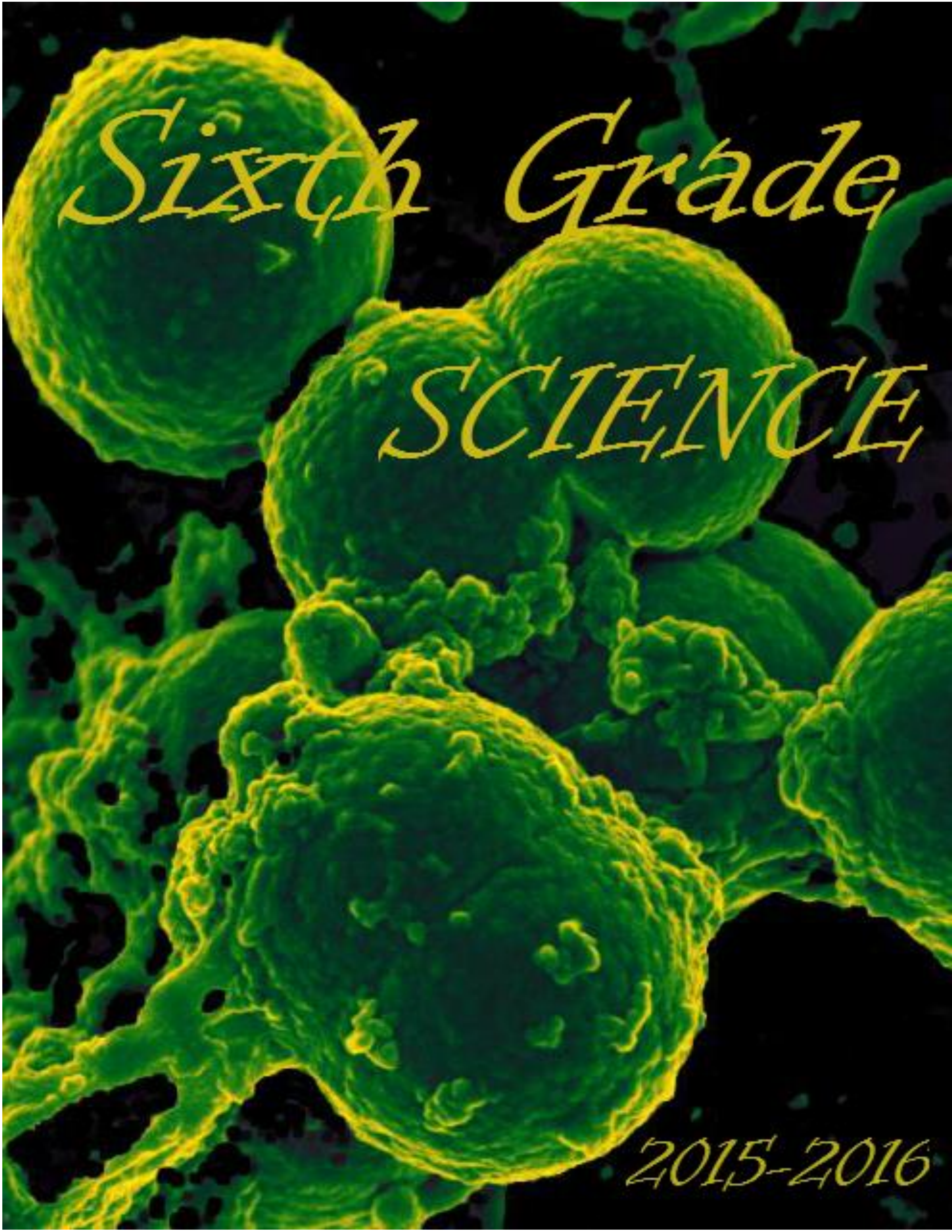

Sixth Grade SCIENCE

2015-2016

Credits

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CK-12

SIYAVULA
TECHNOLOGY-POWERED LEARNING

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Utah Core Curriculum Alignment

Standard 1

Objective 1: Explain patterns of changes in the appearance of the moon as it orbits Earth.

a. Describe changes in the appearance of the moon during a month.
b. Identify the pattern of change in the moon's appearance.
c. Use observable evidence to explain the movement of the moon around Earth in relationship to Earth turning on its axis and the position of the moon changing in the sky.
d. Design an investigation, construct a chart, and collect data depicting the phases of the moon.

Objective 2: Demonstrate how the relative positions of Earth, the moon, and the sun create the appearance of the moon's phases.

a. Identify the difference between the motion of an object rotating on its axis and an object revolving in orbit.
b. Compare how objects in the sky (the moon, planets, stars) change in relative position over the course of the day or night.
c. Model the movement and relative positions of Earth, the moon, and the sun.

Standard 2

Objective 1: Describe the relationship between the tilt of Earth's axis and its yearly orbit around the sun.

a. Describe the yearly revolution (orbit) of Earth around the sun.
b. Explain that Earth's axis is tilted relative to its yearly orbit around the sun.
c. Investigate the relationship between the amount of heat absorbed and the angle to the light source.

Objective 2: Explain how the relationship between the tilt of Earth's axis and its yearly orbit around the sun produces the seasons.

a. Compare Earth's position in relationship to the sun during each season.
b. Compare the hours of daylight and illustrate the angle that the sun's rays strikes the surface of Earth during summer, fall, winter, and spring in the Northern Hemisphere.
c. Use collected data to compare patterns relating to seasonal daylight changes.
d. Use a drawing and/or model to explain that changes in the angle at which light from the sun strikes Earth, and the length of daylight, determine seasonal differences in the amount of energy received.
e. Use a model to explain why the seasons are

reversed in the Northern and Southern Hemispheres.

Standard 3

Objective 1: Describe and compare the components of the solar system.

a. Identify the planets in the solar system by name and relative location from the sun.
b. Using references, compare the physical properties of the planets (e.g., size, solid or gaseous).
c. Use models and graphs that accurately depict scale to compare the size and distance between objects in the solar system.
d. Describe the characteristics of comets, asteroids, and meteors.
e. Research and report on the use of manmade satellites orbiting Earth and various planets.

Objective 2: Describe the use of technology to observe objects in the solar system and relate this to science's understanding of the solar system.

a. Describe the use of instruments to observe and explore the moon and planets.
b. Describe the role of computers in understanding the solar system (e.g., collecting and interpreting data from observations, predicting motion of objects, operating space probes).
c. Relate science's understanding of the solar system to the technology used to investigate it.
d. Find and report on ways technology has been and is being used to investigate the solar system.

