Our Solar System

Dr. Dave's Teaching Manual

Second Edition

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Contents

Introduction

This manual will give you, the teacher, everything you need to teach a unit on the solar system. From the first topic to the last class, it describes how to set up teaching presentations so that they are dynamic, exciting, and meaningful for students. You will see how easy it is to prepare for classes, and you will discover that this teaching approach allows students to experience real learning and real academic success.

Science is a wonderful topic to teach to children. Instead of lecturing for long periods or bogging students down with an avalanche of worksheets, this manual shows you how to make your presentations interesting and challenging to the mind of a child. This is easy to do—once you know how to do it. Children already possess a natural curiosity for science. This manual shows you how to take advantage of their curiosity and to present lessons in a way that creates an exciting learning environment in your classroom.

This manual describes easy teacher demonstrations that use basic materials such as rocks, ice, and balloons. Most of them take only minutes to set up. Show the students a rocky ice-ball that you made as you teach about comets, or lay out chunks of ice and rocks to form the rings of Saturn on your desk. You can be sure that the students will be watching you as you spin a cup around your head while you teach about how the Earth revolves around the Sun.

This unit is rich in earth science and physical science topics. The downgrading of Pluto to a dwarf planet is a good springboard for students to learn about the different-sized rocks that orbit the Sun, along with their names and designations. The students will learn the relationship between planet size, gravity, atmosphere, greenhouse effect, and planet temperature. Of course, no unit on the solar system is complete without the students building a scale model; you can choose from several mentioned in this text, depending on the space you have available in the classroom.

Following the teacher presentations, you can run various student activities at levels that are appropriate for your students' abilities. This manual is flexible, and there are many opportunities for integration of core subjects. In addition, you can choose from many demonstrations, visual projects, experiments, group projects, and research projects. Perhaps the students will construct a large solar system mural that can be displayed in the hallway.

This manual also offers suggestions for assessment and shows examples of exemplary student work. In addition, it provides tips on classroom management, critical thinking questions, modifications, clean-up, and safety. The Teacher Resources section contains a variety of downloadable worksheets that you can use as homework or as in-class assignments; these are available from the Royal Fireworks Press website (rfwp.com). Many of the images in this book can be projected for the students to see and will help them to understand and internalize the concepts being taught; these are available for download as well.

The internet is a rich source of animations and short video clips. If you have the technology available in your classroom, you can use the keywords provided to search the internet to find websites that you can project during your teaching presentations. NASA is also a rich supplemental resource for this unit. Once you link to NASA's home page, it takes seconds to project actual pictures of various objects in space, including pictures from the surface of Mars. Whatever planet you are discussing, you can link to any space mission that a probe has been

General Features of Our Solar System

Objectives

- Students will compare and contrast the features of the inner and outer planets.
- Students will be able to list the objects found within our solar system.

Key Points

- The inner planets are rock planets.
- The outer planets are giant gas planets.
- The inner planets are all clustered together close to the Sun.
- The outer planets are much farther away from the Sun—and from one another.
- The gas planets are much larger than the rock planets.

Vocabulary Words

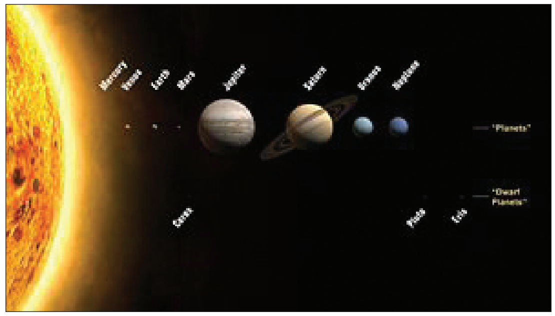
Inner Planets Outer Planets

Start the Class

Review the order of the planets from the Sun with the students. Explain to them that some planets are made of rocks, and some are made of gases. Rock planets are solid. You could even take a small round rock and pound it on your desk. Tell the students that the Earth is an example of a rock planet. Then show a large inflated balloon to represent a gas planet. You might want to write "Gas Planet" on the balloon. Make two points with these visual aids: first, the balloon is much larger than the rock, and second, the balloon is mostly gas, while the rock is a solid. These are important distinctions between the inner planets and the outer planets. Identify the first four planets, Mercury, Venus, Earth, and Mars, as rock planets. Identify the gas planets as Jupiter, Saturn, Uranus, and Neptune.

