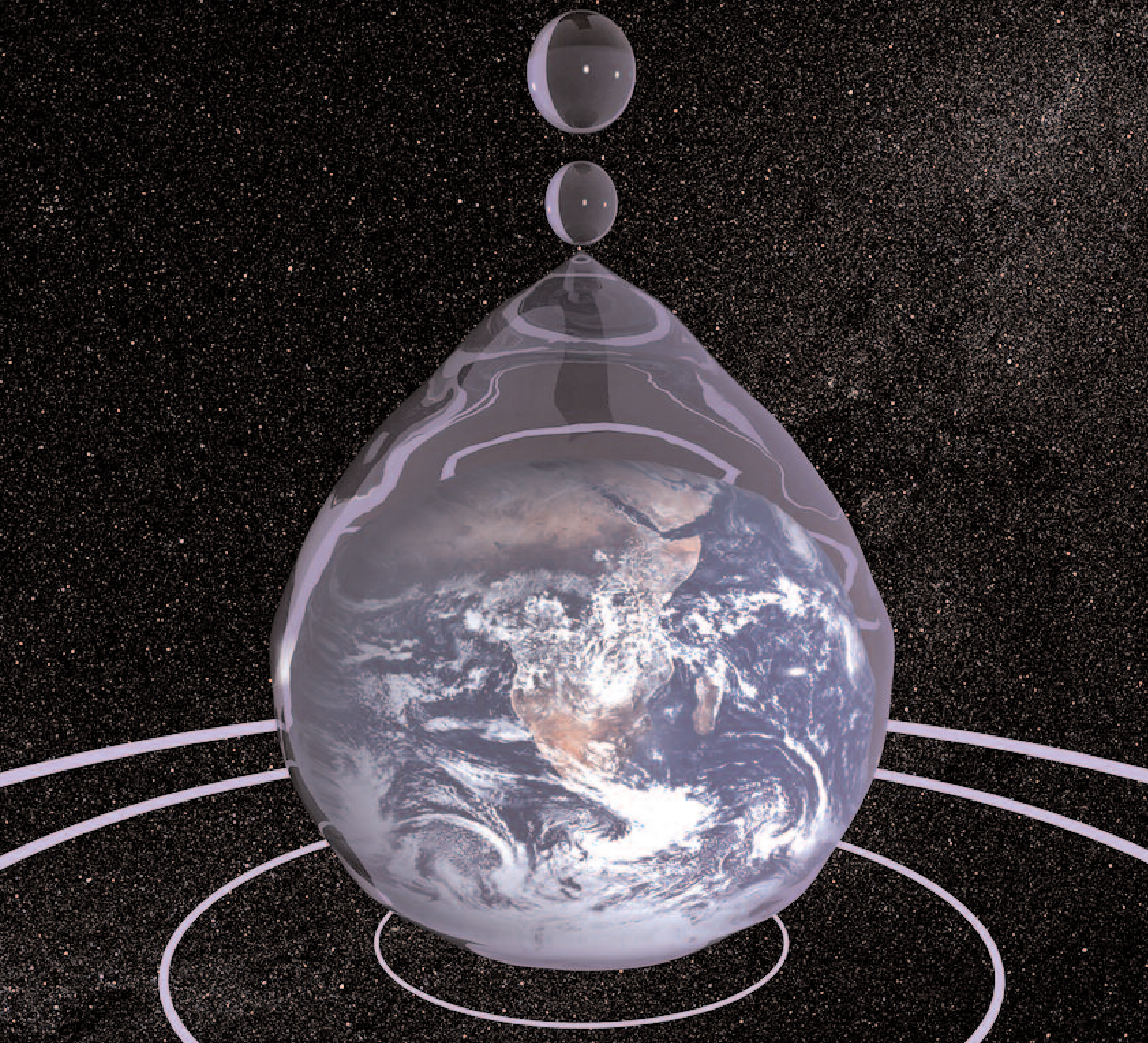
Oasis in Space

Teacher's Guide



SPITZ

Dear Educator,

Welcome to the "Oasis In Space" Teacher's Guide! Created by Spitz, Inc., "Oasis In Space" takes you on a startling and beautiful voyage through our universe, galaxy and solar system in search of water and water worlds like Earth. This guide contains content and activities to do before and after your trip to support your planetarium show experience, and to promote the central premise of "Oasis In Space".

Earth is a very special planet because it has liquid water, and can therefore support life.

The activities in this guide encourages students to wonder about the question:

How can we find out if our planet is the only planet with life?

The guide contains three main sections:
1. **Structure of the Solar System**
2. **The Search for Water**
3. **Looking for Life on Other Planets.**

The third section, Looking for Life on Other Planets, offers suggestions for your planetarium show trip and pulls together learning from the other two sections. However, the sections and activities may also be done independently.

Each section has content pages to help you with the background of each activity. In addition, there are black line masters, where needed, to support the activities. While most of the activities are correlated to the National Science Education Standards for grades 5–8, you'll find activities appropriate for elementary and senior grades as well.

We encourage you to use "Oasis in Space" as a vital and exciting research resource in your classroom. The activities in the guide, especially the culminating activity, are designed not only to help your students enjoy the show, but for the show to help your students to understand the activities.

Enjoy your trip through the solar system!

The Franklin Institute Science Museum

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Description of Oasis in Space planetarium show

We invite you to journey through the solar system and gaze at beautiful images of the planets and their satellites. We start by exploring Earth, with its vast oceans that make life possible. One by one, we fly by the other planets and moons, accompanied by full descriptions of their characteristics, such as atmosphere, temperature, and composition. Spectacular pictures invite students to draw their own conclusions about the other orbiting bodies in our solar system: is there water out there? Is there life beyond Earth?

LITTLE GREEN MEN

Objective:
Introduce students to the possibilities of life on other planets.
Prepare students to study possibilities for life in our solar system.

Standards:
Science as Inquiry: Think critically to discover the relationships between evidence and explanations

Materials:
Pictures of controversial "alien" formations

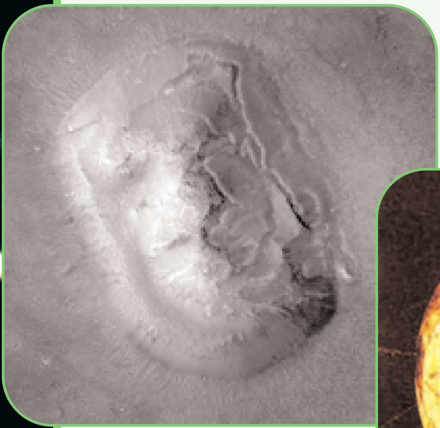
Things to Discuss Before:
Ask students what aliens they are familiar with from movies, books, or television. Create a list of popular aliens and discuss their characteristics.
What do they have in common?
What's different about each one? Do the students think they could exist?
Where might these aliens live? What would they need to survive?