Objective 3: Describe the forces that keep objects in orbit in the solar system.

a. Describe the forces holding Earth in orbit around the sun, and the moon in orbit around Earth.
b. Relate a celestial object's mass to its gravitational force on other objects.
c. Identify the role gravity plays in the structure of the solar system.

Standard 4

Objective 1: Compare the size and distance of objects within systems in the universe.

a. Use the speed of light as a measuring standard to describe the relative distances to objects in the universe (e.g., 4.4 light years to star Alpha Centauri; 0.00002 light years to the sun).
b. Compare distances between objects in the solar system.
c. Compare the size of the Solar System to the size of the Milky Way galaxy.

d. Compare the size of the Milky Way galaxy to the size of the known universe.

Objective 2: Describe the appearance and apparent motion of groups of stars in the night sky relative to Earth and how various cultures have understood and used them.

a. Locate and identify stars that are grouped in patterns in the night sky.
b. Identify ways people have historically grouped stars in the night sky.
c. Recognize that stars in a constellation are not all the same distance from Earth.
d. Relate the seasonal change in the appearance of the night sky to Earth's position.
e. Describe ways that familiar groups of stars may be used for navigation and calendars.

Standard 5

Objective 1: Observe and summarize information about microorganisms.

a. Examine and illustrate size, shape, and structure of organisms found in an environment such as pond water.
b. Compare characteristics common in observed organisms (e.g., color, movement, appendages, shape) and infer their function (e.g., green color found in organisms that are producers, appendages help movement).
c. Research and report on a microorganism's requirements (i.e., food, water, air, waste disposal, temperature of environment, reproduction).

Objective 2: Demonstrate the skills needed to plan and conduct an experiment to determine a microorganism's requirements in a specific environment.

a. Formulate a question about microorganisms that can be answered with a student experiment.
b. Develop a hypothesis for a question about microorganisms based on observations and prior knowledge.
c. Plan and carry out an investigation on microorganisms. {Note: Teacher must examine plans and procedures to assure the safety of students; for additional information, you may wish to read microbe safety information on Utah Science Home Page.}
d. Display results in an appropriate format (e.g., graphs, tables, diagrams).
e. Prepare a written summary or conclusion to describe the results in terms of the hypothesis

for the investigation on microorganisms.

Objective 3: Identify positive and negative effects of microorganisms and how science has developed positive uses for some microorganisms and overcome the negative effects of others.

a. Describe in writing how microorganisms serve as decomposers in the environment.
b. Identify how microorganisms are used as food or in the production of food (e.g., yeast helps bread rise, fungi flavor cheese, algae are used in ice cream, bacteria are used to make cheese and yogurt).
c. Identify helpful uses of microorganisms (e.g., clean up oil spills, purify water, digest food in digestive tract, antibiotics) and the role of science in the development of understanding that led to positive uses (i.e., Pasteur established the existence, growth, and control of bacteria; Fleming isolated and developed penicillin).
d. Relate several diseases caused by microorganisms to the organism causing the disease (e.g., athlete's foot -fungi, streptococcus throat -bacteria, giardia -protozoa).
e. Observe and report on microorganisms' harmful effects on food (e.g., causes fruits and vegetables to rot, destroys food bearing plants, makes milk sour).

Standard 6

Objective 1: Investigate the movement of heat between objects by conduction, convection, and radiation.

a. Compare materials that conduct heat to materials that insulate the transfer of heat energy.
b. Describe the movement of heat from warmer objects to cooler objects by conduction and convection.
c. Describe the movement of heat across space from the sun to Earth by radiation.
d. Observe and describe, with the use of models, heat energy being transferred through a fluid medium (liquid and/or gas) by convection currents.
e. Design and conduct an investigation on the movement of heat energy.

Objective 2: Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

a. Compare light from various sources (e.g., intensity, direction, color).

b. Compare the reflection of light from various surfaces (e.g., loss of light, angle of reflection, reflected color).
c. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).
d. Predict and test the behavior of light interacting with various fluids (e.g., light transmission through fluids, refraction of light).
e. Predict and test the appearance of various materials when light of different colors is shone on the material.

Objective 3: Describe the production of sound in terms of vibration of objects that create vibrations in other materials.

a. Describe how sound is made from vibration and moves in all directions from the source in waves.
b. Explain the relationship of the size and shape of a vibrating object to the pitch of the sound produced.
c. Relate the volume of a sound to the amount of energy used to create the vibration of the object producing the sound.
d. Make a musical instrument and report on how it produces sound.

Why Science?

Many students equate science to learning vocabulary terms, labeling pictures, and memorizing facts. Science by nature is much more inclusive and loosely defined. Have you ever asked yourself questions about your surroundings and wondered how or why they are happening? This is science. Science works best when driven by curiosity and innovation. In order for you to experience science in its fullest sense you must take it beyond the textbook and into your everyday experience, but in order to be meaningful there are certain guidelines that can help us. Science is not constrained to the study of space and microorganisms, but there are cross-cutting concepts threaded throughout all scientific disciplines. These include:

- Patterns; such as the moon phase cycle, rotation, revolution, wavelengths of sound and light.
- Cause and effect: Mechanism and explanation; such as disease-causing microbes, the effects of gravity and velocity on the orbit of celestial objects.
- Scale, proportion, and quantity; such as solar system, universe, galaxy, size of microorganisms.
- Systems and system models; such as solar system, rotation, revolution, constellations.
- Energy and matter: Flows, cycles, and conservation; such as heat transfer, conduction, convection, radiation, sound travels through matter, light does not require a medium.
- Structure and function; such as microorganisms, cell and organelles.
- Stability and change; such as seasons, rotation, revolutions, law of reflection.