Tell the students that the four rock planets are actually made mostly of rock and iron. They have many other features in common as well. As their name implies, they all have solid surfaces. Tell the students that they couldn't stand on the surface of a gas planet like they could on a rock planet—like here on Earth.

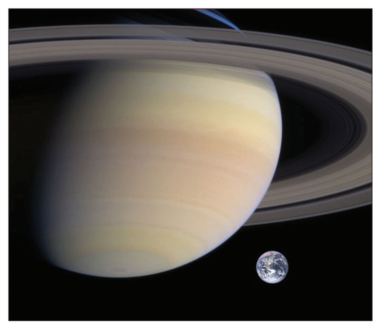
Project any of the images from the previous lesson that portrays the entire solar system again (such as the image below). Re-identify the first four planets as inner planets: Mercury, Venus, Earth, and Mars, and state again that these four planets are rock planets. Then point to and name the four gas planets of Jupiter, Saturn, Uranus, and Neptune. Continue to emphasize the difference between a rock planet and a gas planet.



International Astronomical Union

Make sure that the students observe and appreciate how much larger the balloon is in comparison to the rock. The outer planets are often called *gas giants*. Projecting the images below (of the Earth in comparison to Jupiter and to Saturn) gives the students a sense of the size differences between the inner and outer planets.

NASA



NASA

You can also show the students a dime to represent the Earth and a basketball to represent a gas planet to illustrate the size difference.

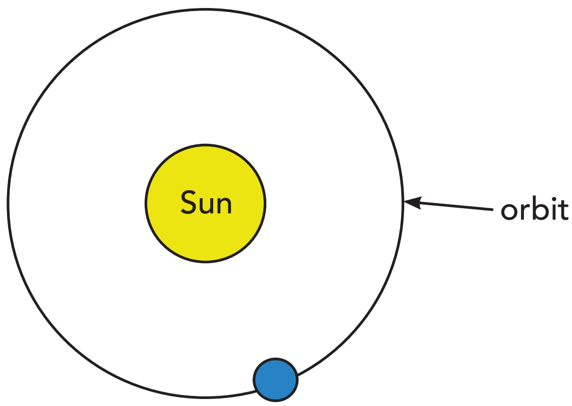
Fact: More than 1,000 Earths could fit into Jupiter.

Teacher Demonstration: Construction Paper Solar System

An important difference between the inner planets and the outer planets is that the four inner planets are close to the Sun, while the gas planets are extremely far away from it. Unfortunately, this isn't easy to understand with traditional pictures and drawings. A good way to make this point is to tape construction paper cutouts of the planets to the wall.

As you spin the cup, point out that its orbit is circular, and inform the students that the same type of pathway is nearly true for the orbits of the planets. In actuality, the orbit paths of the planets are slightly *elliptical* in shape. Project the simple diagram below for the students to see.

Teaching Tip: It is a common misconception that the orbits of the planets are highly elliptical. They are only slightly so.



Ask the students a critical-thinking question: "How long does it take the Earth to go around the Sun one time?" The answer, of course, is one year. Be sure that everyone knows this. It takes the Earth one year to orbit the Sun one time. Try to move the cup around your hand as slowly as possible, telling the students to imagine that it will take 365 days to orbit your hand once.

History Integration: In 1530, Copernicus announced his discovery that the Earth revolved around the Sun. It was an unbelievable concept at the time because everyone then believed that the Earth was the center of the universe.

Student Activity: Revolution Role Play

A simple bodily-kinesthetic activity for the students is to have one student play the Sun, while another student plays a planet. The Sun student stands still, while the planet student orbits around him or her. Later in this lesson is a student activity in which the students role play our entire solar system.

Teaching Tip: Another important example of revolution in this unit is the revolution of the Moon around the Earth.

Activity Extension: Designate one student to be the Earth and another to be the Moon. As the Earth slowly revolves around the Sun, the Moon revolves around the Earth. This gives the students a taste of the complexities of motion within our solar system.

