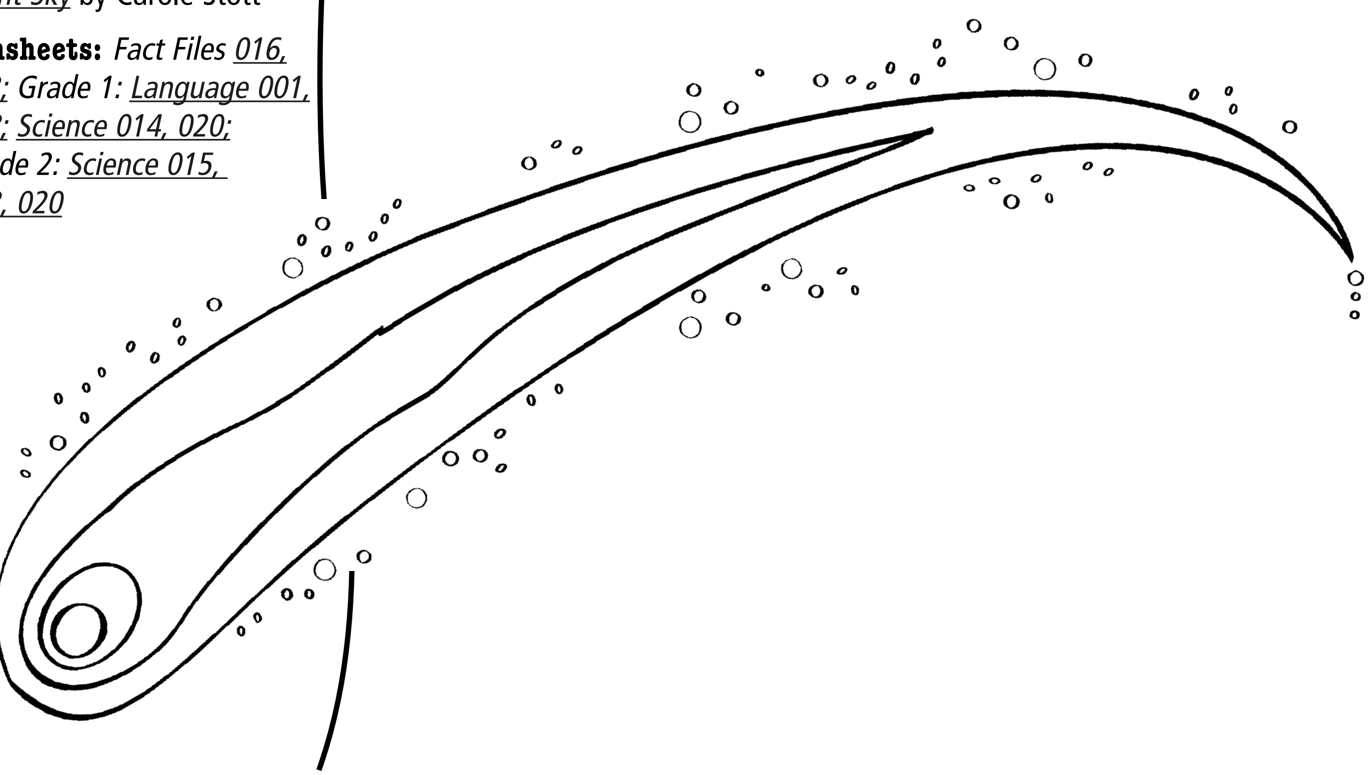
Objective: Students will be able to identify stars, planets, the moon, meteors, comets, satellites, the galaxy, and other space objects by sight.

Introduction: Before leaving, check the links or consult your star map so you can help students find various space objects.

Links: *Sky and Telescope Magazine: www.skypub.com; Astronomy Magazine: www.kalmbach.com/astro/astronomy.html; Mount Wilson Observatory Online Stargazer Map: www.mtwilson.edu/services/starmap/html*

Procedure:

1. Bring students to a place with as little artificial light as possible on a clear, moonless or crescent-moon night. Allow everyone's eyes to adjust to the dark (about 20 minutes). Allow students to lie on their backs and get a feel for how the sky looks so that they can identify moving objects.
2. Divide the students into groups of 3 or 4, and have them search for the objects on the *Sky Finder*. Assist them in locating features such as prominent stars, constellations, planets, and any comets, meteors, or other objects that make appearances.