When studying any specific scientific discipline you should attempt to keep these cross-cutting concepts in mind in order to gain a better perspective of the world as whole and the nature of science. Included in the concepts are the skills and practices that scientists and engineers utilize. When asking questions about the natural world there are certain skills and practices that can help you be generate better conclusions, explanations and inferences. These practices include:

- Asking questions and defining problems
- Developing and using models
- Planning and carrying out investigations
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations and designing solutions
- Engaging in argument from evidence
- Obtaining, evaluating, and communicating information

While these practices and cross-cutting concepts are crucial to your overall success in science, in order to be most meaningful they do need some context. This is where the study of disciplinary core ideas are most impactful. If you study or any other scientific discipline without the cross-cutting concepts and scientific practices then you limit yourself to fact memorization and miss how these concepts relate to our everyday life and our society as a whole. Studying individual scientific disciplines are the vehicle for understanding cross-cutting concepts and acquiring scientific skills. When individual disciplines are studied within the context of practices and cross-cutting concepts they become more meaningful and more impactful.

With technology improvements, the ability to solve problems in creative ways increases. There are many examples in the world around us of how the science we learn in sixth grade helps people in general. As astronomers are better able to see elements of the universe, the same technology is used to improve communication such as the internet, cell phones, and multimedia sources. Medical researchers, doctors, and microbiologists work together to find new cures for illnesses. As the knowledge of the transfer of heat energy improves, companies develop different types of clothing to help runners and athletes cool down or stay warm. Tiny speakers have been invented to amplify sound. The skills we learn in science will help all of us, not just scientists, solve everyday problems.

Moon phases

chapter 1

What causes the moon to change in appearance and position in the sky?

Standard 1: Objective 1 6th Grade
Text Structure: Sequence

Doesn't it seem as if the moon's shape changes night after night? As the moon **orbits** -the curved path of a celestial object or spacecraft around a star or planet–Earth, it appears as though the moon is changing its shape in the sky. This is because as the moon changes its position, the amount of sunlight reflected back to Earth also changes. The moon sometimes appears fully lit and sometimes completely dark. Most of the time we see it partially lit.

The North and South Poles mark Earth's axis. Earth **rotates** on its axis every 24 hours. Another major movement of planets and moons is **revolution**-the circling of an object in space around another object in space. It takes a year for earth, or 365.25 days, to revolve around the sun. It takes the moon about 29 days to revolve around Earth. This path is called an **orbit**.

Just as Earth rotates on its axis and revolves around the sun, the moon rotates on its axis and revolves around Earth. The moon's revolution or orbit around Earth is responsible for the changes in its appearance. It takes the moon about one month to orbit Earth. It also takes the same amount of time for the moon to complete one **axis of rotation**-the spinning of objects around an imaginary center line–the two motions take the same amount of time, so this is why the same side of the moon always faces the Earth.

When the moon is between Earth and the sun, we observe a **new moon**– the side of the moon facing Earth is completely dark. On the day of a new moon, the moon rises when the sun rises and sets when the sun sets. The new moon only takes place during daylight hours. As the moon revolves around Earth, we are able to see more of the lit portion of the moon.

We start by seeing a waxing crescent - the lit portion on the right side of the moon. Sometimes you can just barely make out the round outline of the whole moon at crescent phase. This is because some sunlight reflects off the Earth and hits the moon, a phenomena called "Earth shine." The waxing crescent moon phase lasts for about six days.

When it appears that the right half of the moon is lit, we call this the **first-quarter**. This occurs when the moon has completed one quarter of its orbit around Earth with respect to the sun. Even though the moon will be at this place in its orbit for just a moment, the moon appears half lit for about a day.

The lit portion appears to continue to **wax** – grow bigger—into a **waxing gibbous** phase –more than half-lit but less than full.

A **full moon** occurs when the whole side of the moon facing Earth is lit, this happens when Earth is between the moon and the Sun.

After a full moon, the lit portion starts to **wane**–get smaller. The moon will begin to look smaller as we see less and less of the lighted side. This will first show the **waning gibbous** phase followed by the **third-quarter** moon. As it continues to wane, we will see a **waning crescent** moon for about six days until the cycle is completed and we have new moon again. This whole progression of phases takes 29.5 days or about a month. After a complete phase cycle, the cycle begins again

with a new moon.

Science Language Students Need to Understand and Use

- **revolution** – the circling of an object in space around another object in space
- **orbit**–the curved path of a celestial object or spacecraft around a star or planet
- **rotate** – spinning, like a top
- **axis of rotation**–the spinning of objects around an imaginary center line
- **waxing** – to grow bigger
- **waning** – to get smaller
- **gibbous** – more than half, but less than full
- **crescent** – some light is reflected, but less than a quarter
- **new moon**— the side of the moon facing Earth is completely dark
- **waxing crescent** – the visibly lit portion of the moon is less than half and on the right side
- **first-quarter** – the visibly lit portion of the moon is exactly half and on the right side
- **waxing gibbous** – the visibly lit portion is more than half, but less than full and on the right side
- **full moon** – the full face of the moon is visible
- **waning gibbous** – the visibly lit portion is more than half, but less than full and on the right side
- **last quarter** – the visible lit portion is exactly half and on the left side
- **waning crescent** – the visibly lit portion is less than half and on the left side

Online Interactive Activities

- This interactive will allow students to view the moon, earth, and sun's relative motion, and answer questions related to phases of the moon. http://tinyurl.com/ut6th1-1

- This interactive will allow students to test their knowledge of the phases of the moon, by dragging the phase to their place in their cycle. http://tinyurl.com/ut6th1-1b

Think like a Scientist

1. What causes the phases of the moon to change during the course of a month? List two reasons.

2. Complete the table comparing the sun, Earth and moon. Some answers have been filled in for you.

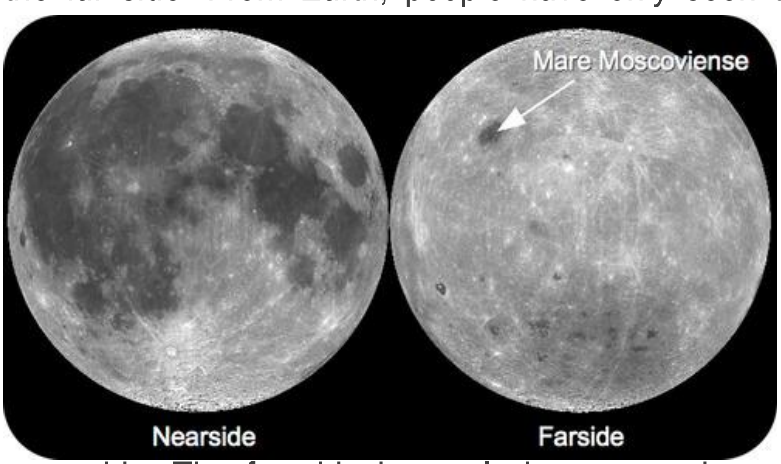
Question	Sun	Earth	Moon
What is the object classified as?			A moon, or natural satellite
What is the shape?			
What is the size relative to the other objects being discussed?	The Sun is the biggest.		
What is the movement in relation to other objects?		The Earth revolves around the Sun.	
What is the object made of?			rock
Can this object produce light?			No, the Moon reflects the Sun's light.