Teacher Demonstration: Rotation

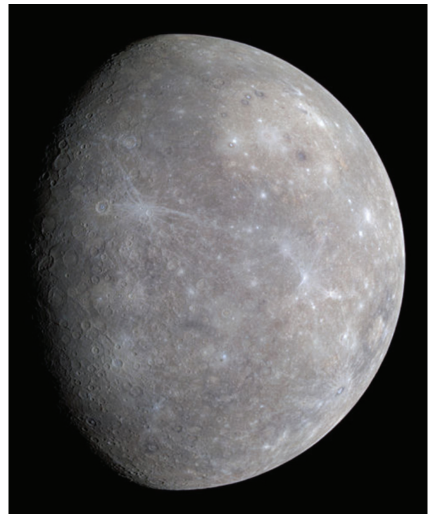
It is important for the students to understand why there is day and night on our planet. Use a small lamp or a flashlight for this demonstration. Dim the lights, and have a volunteer student play the Sun and hold the lamp toward you. Then ask the following critical-thinking question: "What do I have to do to move like our planet so that there will be day and night?"

Guide the students to realize that when you face the light, it is daytime, and when you turn and face the opposite direction, it is night. This kind of spinning around is called *rotation*. Call out "Day...night..." as you spin around slowly.

Now let the whole class experience this. Have all of the students stand up, and shine the light at them. Get everyone rotating in sync, saying "Day" and "Night" as they do. Explain that it takes the Earth 24 hours to rotate one time.

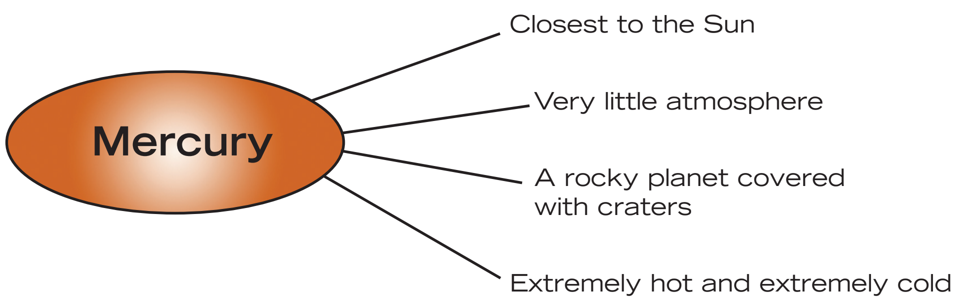
Although the side of Mercury that faces the Sun is indeed hot, the opposite side of the planet that faces space is extremely cold. Tell the students that since Mercury doesn't have an *atmosphere* to hold its heat, nighttime on that planet is space-cold, and that's very cold! Venus, on the other hand, has a thick atmosphere that is able to retain heat like a layer of insulation. This explains why Venus, and not Mercury, is the hottest planet. You'll teach more about this important concept when you discuss Venus.

Project the image of Mercury at right, and point out its heavily cratered surface. Tell the students that Mercury looks somewhat like our Moon in this respect, and note that it is only slightly larger than our Moon. Neither Mercury nor the Earth's Moon has enough mass to produce gravity sufficient enough to hold onto an appreciable atmosphere.


NASA

Technology Integration: Throughout this unit, you can visit NASA's website to view images taken by any spacecraft from any mission to any planet in our solar system. For example, students can see pictures of Venus taken by the planetary spacecraft Magellan *or pictures of the outer planets taken by the* Voyager 1 *and* 2 *space probes.*

Project the image below for the students to see.



Teacher Demonstration: Venus

Following the Sun and the Moon, Venus is the third brightest object in the sky. It is so bright that even the most astronomically challenged person can find it in the sky when it's out. Project the image at right to show the students what Venus looks like at sunrise and sunset. You can see Venus rising near dawn and setting at dusk in the west. It is bright, but it is never very high in the sky.


Bruce Marcot

Teaching Tip: A common mistake is misidentifying Venus as a star. Venus is far brighter than any star.

Cultural History Integration: Venus was named for the Roman goddess of love and beauty.

The Outer Planets

Objectives

- Students will compare and contrast the features of the outer planets.
- Students will describe the composition of planetary rings.