You may want to point out that many Hollywood aliens are bipedal so actors can fit in the costumes, not because aliens are necessarily "little green men."

Things to Do:

1. Pass around pictures and stories of controversial formations on other planets, such as the "Mars Face", the pyramids and the canals some claim to be on Mars (see below).
2. Have students discuss or write about what they believe about the pictures. Do they think the pictures show evidence of aliens? Why or why not?

Things to Discuss After:
What do students think about the pictures? Explain that the "face" is merely caused by shadows playing across elevated surface geologic features. How does Hollywood and science fiction shape our ideas of aliens? Do students think aliens exist? What would they look like?



This picture of the surface of Mars touched off a storm of speculation when it was released in 1976. What do you see? Some people think that this "face" is evidence of intelligent life on Mars. What do you think?

This is a drawing made in the early 1900's by the famous astronomer, Percival Lowell. He saw straight lines on the surface of Mars and thought they were "canals." People thought that these "canals" on Mars were made by intelligent beings who used them to transport melting polar ice to irrigate crops. What do you see? What do you think?

STRUCTURE OF SOLAR SYSTEM

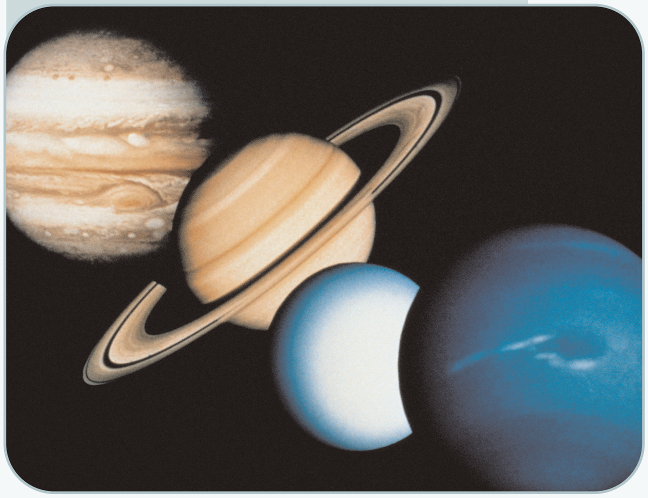
Our solar system is incredibly huge. The parts we are most familiar with, the Sun and planets, occupy only a small percentage of the actual area that is governed by the sun's gravitational influence. If we shrank the Sun into a tiny ball two-thirds of an inch in diameter and placed it on the end zone of a football field, the Earth would be two yards away from the Sun. Far ranging Pluto, however, would be 79 yards away. As big as the Sun and planets are, they become tiny specks in the vastness of our solar system.

The solar system is primarily composed of nine planets revolving around the sun. A close look at the nine planets reveals that the planets share characteristics based on their size, mass, and distance from the sun.

Go to www.solarsystem.nasa.gov/planets for great images and information from NASA about each of major bodies in our solar system.

The Inner, or Terrestrial Planets:
Mercury, Venus, Earth, and Mars

The Outer, or Gas Giant Planets:
Jupiter, Saturn, Neptune, Uranus



GENERAL PLANET DESCRIPTIONS

The four inner planets are small rocky bodies closer to the sun. One major feature of the inner planets is their solid surface. Of the five outer planets only Pluto has a solid surface. Gas giant planets are really made of gas—about 90-95% of their composition! Imagine a rocky pea surrounded by 100 miles of frozen gas.

The outer gas giant planets are significantly bigger than the terrestrial planets. If Jupiter were hollow, 1000 Earths could fit inside! As big as the planets are, they are tiny in comparison to the Sun. It would take a million planets the size of Earth to fill the sun! The Sun makes up 99.85% of the mass of the solar system; all of the planets combined are only 0.135% of the mass.

Pluto does not neatly fit into these two categories. The smallest, coldest, and furthest planet from the sun, Pluto may actually be part of an encircling debris field left over from the formation of the solar system called the Kuiper Belt. Some of our comets come from the Kuiper Belt.

Create a Scale Model of the Solar System

Objective:
Learn the basic structure of the solar system, and understand the scale and distances between the planets.

Standards:
Earth and Space Science: Earth in the solar system.

Materials:
Paper, tape, objects to represent the planets based on the scale of your model (balls, marbles, nuts, beans, M&M's, sprinkles, a pencil dot)

Things to Prepare:
While this can easily be done inside a school building, this activity is most effective with over half a mile of space, ideally outdoors.
Activity Steps:

1. Find the longest space you have access to (ideally outdoors).
2. Use the solar system calculator (http://www.exploratorium.edu/rohn/solarsystem) to calculate planet sizes and distances, based on how much space you have.
3. Choose the objects you'll use to represent the planets.
4. Calculate distance between planets in paces (one pace is approximately one yard).

Things to Discuss Before:
Ask students what they know about the structure of the solar system. Draw a diagram based on their understandings. Explain that the students are going to create a scale model of the solar system. Show them the items that will be used as planets. Discuss the scale of the planets and sun. Divide the class into nine groups. Have each group tape their "planet" to a piece of paper and write the name of their planet on the paper.

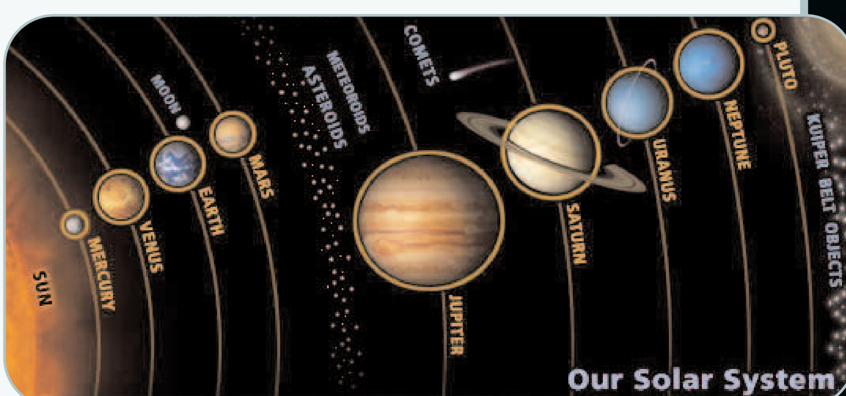
Things to Do:
Place the sun at one end of your space. Pace off the distance to Mercury and have the Mercury group put Mercury down "in orbit." Continue with other planets.

Things to Discuss After:
What did students notice about the distances between the planets?
What would happen if the sun model were bigger?