How does the position of Earth, the moon, and the sun create the appearance of the moon's phases?

Standard 1: Objective 2
Grade 6
Text Structure: Compare and Contrast

The moon is Earth's only **natural satellite**--a body that moves or revolves around a larger body in space. The moon is kept in orbit around Earth by the same gravitational force that keeps Earth orbiting the sun. The moon is 3,476 km in diameter, about one-fourth the diameter of Earth. The mass of the moon is only 1.23 % the mass of Earth. Gravity on the moon is only one-sixth as strong as it is on Earth due to this combination of mass and diameter. If you weigh 120 pounds on Earth, how much would you weigh on the moon? That's right! You would weigh 20 pounds. You can jump six times as high on the Moon as you can on Earth if you weren't wearing a space suit. The moon is also not as dense as Earth.

The moon rotates on its axis in the same amount of time it takes it to make one orbit around Earth. What does this mean? The same side of the Moon always faces Earth, so we always see that side of the Moon in the sky. The side of the Moon that always faces Earth is called the near side. The side of the moon that always faces away from Earth is called the far side. From Earth, people have only seen the moon's



http://goo.gl/FY657T

near side. The far side has only been seen by spacecraft and Apollo astronauts as they orbited the moon.

The rotation of Earth gives the sun the appearance of moving across the sky. The sun is actually in the same place in the sky. As Earth rotates, it brings the sun in and out of view giving us daylight and darkness. Remember the sun is not moving, it is the rotation of earth that brings the sun into view. When sunlight is hitting the part of the moon that is facing away from Earth, we see only the dark side of the moon. When we cannot see any part of the moon's lighted reflection, the moon is invisible to us. We call this a New Moon. The New Moon phase only takes place during daylight hours. As Earth rotates to nighttime, the New Moon is no longer in view, having disappeared behind the horizon.

Science Language Students Need to Know and Use

- **revolution** – the circling of an object in space around another object in space
- **orbit** – the path of a planet or a moon around an object
- **axis of rotation** –the spinning of objects around an imaginary center line
- **natural satellite** - a body that moves around a larger body in space

Online Interactive Activities

- This interactive will allow students to view the moon, earth, and sun's relative motion, and answer questions related to phases of the moon. http://tinyurl.com/ut6th1-1

- This interactive will allow students to test their knowledge of the phases of the moon, by dragging the phase to their place in their cycle. http://tinyurl.com/ut6th6-1b

Think like a Scientist

1. Why does the same side of the moon always face the Earth?
2. How long does it take the moon to rotate on its axis?
3. How long does it take the moon to revolve around the Earth?
4. How is the orbit of the moon around Earth different from the orbit of the Earth around the sun?

Additional Recommended Resources

https://www.youtube.com/watch?v=W47Wa7onrIQ
Animation of the movement of earth, moon and the sun.

Seasons

chapter 2

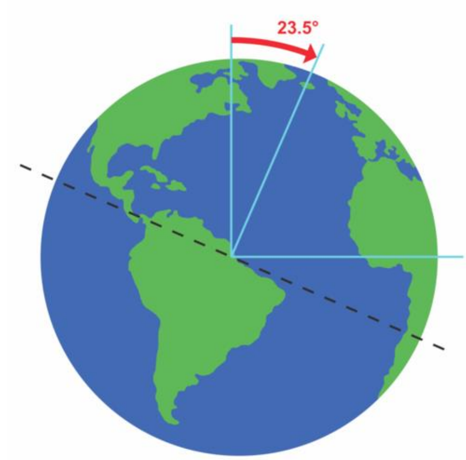
What causes the changing seasons?

Standard 2: Objective 1 & 2
Grade 6
Text Structure: Description (Informative)

The days are getting warmer, flowers begin to bloom. The sun appears higher in the sky, and daylight lasts longer. Spring seems like a fresh, new beginning. What causes these welcome changes?

There are two factors that cause the seasons to occur. First is that the Earth revolves in an **orbit -** the path a planet takes around an object. The **orbit** of Earth around the sun is nearly circular. As Earth moves throughout the year to new positions around the sun, the movement results in our four seasons: summer, autumn, winter, and spring.

The distance from the sun doesn't have much effect on the heating and cooling of Earth. In fact, we are closest to the sun during winter in the Northern Hemisphere. So, why do we feel coldest when Earth is closest to the sun? The second important fact that helps us understand the changing seasons is **Earth's tilt–**a 23.5 degree angle–and **Earth's axis of rotation**– imaginary poles on which Earth spins. It is this tilt

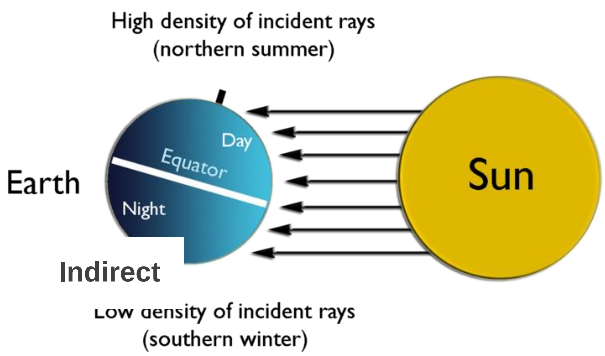


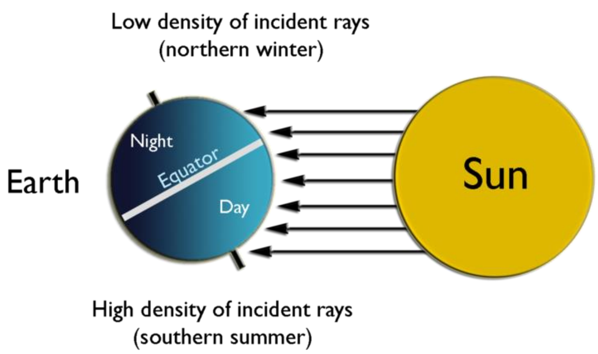
that causes seasons.
http://goo.gl/FQcNBS

As Earth revolves around the sun, it maintains this tilt, and it always points in the same direction toward the North Star (Polaris). The combination of the Earth's revolution around the sun and Earth’s 23.5 degree angle tilt are the reasons we have seasons.