Sky Finder

Grade 1–2

Instructions: Have students try to find and identify these space objects:

Space Object	What It Looks Like	I Saw It!
Star	a point of white light that twinkles	
Planet	a point of light that does not twinkle; it may be colored	
Mars	orange-red	
Venus	greenish; visible at sunset	
Jupiter	tan	
Saturn	has “ears” (rings) through telescope or binoculars	
(Other planets are not readily visible with the naked eye or small instruments.)		
Meteor	sudden streak or line of light	
Comet	fuzzy point, which may have a tail	
Moon	big, white, crescent or round shape	
Satellite	small white dot moving steadily across the sky; may flash or blink	
Milky Way Galaxy	thick band of stars; band of whiteness across the sky	

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LESSON PLAN

3

Skills: understand gravity, multiplication, learn a scientific milestone

Preparation: If possible, find a picture of Albert Einstein and post it in the classroom.

Materials: large sheet or other swatch of fabric, large ball (basketball), small, light ball (ping-pong ball)

Resources: *Who Was Albert Einstein?* by Jess M. Brallier

Funsheets: *Grade 2: Math 019*

A Brand-New Theory of Gravity

Grade 1–2

Objective: Students will learn about the force of gravity by visualizing Einstein's revolutionary theory of how it works. Students will also learn that scientific theories come from people thinking about evidence.

Introduction: Have students get up from their desks and jump. What happened? Did anyone fly into the ceiling? Why not? Gravity, of course. Students are familiar with this force, but they may not be familiar with Einstein's strange theory to explain it.

Procedure:

1. Review that gravity is a force that attracts all objects to each other. Gravity is actually a very weak force—only extremely heavy things, like planets, have enough of it to move other objects. Yet even a pencil exerts a tiny gravitational force on a nearby eraser. Heavy wrecking balls lean slightly toward buildings, and certain kinds of surveying equipment read innacurately because of the gravitational pull of nearby mountains.
2. Gravity gets stronger when the objects get bigger. You can find the strength of gravity by multiplying the weights of the objects. Hold up the earth and the moon from the *Solar System Model*, and say that, hypothetically, the earth weighs 3, and the moon weighs 2. How much would gravity be? (3 x 2) Hold up the basketball and the ping-pong ball. Say that the basketball weighs 9, and the ping-pong ball weighs 2. How much gravity is between them? Hand out *Fun Sheet Grade 2: Math 019*, and help students calculate the "gravity" of the "planets."
3. Ask your students a simple question: What causes gravity? Explain that Albert Einstein, an astrophysicist, thought about that very same question and came up with a theory. You may wish to include a biography of Einstein in your lesson.
4. Have your students stand in a circle, hold the edges of the sheet, and stretch it out tight. Drop the basketball into the middle of the sheet. What happens? The sheet dips in the center where the basketball settles.
5. Place the ping-pong ball near the edge of the sheet and let go. If the sheet is held still and tightly, the ping-pong ball should roll toward the basketball.
6. Einstein's theory is that gravity actually bends or dents space the way the basketball dents the sheet. Objects that move because of gravity are sort of rolling downhill—through space itself.
7. Gravity is the force that holds the planets and moons in their orbits. To demonstrate this, gently roll the ping-pong ball across the sheet, near but not toward the basketball. This is tricky, but if you can get it close to the right speed, it will spiral in circles as it approaches the basketball. This is how planets orbit—they try to move in a straight line, but the curved space caused by gravity forces them in a circle. (If your ping-pong ball crashes into the basketball, be sure to reassure students that the earth is going plenty fast enough to keep from crashing into the sun, and the moon is going fast enough to keep away from Earth.)

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Pluto—Planet or Moon?