Extensions:

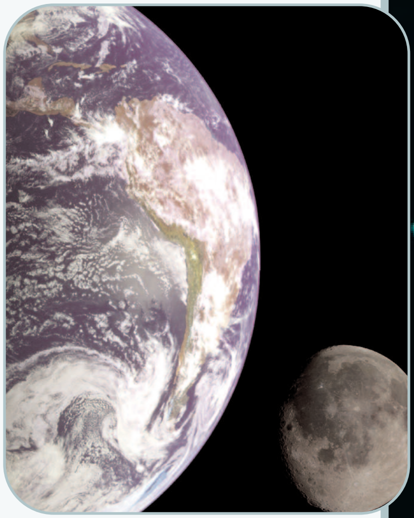
- Overlay your scale model on a map. If the school was your sun, what street would Earth be on?

  What community would Pluto be in? What if the sun were bigger—where would the planets be on a map?



(Image courtesy of NASA)

Moon and Planet Patterns



Children are usually presented with a model of the solar system as a collection of whirling planets whizzing around the sun. But what does this model actually mean? The model has more meaning for children if they are able to connect it with the reality of what they see outside. Direct observations of the moon and the planets offer children "hands-on" opportunities for discovering the structure of the solar system and help students make a personal connection to our solar system. The moon is a familiar feature in the night sky, but few children are able to describe and predict its movements and phases. Join your students as they discover the patterns of our solar system!

Go to http://aa.usno.navy.mil/data/docs/RS_OneDay.html to find out the sun and moon rising and setting times for your area.

Tips for helping children perform astronomy observations

Children need patience and repetition to observe successfully. They do not need to gaze at the sky for extended periods of time. Instead, they can take quick 60 second observations. Suggest to the children that they look up in the sky at certain times: when they are leaving school, every time they enter their home, or right before bedtime. You can add different challenges to keep the observations fresh and interesting. Can the students identify the brightest star? How about stars with colors? Can the children make a shape out of the stars in the sky?

Children also need guidance. Stress that the children should draw as they are looking up at the sky and not trust their memories to draw what they see later; without supervision, there is the danger that children will draw what they think they should see instead of what they actually see. Ideally, children will have some help to make their observations such as a previous planetarium experience, a knowledgeable guide, or best of all, a parent.

One great way to involve parents is to invite your local astronomy club to your school one evening and hold a star gazing party for students and families. Astronomy clubs are usually quite eager to bring their telescopes and discuss interesting phenomena in the sky. Parents can learn about astronomy right along with their children, and the family has a new hobby to do together!

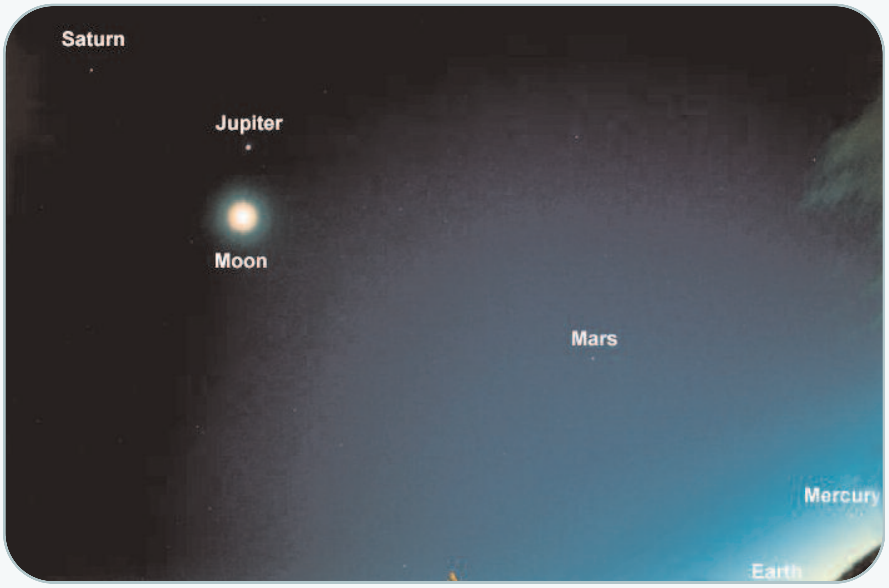
Moon Phases

The moon goes through a full cycle of phases once a month (a "moonth"), or every 29.53 days. As the moon grows, we call it a *waxing* moon. As it shrinks, we call it a *waning* moon. The lighted side always faces the sun because moon-light is actually reflected sunlight. On average, the moon is visible about 12 hours a day. Like the sun, it rises in the east and sets in the west. It rises and sets approximately 50 minutes later every day. When full, the moon rises and sets 12 hours later than the sun. When new, the moon rises and sets about the same time as the sun. You will find it difficult to see the moon when it is new. Its position in the sky is so close to the sun's position, the sun's light makes the moon impossible to see.

Viewing the planets
There are five "naked eye" planets, or planets that are visible without equipment: Venus, Mars, Jupiter, Saturn, and Mercury. However, Mercury is small and difficult to see, so you may want to concentrate on the other four planets.

You can tell the difference between stars and planets because stars twinkle while planets do not. The light from stars travels over a much greater distance than the light from the planets. The twinkling is a result of light distortion as the light passes through Earth's atmosphere. If you include the planets in your daily observations, you may want to start by challenging your students to find the non-twinkling "stars" in the sky, watch their movements, and guess what they are.

Planets are also brighter than stars. We can use this to our advantage during twilight. When the sun first goes down, but while it is still light, the first objects we see in the sky are the planets. 10 to 15 minutes after the appearance of the planets, we start to see the brightest stars in the sky and finally, as the sky darkens, we see the dimmest stars.



(Image courtesy of Steve Sumner)

Venus: Venus is easy to spot because it is the brightest and largest "starlike" object in the sky. It is unusually bright and white, like a headlight.

Mars: Mars is known as the "Red Planet," and it deserves its name: it is the only planet with a distinct reddish color, and is therefore easily identified. When Mars' orbit brings it close to Earth, it is extremely bright—twice as bright as the brightest star in the sky. However, when it is far away, it is small and dim.

Jupiter and Saturn: Even though Jupiter and Saturn are much bigger in size, they look 30-40% smaller and are dimmer than Venus. It's a subtle difference, but Jupiter has a creamy color, while Saturn is more yellowish. These two planets are fascinating to see through a telescope. Jupiter has an enormous storm in its atmosphere called the Great Red Spot. Its four largest moons are easily visible in a small telescope, and it is interesting to watch the changing positions of the moons. Saturn has gorgeous rings and their visibility changes slowly over a 15-year period caused by the tilt of the rings.

Moon and Planet Observations

Objective:
Have children become familiar with the patterns of the moon and discover the planets through observation.

Standards:
Earth and Space Science: Earth in the solar system
Science as Inquiry: Develop descriptions, explanations, predictions, and models using evidence

Materials:
Moon and planet observation journals for each student (can be paper stapled together), a big chart, small pieces of black, blue, and white paper, chalk

Things to Discuss Before:
Ask children what they know about the moon. What does the moon look like? What have they observed?