Northern Hemisphere Summer

The North Pole is tilted towards the sun and the sun's rays strike the Northern Hemisphere more directly in summer. At the summer solstice, June 21, the sun's rays hit the Earth most directly along the Tropic of Cancer (23.5oN). When it is summer solstice in the Northern Hemisphere, it is winter solstice in the Southern Hemisphere.





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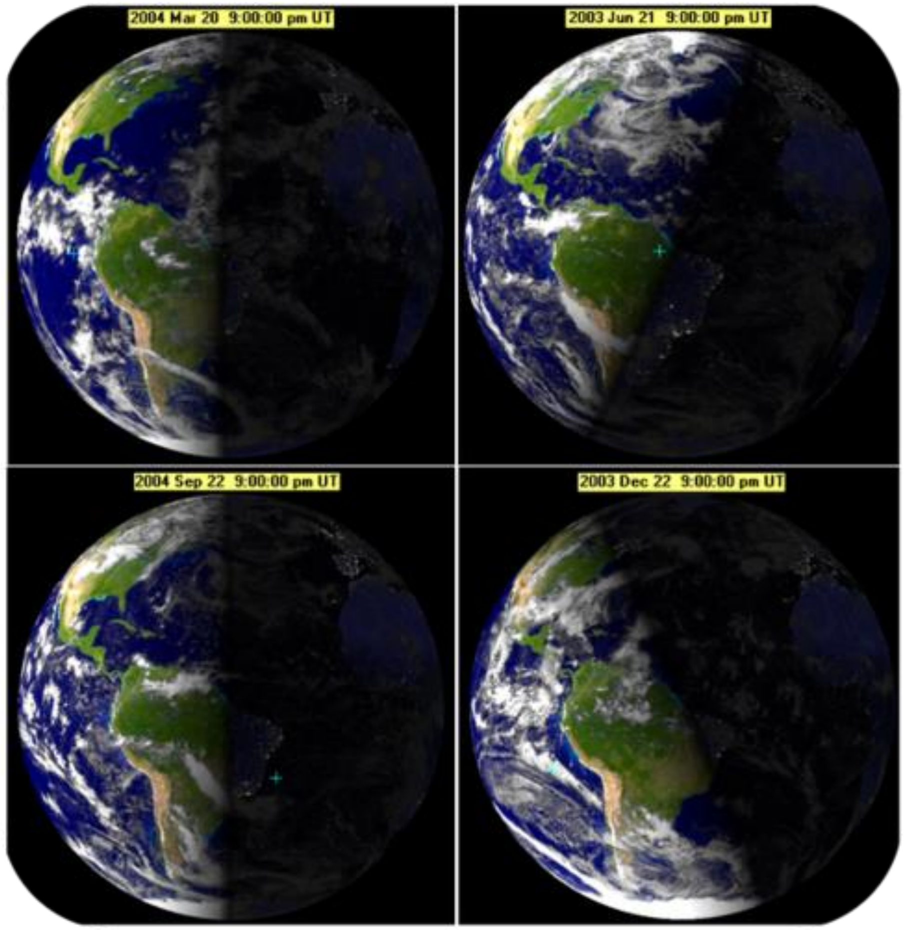
http://goo.gl/6eqeWg

Northern Hemisphere Winter

Winter solstice for the Northern Hemisphere happens on December 21. The tilt of Earth's axis leans away from the sun. Light from the sun is spread out over a larger area, so that area isn't heated as much. With fewer daylight hours in winter, there is also less time for the sun to warm the area.

When it is winter in the Northern Hemisphere, it is summer in the Southern Hemisphere.

Interactive Seasons: http://goo.gl/XT8X

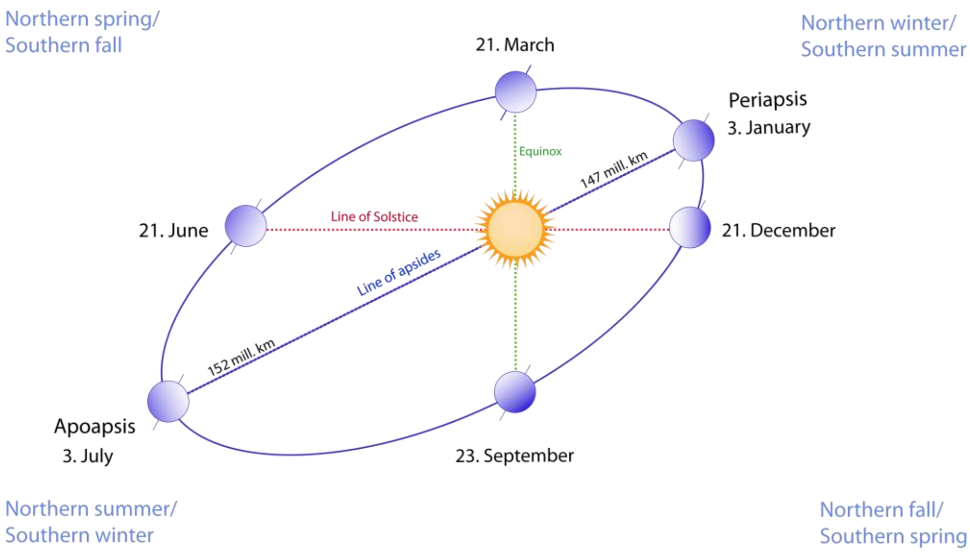


During the summer, areas north of the equator experience longer days and shorter nights. This is because at this time the Northern Hemisphere is tilted towards the sun and receives more direct rays. At the same time in the Southern Hemisphere it is winter and locations will have longer nights and shorter days. This is because this Hemisphere is pointed away from the sun and receives less direct rays.

Summer occurs in the hemisphere that is tilted toward the sun. This is when the sun appears high in the sky. Its radiation strikes Earth more directly for longer periods of time. The hemisphere that is receiving less radiation experiences winter.