Key Points

- All of the outer planets are giant gas planets.
- The outer planets are extremely far away from the Sun.
- The outer planets have many more moons than any inner planet has.
- All of the outer planets have rings; Saturn's are the most prominent.
- The rings of Saturn are made of chunks of ice and rocks.
- Pluto is a small, rock dwarf planet.
- Beyond Pluto is a huge ring of rocks called the Kuiper Belt that orbits the Sun.

Vocabulary Words

Rings Kuiper Belt

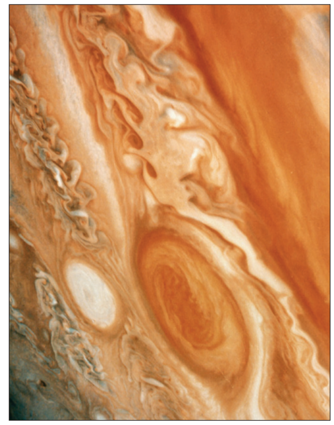
Teacher Demonstration: Jupiter

The outer planets are all giant gas planets. To begin this lesson, remind the students of the general differences between a gas planet and a rock planet. You might even want to show them a balloon and a rock again to reinforce the differences. Inform them that Jupiter is the biggest planet. It has dozens of moons, and many more may still be discovered. Jupiter is the fourth brightest object in the sky. It is brighter than any star. Project the image below for the students to see.

Technology Integration: Search the internet using the keywords "Jupiter" and "current night sky" to find websites that show where Jupiter, as well as the other planets, can be located in the sky on the current date.

NASA

Aside from its size, the most well-known feature of Jupiter is its large red spot, which is believed to be an Earth-sized hurricane that has existed for hundreds of years. Project the image at right so that the students can see the red spot.



NASA

The composition of Jupiter and its atmosphere are nearly identical to those of the Sun. In fact, Jupiter has been called the planet that didn't have quite enough mass to be a star. Like a star, Jupiter produces its own heat, which is one reason why it has such violent weather.

History Integration: In 1610, Galileo discovered Io, Europa, Ganymede, and Callisto, the four largest moons of Jupiter.

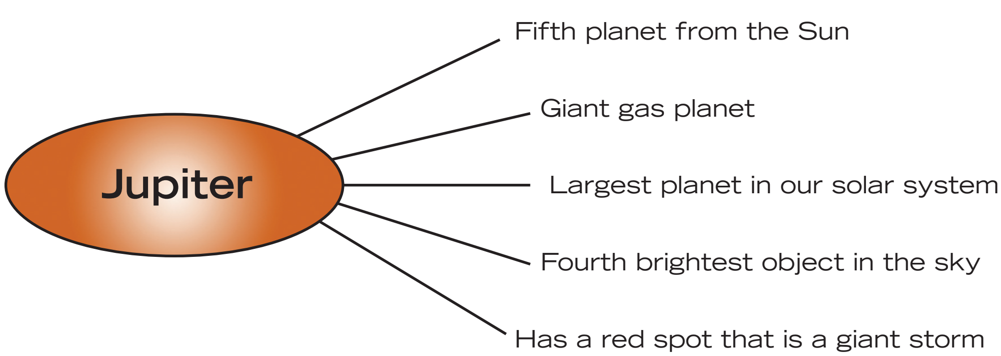
Teacher Demonstration: Jupiter's Stormy Surface

Here is a good visual demonstration to simulate Jupiter's stormy surface. Have the students gather around so they can see. Pour some milk into a shallow clear plastic or glass container, such as a petri dish. Gently add a one or two drops of different colors of food coloring to the milk, spacing the colors apart from one another. Then dip a toothpick into some dish detergent, and touch the toothpick to the center of each spot of the food coloring. Watch the colors spread. Gently touch the toothpick to other areas in the milk, and watch the colored swirling storm. Tell the students to use their imagination to pretend that they are approaching Jupiter, and this is what they see: swirling colored gases.

Teaching Tip: You could have the students perform this experiment as an activity by distributing the materials to groups of students and having them mix the milk and food coloring themselves.

Teaching Tip: You could connect this demonstration to a writing activity about a trip to Jupiter.

Project the image below for the students to see.