Things to Do:

1. (optional) Take students outside to observe the moon. Practice drawing the moon together in the moon observation journals.
2. Have students draw the moon every time they see it in their moon observation journals. Make sure they include the date, time of the observation, position of the moon in the sky, and the position of the sun (see previous pages for tips on observing the moon).
3. Every day, have students copy their moon observations on small pieces of paper and write their names on their observations. Create a large class chart organized by date and time. Paste the moon observation pictures on the chart.
4. As the children become familiar with tracking objects in the sky, have them observe and draw pictures of the planets as well. Add the planets to your class observation chart (see previous pages for tips on observing planets).
5. Continue observing the moon and planets for one to three months to collect a rich body of data to analyze.

Things to Discuss After:
What patterns do students notice about the moon and the planets? How can they account for the patterns they see? Can the children make predictions about what they will see next?

see next page for moon observation chart

Moon Chart

Time of day	Sun	Mon	Tues	Wed	Thurs	Fri	Sat
Early Morning (4am-8am)							
Morning (8am-12 pm)							
Afternoon (12pm-6pm)							
Evening (6pm-9pm)							
Night (9pm-12am)							
Late night (12 am-4am)							

Modeling Phases and Movements of the Moon and Planets

Objective:
Study models of moon and planet movements to understand observations.

Standards:
Earth and Space Science: Earth in the solar system
Science as Inquiry: Develop descriptions, explanations, predictions, and models using evidence

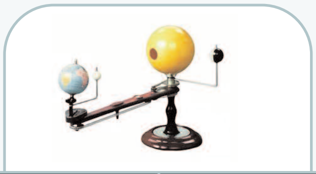
Materials:
Bright unshaded lamps (the sun), volleyballs or latex painted Styrofoam balls (the moon), other balls of various sizes and shapes (the planets)

Things to Discuss Before:
Based on observations and the planetarium show, how do students think the moon moves?
How do the planets move around the sun?

Things to Do:

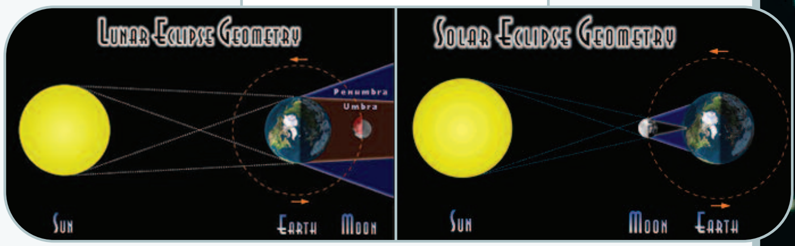
1. Set up a bright lamp (the sun) in the middle of the room and dim the lights. Position yourself (or a student) so that the lamp is in front of you and the students are behind you. Tell the students that you are the earth. Hold up a volleyball or Styrofoam ball (the moon) out in front of you but to your right or left at about shoulder height. You (the earth) should see a thin cresent of light on the moon.
2. Have another student hold "the moon" and walk around the earth in a circle representing how the moon orbits the sun. Be sure the students see how to make the thin cresent seen in the previous step and make sure they see that half of the moon is always illuminated by the sun no matter what the phase is.
3. Break the students into groups around other lamps and give each student their own "moon." Have them to rotate their moons around themself (as the earth) and describe what they see.
4. Have the students write and draw representations of how the moon is moving around the earth to create phases.
5. Bring the class together. Appoint various children to represent the earth, moon, and their motions.

Things to Discuss After:
How does this activity connect to observations of moon phases?
How does this activity connect to planet movements?



Extensions:

- Use your models to demonstrate eclipses, which is when the moon blocks the sun or the sun blocks the moon.



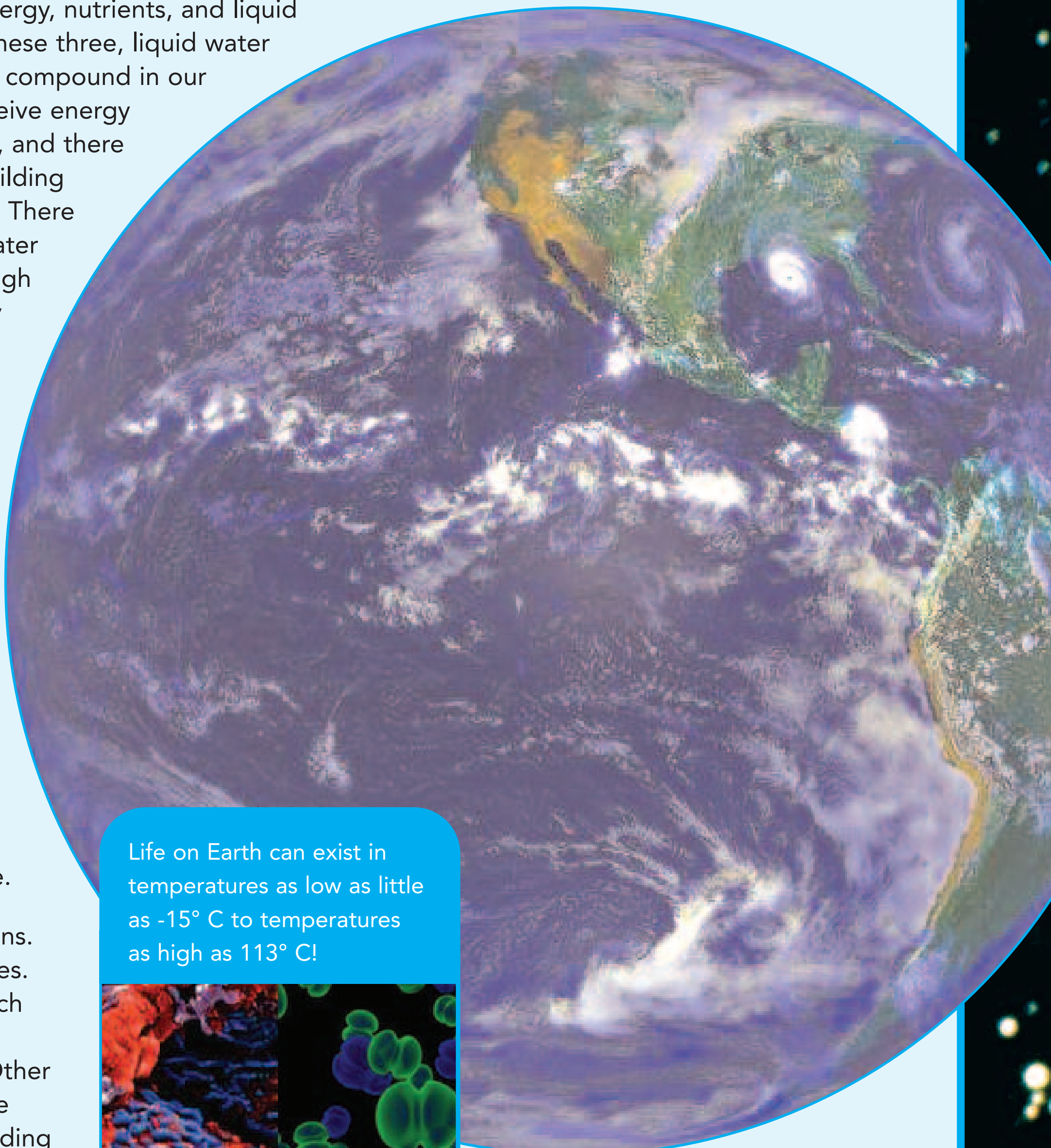
Contact your local astronomy club to hold a star party for your grade or your school. Often, astronomy clubs enjoy setting up their telescopes to show the public planets and other phenomena in the sky for free. In addition, this exposes the children to outlets for a new hobby; children may want to continue their astronomy observations by attending club meetings, or even starting their own astronomy club at school.