Equinox

There are two times during the year when the Northern and Southern Hemisphere have the same amount of daylight. They are March 21st and September 21st. These mark the first official days of spring and fall. The tilt of Earth affects the height of the sun in the sky and the length of daylight.



Science Language Students Need to Know and Use

- **Earth's tilt -** a 23.5 degree angle
- **Earth's axis of rotation** - imaginary poles on which Earth spins
- **orbit -** the path a planet takes during its revolution

Online Interactive Activities

- This interactive will allow students to view the seasons from various places on Earth and to see what month a season occurs based on their relative location on Earth. http://tinyurl.com/ut6th2-1

- This interactive will allow students to see the angle of incidence of sunlight as the Earth revolves around the Sun. http://goo.gl/XT8X

Think like a Scientist

1. What causes Earth's seasons?
2. What is the longest day of the year in the Northern Hemisphere?
3. Why is it summer in Earth's northern hemisphere at the same time it's winter in the southern hemisphere?

The Solar system

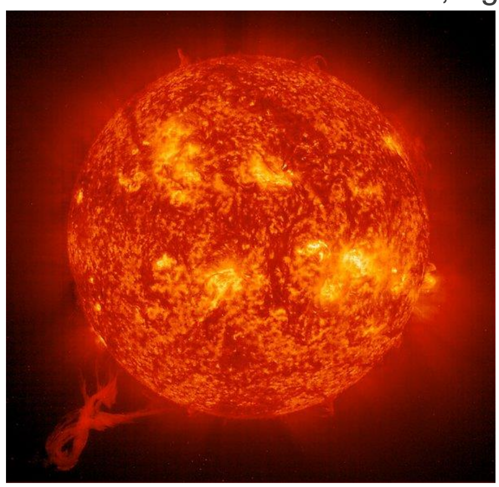
chapter 3

What components make up the Solar System?

Standard 3, Objective 1,
6th Grade
Text Structure: Description; Compare and Contrast

Have you ever looked at the sky and wondered what is out there? Many people have asked that question over time. With the use of telescopes, artificial satellites, binoculars, and even observations with the naked eye, men and women have discovered many different **celestial objects**–any natural objects in space that make up our universe.

This unit is about the celestial objects within our **solar system**–the system made up of eight planets and their moons, asteroids, comets, and many smaller objects that orbit the Sun. The Sun, a star, is at the center of our solar system and sustains life on Earth as a source of heat, light, and energy.



A **planet--**a celestial body that revolves around a star–does not give off its own light, and is larger than asteroids or comets. The **planets** of our solar system, in order from the Sun, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

At one time, Pluto was also considered a planet, but its status was changed to a dwarf planet on August 24, 2006 by the International Astronomical Union (IAU). Why isn't Pluto a planet anymore? Watch this video to find out.
http://goo.gl/tx8G2

The inner planets, Mercury, Venus, Earth, and Mars, are made up of rocky, solid matter. The outer planets, Jupiter, Saturn, Uranus, and Neptune, are made up of gasses.

The following chart shows the **distance--**a measure of the amount of space between objects--of planets from the Sun.

Average Distance from the Sun:

Name of the Planet	Miles	Kilometers
Mercury	36,000,000	58,000,000
Venus	67,000,000	108,000,000
Earth	93,000,000	150,000,000
Mars	141,000,000	228,000,000
Jupiter	484,000,000	778,000,000
Saturn	888,000,000	1,429,000,000
Uranus	1,786,000,000	2,875,000,000
Neptune	2,799,000,000	4,504,000,000

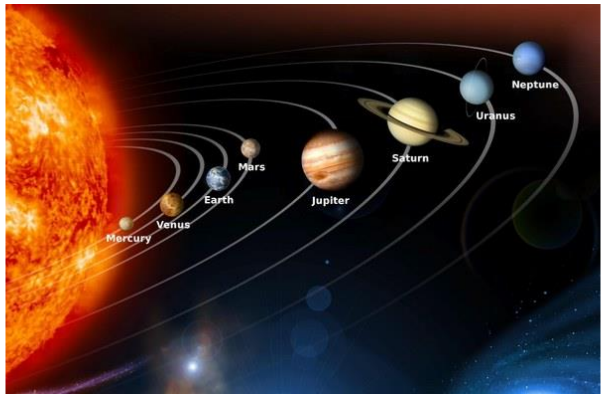
Although the Sun is just an average star compared to other stars, it is by far the largest object in the solar system. The Sun is more than 500 times the mass of everything else in the solar system combined! The table below gives data on the sizes of the Sun and planets relative to Earth.

Sizes of Solar System Objects Relative to Earth

Object	Mass (Relative to Earth)	Diameter of Planet (Relative to Earth)
Sun	333,000 Earth's mass	109.2 Earth's diameter
Mercury	0.06 Earth's mass	0.39 Earth's diameter
Venus	0.82 Earth's mass	0.95 Earth's diameter
Earth	1.00 Earth's mass	1.00 Earth's diameter
Mars	0.11 Earth's mass	0.53 Earth's diameter
Jupiter	317.8 Earth's mass	11.21 Earth's diameter
Saturn	95.2 Earth's mass	9.41 Earth's diameter
Uranus	14.6 Earth's mass	3.98 Earth's diameter
Neptune	17.2 Earth's mass	3.81 Earth's diameter

Orbits and Rotations

Distances in the solar system are often measured in **astronomical units** (AU)--the distance from Earth to the Sun. 1 AU equals about 150 million km, or 93 million miles.