Grade 1–2

LESSON PLAN 4

Skills: creative writing, comprehension, argument, structure of a paragraph

Materials: Pluto from the *3-D Solar System Model*, ball or light to represent the sun, pencils, paper, *Pluto*, by Gregory Vogt

Resources: *Pluto*, by Larry Dane Brimner

Preparation: Have students read *Pluto*, by Gregory Vogt. Review the major features of Pluto, including its size, distance from the sun, its moon, its surface features, and its orbit.

Funsheets: *Fact File 011; Grade 1: Science 009; Grade 2: Science 010;*

Objective: Students will carefully evaluate the evidence in the debate over whether Pluto is a planet or a "trapped" moon. They will decide which version they believe and write an expository paragraph using the evidence they evaluated.

Introduction: Have students review the facts they learned about Pluto from the book *Pluto*. Explain that there are many mysteries about space, one of the most familiar being the debate over Pluto. Pluto was discovered relatively recently, and scientists still argue about its true identity. Can it really be called a planet, or is it just a little moon that got trapped by the sun's gravity?

Procedure: Write a chart on the board with two main columns, "Planet" and "Moon." Each of these columns has two columns, one for evidence, and one with the label "But . . ."

Planet		Moon	
Evidence	**But . . .**	**Evidence**	**But . . .**

Under "Planet," have students look back in the book and see how Pluto is like a planet:

1. Pluto revolves around the sun, not another planet.
2. Pluto has its own moon. Moons do not have their own moons.

Under "Moon," have students look back and find evidence that Pluto might be a trapped moon:

1. Pluto is very small—smaller than our moon.
2. Pluto's orbit is crooked. Demonstrate this using the Pluto ball. Other planets orbit in a flat plane—they circle around the sun's equator. But Pluto's orbit is tilted.

Under "But . . ." challenge students to counteract and refute the previous evidence. For instance: Pluto revolves around the sun. But . . . that may be because it got hit by an object. Maybe it used to orbit Neptune. Or: Pluto's orbit is crooked. But… that may be because it got hit by an object. Maybe it used to have a normal orbit.

Have students decide whether they think Pluto is a planet or a moon. Instruct them on how to write an argument in a paragraph by using a topic sentence ("Pluto is a ______."), and then following it with the evidence from the chart. Encourage them to use the "But . . ." evidence to counteract other people who might argue against them. Model the sentence, "Some people may say______. But ______(evidence)______."

Have students read their paragraphs to their classmates. Are any students convinced by their fellow students' arguments?

The Life of a Star

Grade 1–2

LESSON PLAN
5

Skills: sequencing, compare and contrast, cause-and-effect, sort

Materials: scissors, one piece each of red, orange, yellow, white, blue, and black construction paper for each student, circle stencils of various sizes, crayons, glitter

Preparation: Locate photographs of various sizes of stars and supernovae. Check out www.nasa.gov/missions/deepspace/Hubble_Multimedia. This is a great source for fantastic images from the Hubble Telescope.

Resources: *When the Sun Dies* by Roy A. Gallant; *Black Holes* by Paul B. Sipiera; *Highlights from the Hubble Telescope: Postcards from Space* by Melanie Chrismer

Funsheets: *Fact Files 019–021; Grade 1: Language 013 Grade 2: Science 012;*

Objective: Students will learn the life cycles of two kinds of stars—small/average stars and large stars—and compare the two. Students will also sequence the two life cycles using cause-and-effect relationships.

Introduction: The stars may seem permanent, but every star has a beginning, and every star will have an end. Between those two times, stars go through amazing changes. The life cycle of each star depends on its size.

Procedure: Have students read *When the Sun Dies,* by Roy A. Gallant. As you review the life cycles of stars step-by-step, have students cut out circles of various shapes and colors to represent each stage.