Take your students on a field trip to a local observatory.

THE SEARCH FOR WATER

Liquid Water: Elixir of Life

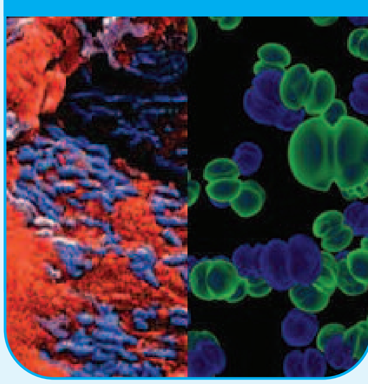
As far as we know, life needs energy, nutrients, and liquid water to form and survive. Of these three, liquid water is the most elusive and precious compound in our solar system. Other planets receive energy from the sun and internal forces, and there is plenty of carbon, the basic building block of life on Earth, available. There is even a great deal of frozen water and water vapor scattered through our solar system. However, only our planet has liquid water.



Liquid water is crucial for life because biochemical reactions require a solvent, or some sort of medium to move reactants around so they can react with each other. Ice has a solid matrix, not allowing molecules move, and vapor is too wispy and spread out. Other solvents, such as ammonia, may be conducive to life, but have such extreme boiling and freezing points that they are liquid outside of temperature ranges where we have found life.

Life on Earth started in the oceans. We are two-thirds water ourselves. Therefore, much of NASA's search for life in our solar system has focused on looking for water. Other planets and orbiting bodies have such extreme conditions that finding "little green men" is highly unlikely; if life existed on other planets, it would probably be in the form of tiny microorganisms. Still, the presence of other life in our solar system, albeit primitive, would boost our understanding of life and give us hope that other intelligent life exists in the universe.

Life on Earth can exist in temperatures as low as little as -15° C to temperatures as high as 113° C!



MICROBES BACTERIA

Liquid Water: Elixir of Life

Objective:
To understand why liquid water, not ice, is necessary for life to exist by using water and ice in chemical reactions.

Standards:
Life Science: Structure and function in living systems

TIP: The ice should be dry when it is added to the bag to ensure no reaction will take place.

Materials: Calcium chloride (used to melt driveways in the winter), sodium bicarbonate (baking soda), ziplock bags, water, very cold ice, spoons

Things to Discuss Before:
What does life need to survive? Is water necessary for life, and why?

Things to Do:
1. Have students add a spoonful of calcium chloride and a spoonful of sodium bicarbonate to a bag, seal, and shake. Observe and note what happens (there should be no reaction).
2. Have students add about 1/3 cup of water to their bags and shake. Observe and note what happens (the bag will inflate with carbon dioxide gas).
3. Have students prepare another bag of calcium chloride and sodium bicarbonate. Have students add ice to their bag, seal, shake, and observe and note what happens (there should be no reaction).
4. Dispose of waste down the sink or in the trash.

Things to Discuss After:
Discuss what students observed. Why did adding water produce a chemical reaction? Why didn't the ice have a similar effect? Explain that chemical reactions are necessary for life processes, and that water is necessary for chemicals to "move around" so they can react with each other. What implications does this have for looking for life on other planets?

Extension:
- Use phenol red in a third trial. The produced carbon dioxide is acidic, so the phenol red indicator will turn yellow.

Calcium chloride and sodium bicarbonate react to form carbon dioxide, calcium carbonate, and water. Ca2+ + 2 HCO3 ---> CaCO3 + H2O + CO2

Looking for Water

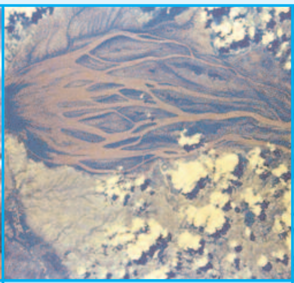
NASA scientists are eagerly looking for signs of water on other bodies in our solar system. Landforms on other planets may possibly offer evidence that water flows or might have flowed there. We can compare them to landforms formed by water on Earth.

Some common types of landforms formed by water on Earth are **channels**, which are stream or river beds. Channels may be straight, or they may **meander**. A meander is a loop or bend in a river. Flowing water can also form **floodplains** - wide, flat areas next to rivers. **Deltas** are formed at the mouth of rivers. Deltas are made of deposited silt, which builds up into a flat plain. **Sedimentary layers** are created as soil settles out of a lower energy stream environment like a slowing river or ocean. Sedimentary rock is created over thousands of years as the settling soil is compressed into layers.

CHANNELS

MEANDER

FLOODPLAINS



DELTAS

SEDIMENTARY LAYERS

Mars offers compelling evidence that water once flowed there. The pictures of Mars' surface on page 16 suggest there are remarkably similar to landforms on Earth that were carved by water, including channels, meanders, and sedimentary layers.

Scientists are also interested in Europa, one of Jupiter's moons. Conditions created by its magnetic fields may indicate the presence of a large, salty ocean. Europa is also covered by a thick sheet of fractured, but mostly smooth ice. These fractures, and the lack of craters, suggest that water repeatedly seeped through cracks in the ice and refroze, giving Europa a comparatively smooth surface. There is little evidence that liquid water exists elsewhere in our solar system.

We don't always have to go to other planets to study them; sometimes bits of other planets come to us in the form of meteorites. When scientists are able to study meteorites right after they've fallen (before they are changed by Earth's atmosphere or contaminated) they can discover clues about other planets and the origins of the solar system. Scientists have even found liquid water in some meteorites. It's rare to find a large meteor, but we can collect micrometeorites in our rainwater (activity, page 18). Meteorites are made of rock, metal (nickel and iron), or both. By using a magnet, we can collect metallic micrometeorites. Earth is constantly hit by many of these tiny particles.