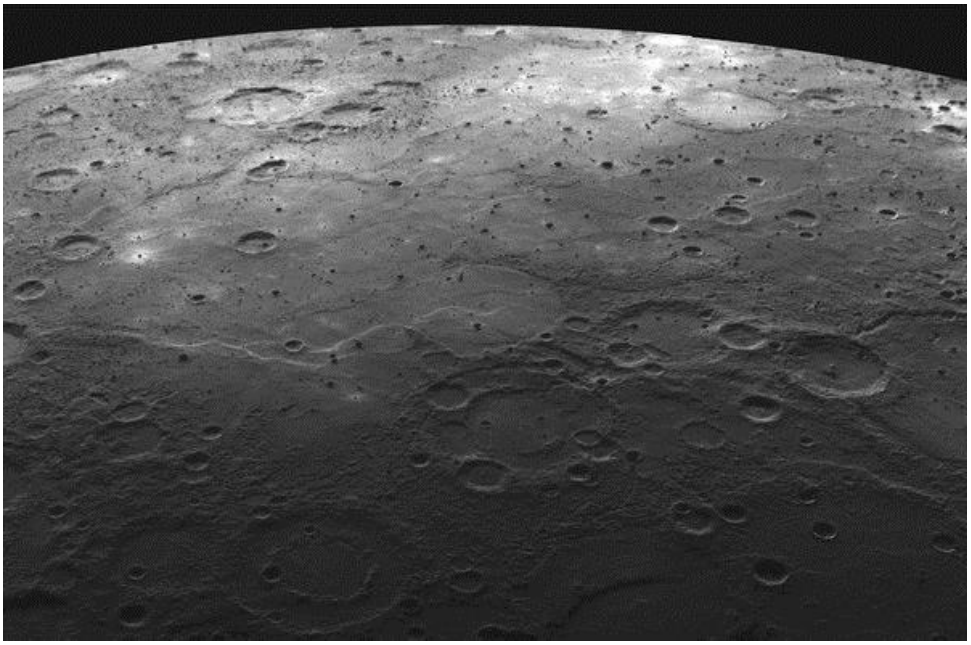
Distances to the Planets and Properties of Orbits Relative to Earth's Orbit

Planet	Average Distance from Sun (AU)	Length of Day (In Earth Days)	Length of Year (In Earth Years)
Mercury	0.39 AU	56.84 days	0.24 years
Venus	0.72	243.02	0.62
Earth	1.00	1.00	1.00
Mars	1.52	1.03	1.88
Jupiter	5.20	0.41	11.86
Saturn	9.54	0.43	29.46
Uranus	19.22	0.72	84.01
Neptune	30.06	0.67	164.8

Distances to the Planets and Properties of Orbits Relative to Earth's Orbit

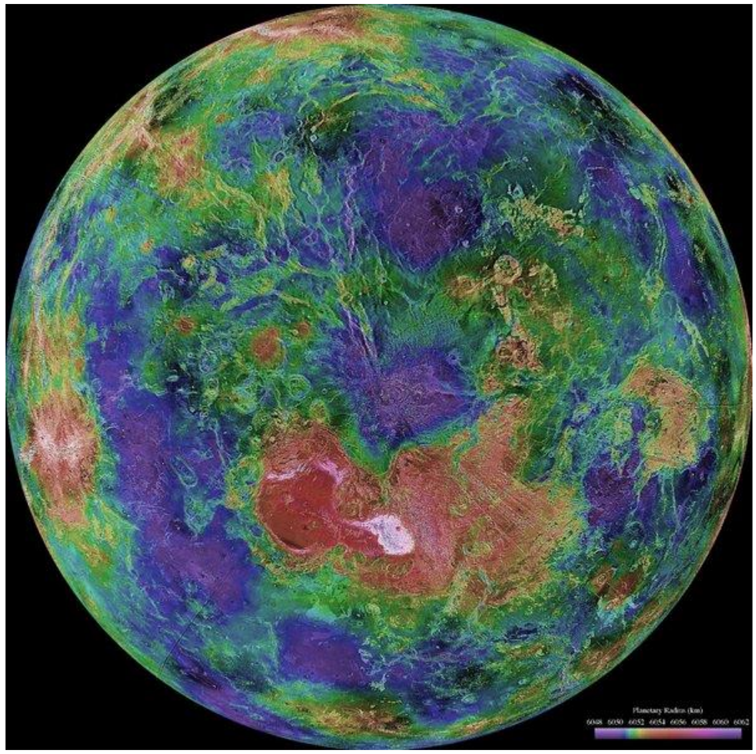
The **table** below shows the distances to the planets (the average radius of orbits) in AU’s. The table also shows how long it takes each planet to spin on its axis (the length of a day) and how long it takes each planet to complete an orbit (the length of a year); in particular, notice how slowly Venus rotates relative to Earth.

The following facts can be used to compare the planets:



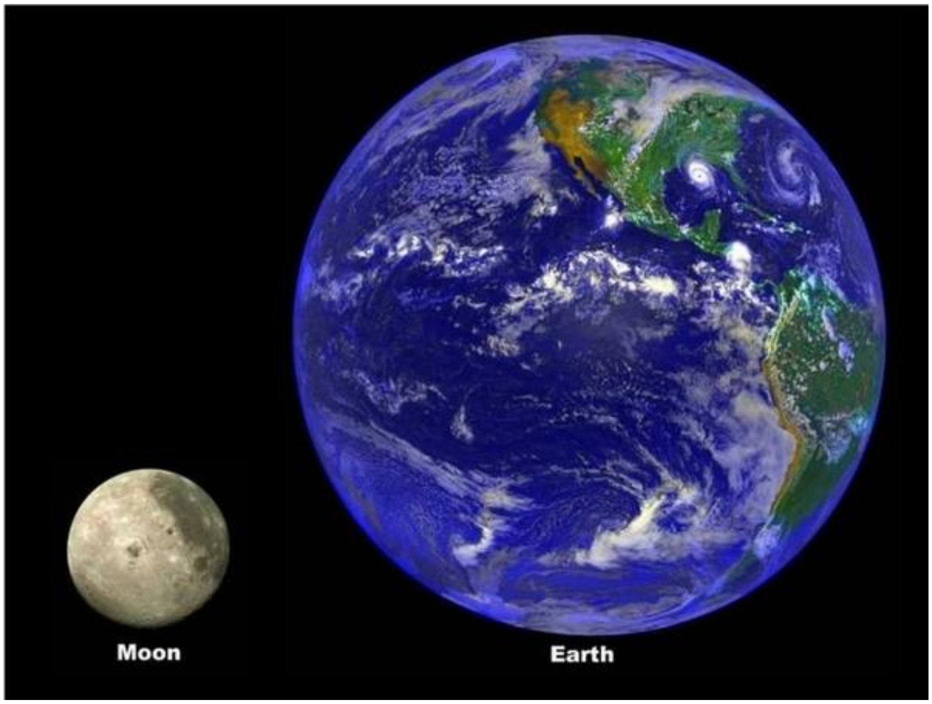
Mercury

- It is the nearest planet to our sun.
- Our moon and Mercury's surface look similar.
- It has no atmosphere.
- It has no moons.
- It has the greatest range of temperature, 662° F (day) to -274° F (night) = 936°
- Rotation: 58.7 Earth days
- Revolution: 88 Earth days
- 0.39 AU's