1. Stars form when gravity squeezes clumps of gas until they are big and dense enough to press hydrogen into helium. The star begins its Main Sequence, which can last for billions of years. Small stars, like our sun, burn red or yellow. Large stars are hotter and burn blue. Have students cut out small yellow and large blue stars.
2. When the hydrogen begins to run out, both kinds of stars begin to cool and expand. Small stars (like the sun) expand into red giants. Big stars expand into even larger red supergiants (you may want to have students use orange to represent a regular giant to prevent confusion). Stars are like cars—the smaller ones are more fuel-efficient, and they stay in Main Sequence much longer than big stars.
3. As a small star expands, eventually it cannot burn any more fuel, and the outer layers blow away. What is left is a white dwarf—the remains of the star's core.
4. A large star is heavy enough that even when the hydrogen and helium are gone, it can burn the remaining carbon. Eventually, all that is left is iron, which cannot burn. Without heat, gravity takes over, and the center of the star collapses, while the outer layers explode in a brilliant supernova. Have students use crayons and glitter to draw a supernova on their choice of colored paper.
5. After the supernova, the core of a giant star keeps collapsing. Sometimes, the star becomes a neutron star or pulsar, flashing energy as it spins. But sometimes the star is so heavy that it shrinks to an infinitely small point and becomes a black hole. Only stars of huge mass have enough gravity to make a black hole. Students can use single-hole punches to make tiny black holes.
6. Post students' star life cycles. When they aren't looking, mix up the order of the cycles. Have students unscramble them. Mix up the 2 types of stars by, for example, putting a supernova in the small-star sequence. Have students correct it.
7. Ask students the following cause-and-effect questions:
   - Why can't small stars make black holes?
   - Why do big stars have shorter lives?
   - Why do supernovae happen?

Comet Visitors

Grade 1–2

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LESSON PLAN
6

Skills: addition of 2–, 3–, and 4–digit numbers

Materials: Photographs of comets (optional), *Comet Period Math Worksheet*

Preparation: Post photos of the most recent appearance of Halley's comet and the spectacular Hale-Bopp comet of 1998. Reproduce the *Comet Period Math Worksheet*. On the board, draw a diagram of a comet's elliptical (oval or football-shaped) orbit, drawing the sun near one small end.

Resources: *Comets* by Samantha Bonar; *Look at Comets* by Ray Spangenburg and Kit Moser

Funsheets: *Fact Files 013; Grade 1: Science 016; Math 018; Grade 2: Math 005, 010; Language 003*

Objective: Students will learn that comets are space objects with highly elliptical orbits and long periods. Students will calculate the return dates of comets with various periods.

Introduction: Comets are objects from deep space—many from beyond Pluto. They are more rare and mysterious than the stars, and it is little wonder that past civilizations considered them omens. Their composition is of various ices and dust; they are sometimes known as "dirty snowballs." As comets approach the sun, their ice vaporizes, carrying dust and ions into a glowing tail.

Procedure: Tell students that comets take a very long time to orbit the sun—millions of years for some distant comets. Show them the diagram of the elliptical orbit to illustrate that comets spend most of their time far out in space, away from the sun. They are going to calculate when some familiar comets will return visibly to Earth's neighborhood.

Hand out the worksheet. Explain that the time it takes a comet to return to the sun is called its period. Hand out the *Comet Period Math Worksheet*. It lists the name of short-period comets, the years of their last appearances, and the number of years it will take them to return (their periods). To calculate when the comet will return next, students will add the period to the year the comet was last seen. The result will be the year when they can expect the comet to come back.

Extensions:

Students can continue calculating a comet's appearances well into the future.

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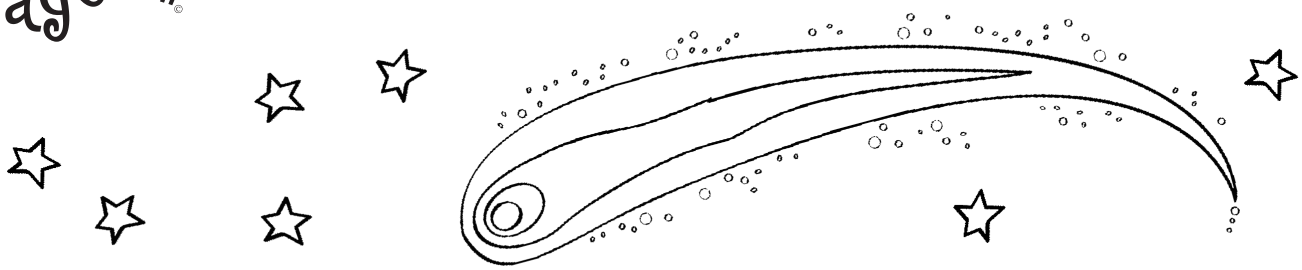
Comet Period Math Worksheet