Signs of Water

Objective:
Compare sand patterns in stream tables to pictures from other orbiting bodies to hypothesize the likelihood of liquid water.

Standards:
Earth and Space Science: Structure of the Earth system

Materials:
Stream tables, pictures of landforms from other planets
(recommended: help students understand why we are searching for water as a marker for life by doing the activity from page 13 first).

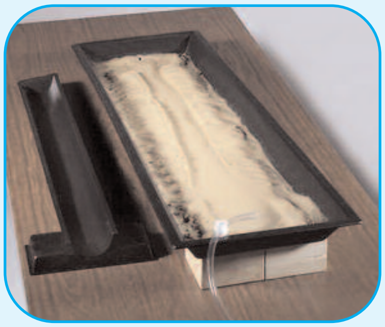
Stream Table Set Up
Practice making stream patterns before doing it with your students.

1. Fill shallow, long dishpans with sand. Prop one end up so it is inclined.
2. Set up a siphon system to create a water flow: Fill a bucket with water and raise it so it is higher than the dishpan. Place a very thin plastic tube in the bucket and submerge and shake it underwater to get all the bubbles out. Keep one end under water. Place your finger on the other end, lift that end out of the water, hold it over the dishpan, and let your finger go. The water should start flowing through the tube. The water should flow down the sand in a steady stream, creating stream patterns. It helps if you wet the sand first.

Things to Discuss Before:
Ask students how they can tell if liquid water existed on other planets. What are some signs of liquid water?

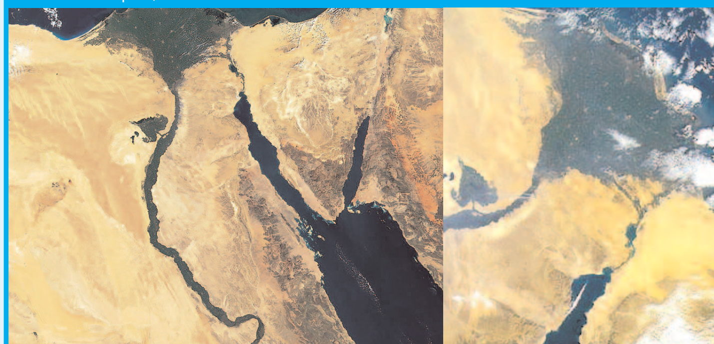
Things to Do:

1. Set up stream tables, approximately one for every four students (see above on how to set up a stream table).
2. Have students observe and sketch the patterns the water makes in the sand as it flows (children enjoy playing with stream tables. You may need a full class period for this). Encourage children to simply let the water flow after they've had a chance to play with the water and sand. Stop and discuss what patterns students noticed before the next step.
3. Pass out pictures of landforms from Earth and other orbiting bodies (next page). Have students decide which landforms may have been formed by flowing water based on their observations of stream tables and write or discuss why.



Things to Discuss After:
What did students notice about the stream tables? What planets do they think may have water?

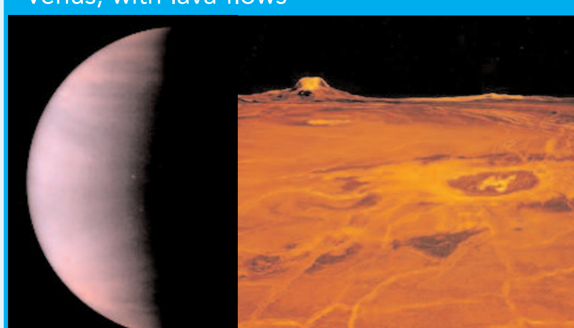
Earth, Nile River
(NASA/GSFC/MITI/ERSDAC/JAROS, and U.S./Japan)



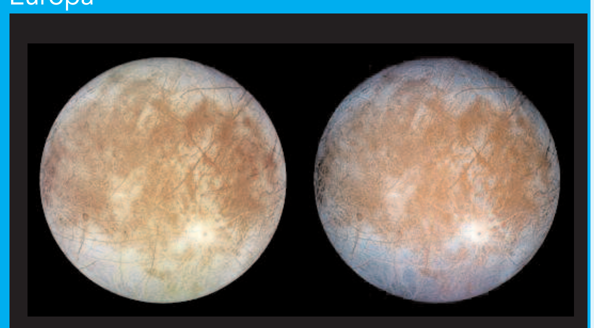
The lower Nile Valley
(Jeff Schmaltz, MODIS Rapid Response Team, NASA/GSFC)

Mars (Images courtesy of NASA/JPL/MSSS)

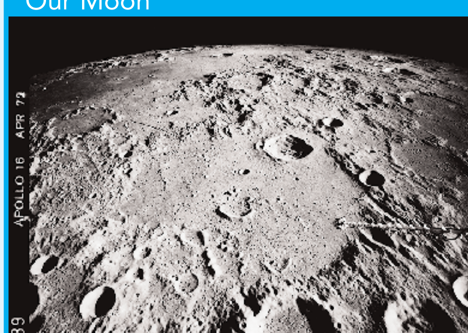
Venus, with lava flows



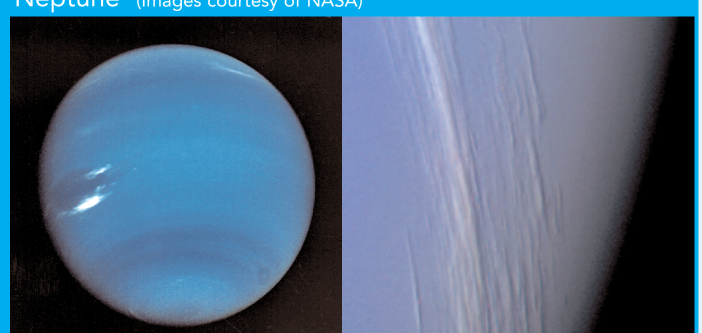
Europa



Our Moon



Neptune (Images courtesy of NASA)



Collecting Micrometeorites

Objective: To collect information from space.

Standards:
Earth and Space Science: Earth in the solar system

Materials:
Dish, plastic ziplock bags, strong magnets (bar magnets work well), distilled water, pan, hot plate, microscopes

Things to Discuss Before:
Explain that micrometeorites are tiny pieces of rock and metal that fall on Earth from space. Ask students how common they think micrometeorites are.

Things to Do:

1. Leave a clean dish outside to collect rainwater during a rainstorm. If you do not get a lot of rain, leave a dish of distilled water outside for several days.
2. Wrap a plastic bag around a small, strong magnet. Have students run the plastic wrapped magnet through the rainwater slowly and thoroughly.
3. Have students place the wrapped magnet in a clean pan of distilled water and remove the magnet. Swish the plastic bag around in the water to shake off all particles.
4. Evaporate the water over a hot plate.
5. Examine particles under a microscope. Meteorites are round and pitted.