Integrate art into the lesson by projecting the image at left for the students to see. It is a 19th-century engraving of the Leonid meteor shower of 1833, which was a spectacular sight. Records describe how during the meteor shower that year, the sky over the United States was so ablaze with meteors that it looked like it was on fire. According to some sources, more than 30,000 meteors fell per hour. At the time, many people were afraid; it seemed to them that the world was ending. Students could create their own artistic versions of this event, or you could integrate writing into the lesson as well by having the students write a paragraph describing what they saw and felt as if they had been there to witness the shower themselves.

Technology Integration: Search the internet using the keywords "shooting star" and "animation" to find websites that show meteor shower animations.

Teacher Demonstration: Asteroids and Craters

It is time to move on to bigger space rocks: asteroids. Explain to the students that asteroids can be huge, sometimes as large as small moons. Review the location of the asteroid belt. Occasionally the orbits of asteroids intersect with the orbit of the Earth. Periodically these huge rocks hit the Earth, some causing catastrophic damage. In fact, one of the leading theories about how the dinosaurs became extinct is that an enormous asteroid hit our planet, causing massive, worldwide extinctions. Project the images below so that the students can see what artists think an asteroid impact on the Earth would look like.

David A. Hardy

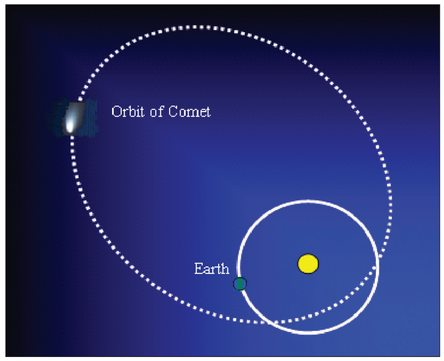
Throughout history, people have observed asteroid strikes on Earth. New technology in the 21st century has allowed scientists to detect more and smaller objects in the sky that could impact our planet. There are a few asteroids that these scientists warn could come close enough to the Earth to make contact. As an extension, students could learn more about asteroids that have impacted the Earth or that may impact it in the future.

Technology Integration: Search the internet using the keywords "asteroids" and "near misses" to find information about asteroids that have come close to the Earth.

Don Davis

As previously mentioned, one of the theories about why dinosaurs became extinct is that a massive asteroid hit our planet. A good critical-thinking question to ask the students is: "If this theory is true, what should be present on the surface of the Earth?" (*Answer: A huge crater*)

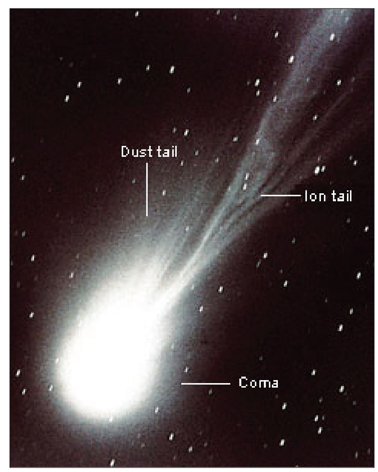
The orbits of comets are extremely elliptical. Project the image below, which shows how a comet comes close to the Sun at one end of its path and swings out far away from it at the other. Review by comparing the extreme elliptical orbits of comets to the near-circular orbits of planets.



Extension: Students can learn about the Oort cloud, which is a huge spherical cloud that surrounds our solar system and lies beyond the Kuiper Belt. Many comets originate from the Oort cloud, especially those that have long lifespans. These comets have large orbits and take more than 200 years to orbit the Sun.

Halley's Comet

The most famous comet is Halley's Comet, which passes by the Earth every 75 to 76 years. This comet was the first comet to be understood as a periodic comet—one that returns on a regular time interval. Project the image of Halley's Comet at right, and identify the tail, which is the most obvious feature of a typical comet. Most comets have two tails; one is a dust tail, and the other is a tail of ionized gas.



NASA: Lick Observatory

Student Activity: Measuring Craters

This activity is similar to the crater formation teacher demonstration from earlier in the lesson. Divide the students into groups, and have each group drop a rock into a shallow pan of sand or flour and then measure the depth of the resulting crater. The students should raise the height from which they drop the rock (10-100 cm) so that the velocity of the falling rock increases; consequently, the depth of the crater will also increase. Have the students record these numbers in a table like the one at right.

Look Out Below!	
Drop Height	Crater Depth
10 cm	
20 cm	
30 cm	
40 cm	
50 cm	
60 cm	
70 cm	

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