Grade 1–2



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Comet	Last Appearance	Period	Next Appearance
Halley's	1986	76 years	1986 + 76 = 2062
Encke	2003	3 years	
Holmes	2000	7 years	
Neujmin 3	1993	11 years	
Tuttle	1994	14 years	
de Vico	1995	74 years	
McNaught-Hartley	1994	300 years	

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LESSON PLAN

7

On the Moon

Grade 1–2

Skills: movement, art, creative writing

Resources: Books: *Race to the Moon: The Story of Apollo 11* by Jen Green; *What the Moon Is Like* by Franklyn Mansfield Branley; various art materials

Preparation: Gather various articles, links, books, and films of the first moon landing for inspiration.

Funsheets: *Fact Files 012, 023A, 023B, 024; Grade 1: Science 001, 002; Grade 2: Science 011, 013*

Objective: Students will use an artistic medium (art, dance, drama, video, writing) to celebrate the accomplishment of the first human being to land on the moon.

Introduction: If you remember it, tell students your memories of watching or hearing about the moon landing. In any case, as you introduce the lesson, emphasize that the moon landing was an extremely powerful symbol, one that united the people of Earth in a sense of accomplishment.

Procedure:

1. Have students read your choice of books on the Apollo 11 mission. After reading, discuss the book to ensure that students understand the essential facts of the mission: Who (names of astronauts, both of the Apollo 11 mission and previous Apollo missions), What (names of spacecraft, launchers, and procedures), When (chronology of mission as well as critical dates), Where (location of preparation, launch, mission control, the distance to the moon, the location of the landing) and Why (political and scientific competition with the former Soviet Union, difficulty of the technical achievement).
2. Have students split into groups of 3 or 4, and have each group decide on a format for their project. Help each group brainstorm ideas. Some "starters" could be:
   - **a.** Writing a story from the point of view of a Soviet scientist or cosmonaut watching the moon landing on television
   - **b.** Performing a dance based on the hopping motion of the astronauts in 1/6 gravity
   - **c.** Creating a mural showing the distant view of Earth from the surface of the moon
   - **d.** Performing or videotaping a newscast reporting on the landing
3. Depending on the elaborateness and number of projects, allow several hours to several days of preparation time. When the projects are complete, have each group present to the rest of the class.

LESSON PLAN

8

The Gas Planets

Grade 1–2

Skills: research, writing, compare and contrast, charting facts, cooperation

Preparation: Create a "Jovian Planets" center in your *Space Learning Center* by collecting and displaying books and other materials on Jupiter, Saturn, Uranus, and Neptune. Display the 3-D models from the *Solar System Model (Lesson 1)*. Prepare Jovian Planets charts with rows for Jupiter, Saturn, Uranus, and Neptune and columns for: size, composition, distance from sun, time to rotate, time to revolve, number of moons, number of rings, interesting features.

Materials: books, library and Internet access time, Jovian Planets chart for each group

Resources: *Destination: Jupiter; Saturn,* and *Uranus* by Seymour Simon; *Jupiter: The Spotted Giant* by Isaac Asimov; *Neptune and Uranus: A True Book* by Larry Dane Brimner; *Saturn* by Elaine Landau; *Neptune* by Franklyn Mansfield Branley