Things to Discuss After:
Ask students what they noticed about the micrometeorites. Were they surprised by how common they were? Explain that scientists can study meteorites to find out more about our solar system, including finding evidence of water in meteorites.

Extensions:

- Observe a meteor shower, or shooting stars. 10-15 meteors normally fall per hour, but during a meteor shower, we may see up to 100 meteors an hour.
  Go to http://comets.amsmeteors.org/meteors/calendar.html for a calendar of meteor showers.
  Of note are the Perseid meteors in August and the Geminid meteors in December.

LOOKING FOR LIFE ON OTHER PLANETS

Life needs water to exist, but it also needs other favorable conditions. An atmosphere protects the planet, moderates the temperature, and is a source of biochemicals. On Earth, life has been found at temperatures between -15°C to 115°C. Any hotter, proteins and DNA break down; any lower, cellular reactions proceed too slowly. Life also needs a source of energy, which may be sunlight or chemical (some microbes on Earth gain energy by breaking down chemicals). Finally, life needs nutrients, or materials to build and sustain itself.

Mars and Europa (one of Jupiter's moons) are two top contenders for harboring life in our solar system, either now or in the past. They may have liquid water (see page 15). Mars has an atmosphere and temperatures between -133C° and 27C°. It is close enough to the Sun for the Sun to be a source of energy. Europa is far away from the sun, but may have internal heating to provide energy and keep its possible large ocean melted. Both bodies, like most bodies in our solar system, have the.organic compounds .

Oasis in Space Planetarium Show

You can use "Oasis in Space" as a research resource for your students. The show gives us an overview of the orbiting bodies of the solar system and some of their characteristics. Before the show, you may want to discuss with your class some of the factors that make a planet favorable for life and go over the provided trip sheet so the students are ready to answer the questions. Students could be prepared to think critically about the evidence presented in the planetarium show and be ready to pick a planet to research for the culminating activity.

Planetary Exploration Culminating Activity

The final activity, "Planetary Exploration," helps students reflect and synthesize the material from the other lessons. You may want to refer students back to previous activities.

These are three questions that drive that solar system exploration:

1. Where do we come from?
2. Where are we going?
3. Are we alone?

While much of our exploration is focused on finding water, scientists are dedicated to discovering the origins of our solar system, of life, and how our solar system continues to develop.

Check out http://solarsystem.nasa.gov/multimedia/downloads/SSE_Roadmap.pdf for more information about NASA's goals, technology, and future directions for solar system exploration.

Oasis in Space Planetarium Show Trip Sheet

Name: ______________________________

1. Why is Earth an Oasis in Space? (hint: an oasis is a place of refuge, or a fertile, growing place in a desert)

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2. What orbiting body (the planets and their moons), besides Earth, is the most likely to have life? (the show mentions our Moon, Mercury, Venus, Mars, Jupiter, Europa (Jupiter's moon), Saturn, Uranus, Neptune, and Pluto)

____

Why?

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3. Draw a picture of an alien life form you think might be on this chosen planet.

4. Describe why you have chosen the specific characteristics it has.

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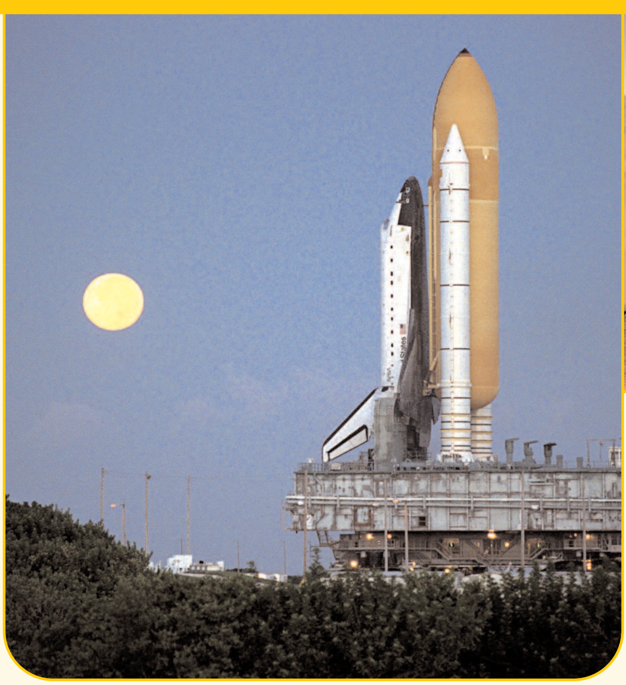
Are We There Yet?

We can collect information about our solar system with telescopes, probes, rovers, and shuttles. Space **Telescopes**, like the Hubble Space Telescope, are not sent to other planets but take pictures from Earth orbit. They take astonishing pictures because they are not obstructed by the Earth's atmosphere. **Probes** are unmanned spacecraft that are sent to other parts of our solar system. They carry sophisticated instruments and communicate with Earth via radio. Probes can be sent into orbit around a planet, fly by a planet, or soft-land instrument packages, such as a rover. **Rovers** are vehicles that can explore the terrain of a planet or satellite. **Space shuttles** are currently NASA's only vehicle for transporting people in space. They are used to launch and repair satellites, assemble and service the International Space Station, and conduct scientific experiments.

Even traveling at very high speeds space probes still take a long time to reach other planets. The Cassini-Huygens probe took almost seven years to reach Saturn. A manned mission to our neighbor, Mars, would still take six to nine months to get there—one way! After a three month stay at Mars (Mars and Earth need to be in the proper positions before heading back) and a return, a manned mission to Mars would last 21 months. Astronauts would need a great deal of water, food, and toilet paper to make it through their trip, to say nothing of the enormous amount of fuel required to launch all of it. While children realize that wormholes and warp drive do not exist, they usually do not have a grasp of how vast space is.

The worksheet on page 21 assumes that the planets are stationary and that we can travel in a straight line from one planet to the next. With these assumptions, a trip to Mars via space shuttle would take four months. However, when we factor in the movements of the planets, the journey actually takes nine months.



Are We There Yet?

Objective:
Help students understand the vastness of space and some methods of exploring.

Standards:
Science and Technology: Understandings about science and technology

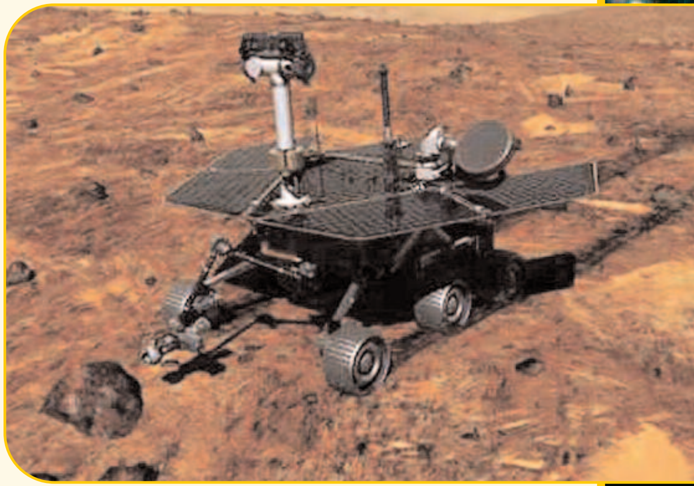
Materials:
"Are We There Yet?" worksheets
(answers to worksheet on following page)
(recommended: first build a model of the solar system, page 7).