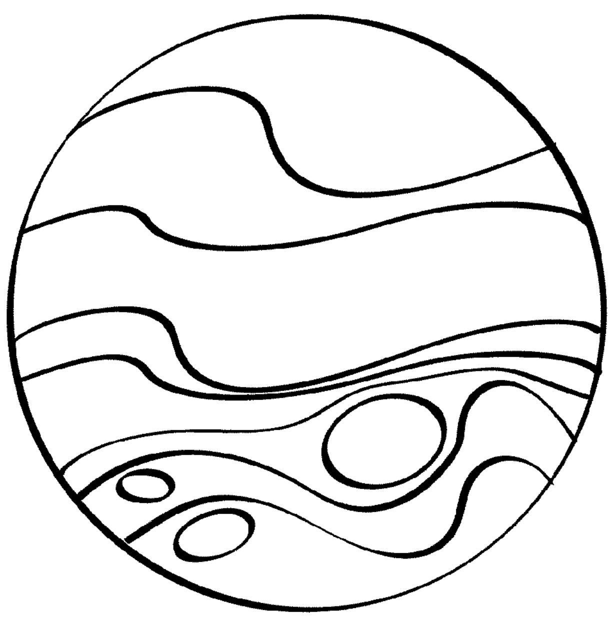
Funsheets: *Fact Files 007–010;* Grade 1: *Science 005–008; Language 010, 011, 015* Grade 2: *Science 006–009, 014; Language 019*

Objective: Students will research and write short reports on one of the big gas planets. After their reports are complete, students will work in groups to fill in a Jovian Planets Chart.

Introduction: The big gas planets are called the "Jovian" ("like Jupiter") planets. These planets are fascinating because of their enormous size and because they are so different from Earth.

Procedure:

1. Assign each student a planet, either by their choice, random choice, your assignment, or a combination. Allow students to use any available materials to compose a one-page report on their planet. This activity should take no more than one day.
2. When the reports are complete, divide students into groups of four (one planet per group—if your class does not divide evenly, add students to make groups of 5 or 6). Have students combine their information to fill in the Jovian Planets Chart. Students will have to cooperate to ensure that all of the information is included. You may wish to have students preview the charts before completing their reports so that students know what to write down.
3. After the charts are finished, ask each group questions about the Jovian planets:
   - How are the planets alike?
   - How are they different?
   - What is their order from the sun?
   - What is special about Jupiter? About Saturn? Uranus? Neptune?



The Rocky Planets

Grade 1–2

LESSON PLAN

9

Skills: research, report writing, compare and contrast, charting facts, cooperation

Preparation: Create a "Terrestrial Planets" center in your Space Learning Center by collecting and displaying books and materials on Mercury, Venus, Earth, Mars, and Pluto. Display the 3-D models from the *Solar System Model (Lesson 1)*. Prepare Terrestrial Planets charts with rows for Mercury, Venus, Earth, Mars, and Pluto, and columns for: size, composition, distance from sun, rotation time, revolution time, number of moons, and interesting features.

Materials: Books, library and Internet access time, 1 large piece of poster paper for each group

Resources: *Mars; Venus; Earth: Our Planet in Space;* and *Mercury* by Seymour Simon; *Mercury: The Quick Planet;* and *Mars: Our Mysterious Neighbor* by Isaac Asimov; *Venus;* and *Pluto* by Larry Dane Brimner; *Pluto* by Gregory Vogt

Funsheets: *Fact Files 002–006, 011;* Grade 1: *Science 005–008; Language 010, 011, 015;* Grade 2: *Science 002–005, 010*

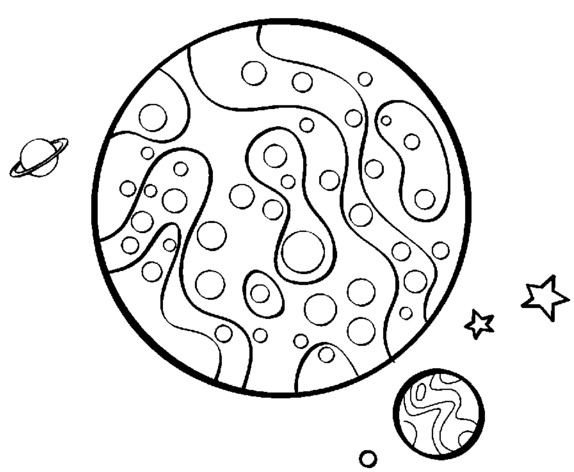
Objective: Students will research and write short reports on one of the small rocky planets. After their reports are complete, students will work in groups to fill in a Terrestrial Planets Chart.

Introduction: The Terrestrial ("like Earth") planets may seem small compared to their gigantic neighbors, but each of these planets is fascinating in its own way.

Procedure:

1. Assign each student a planet, either by his or her choice, random choice, your assignment, or a combination. Allow students to use any available materials to compose a one-page report on their planet (this activity should take no more than one day).
2. When the reports are complete, divide students into groups of 5 (1 planet per group—if your class does not divide evenly, add students to make groups of 6 or 7). Have students combine their information to fill in the Terrestrial Planets Chart. Students will have to cooperate to ensure that all of the information is included. You may wish to have students preview the charts before completing their reports so that students know what to write down.
3. After the charts are finished, ask each group questions about the Terrestrial Planets:
   - How are the planets alike?
   - How are they different?
   - What is their order from the sun?
   - What is special about Mercury? About Venus? Earth? Mars? Pluto?

Extension: Combine the Terrestrial Planets Chart with the Jovian Planets chart to create charts for all of the planets of the solar system. Have students practice putting the planets in order by distance from the sun, size, length of day, length of year, and number of moons.



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LESSON PLAN

10

Skills: mapping and drawing objects, research, cooperation

Materials: at least 12 large pieces of black construction paper and enough extra to cover any gaps in the planetarium, tape, pushpins, lantern-style light or other light that can sit on a flat surface and shine on all sides, large clear plastic or glass punch bowl

Preparation: Find a usable enclosed room or use tape to seal the windows and doors so that no light can enter your classroom (do not seal air vents). Reproduce and enlarge *Fact File 018, The Zodiac*. Cut pieces of construction paper to make 12 pie slices that will make a circle somewhat larger than the punch bowl. You may also want to cut out each zodiac "slice" from the Fact File to distribute to students.

Make Your Own Zodiac Planetarium (Advanced Activity)

Grade 1–2

Objective: Students will draw and plot the constellations of the zodiac onto black paper, which they will then form into a working planetarium.

Note: The constellations of the zodiac rise and set throughout the year. This planetarium shows an imaginary view of all 12 objects in the sky at once.

Introduction: People have been drawing dot-to-dot with the stars for thousands of years. Twelve of the longest-lasting and most famous images are the Western zodiac signs. Students will be creating their own planetarium using these constellations.

Procedure:

1. Assign each student a constellation, making sure that all the signs are covered (if you have more than 12 students, they will share signs). Have students use a piece of black paper, the Fact File, and library or Internet sources to trace or draw the constellation, including all of its stars. Have students summarize the constellation myth orally or in paragraph form. Be sure to monitor Internet use—searching for zodiac signs may turn up inappropriate horoscopes and fortune-telling scams.
2. Hand each student a pushpin, reminding them to be careful with the sharp point. Have them punch a single, clear hole on each star (putting the paper on corkboard or another soft, pierceable surface may help).
3. Turn the punch bowl upside-down and have students tape their slices to it, wide-end down. Cover any gaps with extra paper, making sure to not cover any stars. Once the punch bowl is completely black except for the stars, turn on the lantern, place the punch bowl upside down over it, and turn off the lights. The constellations will shine around the room. Follow the tips below to fine-tune your planetarium.

Note: Be fire safe. Do not leave the planetarium turned on for extended periods. Periodically touch the paper to make sure that it isn't hot.

Extension: Use a star map to create a planetarium of the sky in your area on a particular date.

Tips:

1. A plain punch bowl with the least decoration and a flat rim will produce the clearest light.
2. You may have to adjust the size of the holes in the paper to make the stars clear, but make sure that you start small and increase the size gradually, or that you test with one constellation before changing the size on the rest. Once the holes are too big, the only option is to start over.
3. To make the clearest stars, try raising and lowering the planetarium onto a desk, table, or other object. Also try clearing objects to the edges of the room so that they do not block the light from the "stars."