Things to Discuss Before:
Discuss different methods of exploring. What are some ways students would explore other orbiting bodies? Explain that we currently use probes, telescopes, rovers, and shuttles to explore our solar system. Explain the differences between the four types of craft. Explain that these craft can orbit the Earth and take pictures, such as Hubble; not all craft need to journey to other planets.

Things to Do:

1. Demonstrate the math necessary to do the worksheet on the following page.
2. Have kids fill out worksheets to calculate how long it takes to get to other orbiting bodies by probe, shuttles, light, car, bike, jet plane.

Things to Discuss After:
What did students notice about exploring our solar system?
What methods do they think we should use?

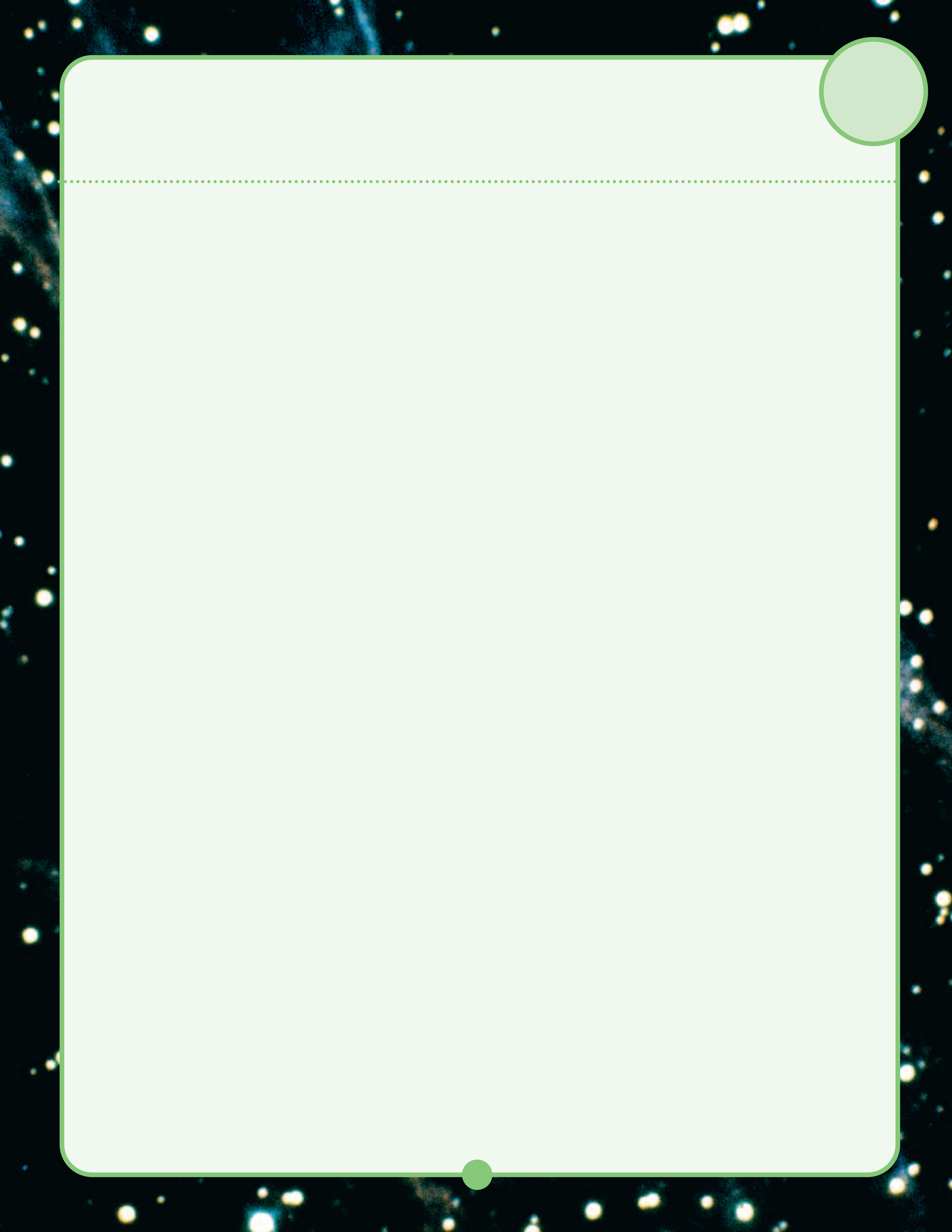


Are We There Yet?

Name: ______________________________________

Calculate how long it takes to get to other bodies in our solar system using different methods of exploration. For example, Venus is 26,040,000 miles away from Earth. Therefore, to travel by shuttle, we would divide the distance by the speed of the shuttle: 26,040,000 miles / 17,000 mph = 1532 hours/24 hours per day = 64 days.

Orbiting body distance from Earth	**PROBE speed = 11,700 mph (Cassini probe)**	**SHUTTLE speed = 17,000 mph**	**LIGHT speed = 670,616,629 mph**
Moon 239,000 miles			
Venus 26,040,000 miles		64 days= 2 months	
Mars 48,360,000 miles			
Jupiter 390,600,000 miles			
Pluto 3,576,780,000miles			



Mission Costs

Name: ____

Team Name: ____

		Quantity	Subtotal
1. Pick the spacecraft:			**Subtotal**
Space Shuttle	1.5 billion		$
Space probe (Note: probes can be used to orbit a planet, land science equipment ona planet, like a rover, or fly by a planet.)	560 million		
Telescope (orbits Earth)	506 million		
2. Pick the instruments you need to do research:		**Quantity**	**Subtotal**
Rover	216 million		$
Radio	50 million		
Computer	100 million		
Sample Collector	30 million		
Camera	50 million		
Lander (to land on surface)	100 million		
Drill to drill into surface and take samples	25 million		
Remote sensor	30 million		
3. Calculate the total cost These are not actual costs. Check out http://www.jsc.nasa.gov/bu2/SVLCM.html for NASA's cost estimate calculator.			**Total Cost** (Can't be over 2000 million!) $

Glossary

Suggested Resources

http://nai.arc.nasa.gov/astrotech/solarindex.cfm
This website from NASA explores the possibility of life in our solar system. It guides students in analyzing amazing images from the orbiting bodies of our solar system for signs of life.