Venus

- It is the second planet from the sun.
- It spins slowly backwards as it orbits the sun.
- Its atmosphere is mostly made up of carbon dioxide.
- The atmosphere traps heat making Venus the hottest planet (860° F).
- Its surface is one dominated largely by volcanic activity. http://goo.gl/M7R7pe
- VERY FEW craters on Venus
- It has no moons.
- Rotation: 243 Earth days
- Revolution: 224.7 Earth days
- 0.72 AU's



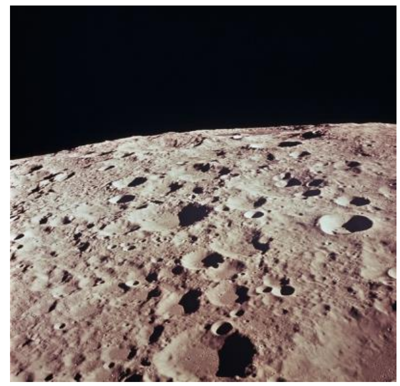
Earth

- It is the third planet from the sun.
- It is covered by about 70% water and 30% land.
- It has 1 large moon.
- It has the only conditions necessary for life as we know it in our solar system.
- It has volcanoes, mountains, earthquakes and a few craters.
- Rotation: 24 hours
- Revolution: 365.25 days
- 1 AU's

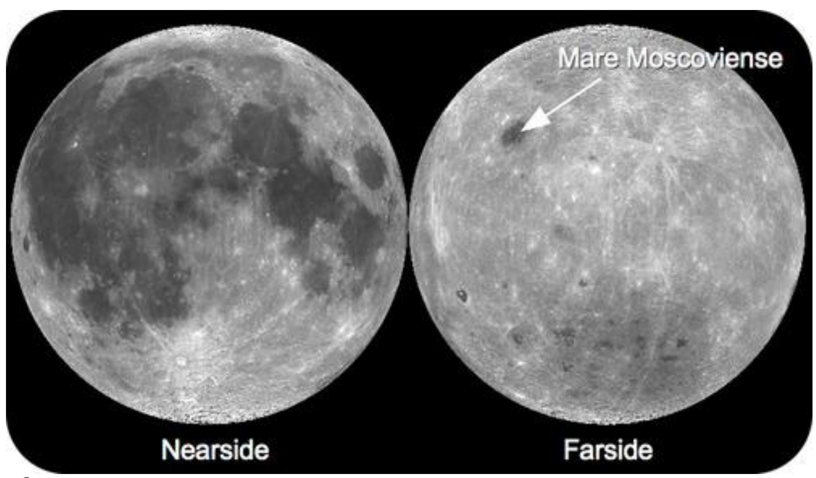
The Surface of the Moon

The surface of the Moon is covered with holes called craters. These craters are made by space rocks that hit the Moon at incredible speed. These rocks may be as small as grains of sand or as big as a house. They travel so fast that they explode when they hit the Moon, and they make a round hole.

The surface of the Moon - can you see all the craters?



The Moon has a pale grey surface with dark grey marks on it. While we had pretty detailed photos of the moon before we went there, we didn't know for sure how deep the dust was until spacecraft landed on the Moon. The first astronauts to walk on the Moon stepped into fine, powdery dust. They collected rock samples (small pieces) to bring back to Earth. The footprints from the astronauts who first walked on the Moon are still there! There is no wind on the Moon to blow them away. Those footprints will still be on the moon in many



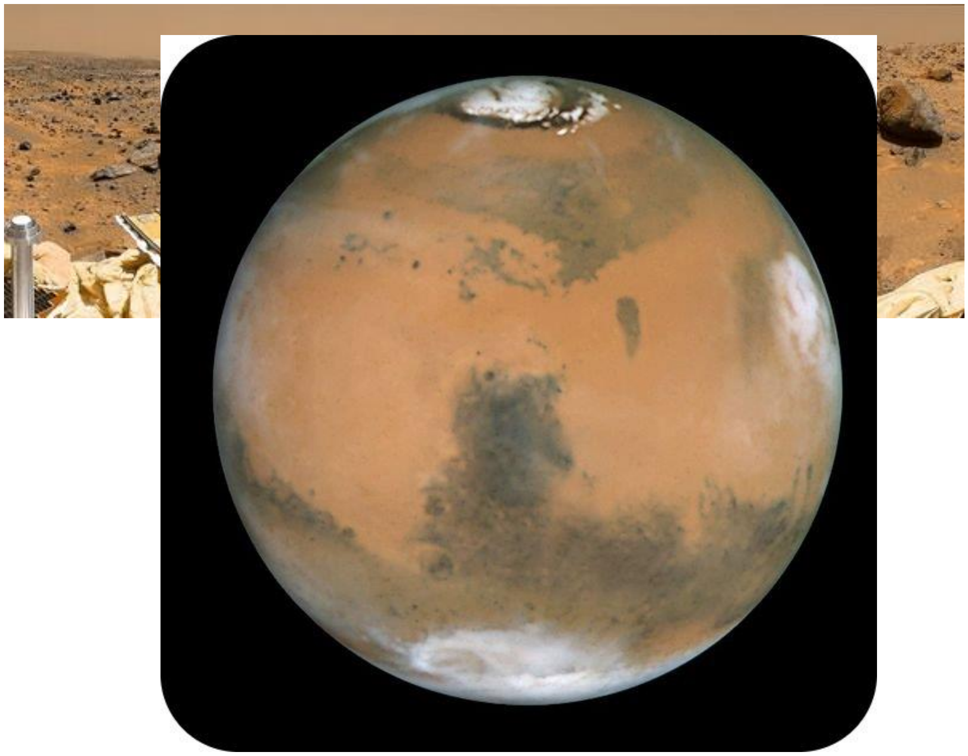
thousands of years.

The light-colored areas on the Moon are craters, and the darker areas are plains. Some of these plains were made when huge space rocks made giant craters. These later filled with lava after the interior of the moon heated up due to radioactive decay. Because the Moon has no air, no wind, and no water, there is no erosion. That is the reason why the craters on the Moon change very little after they are made.

Mars

- It is the fourth planet from the sun.
- Iron oxides (rust) cause its surface to be reddish in color.
- It has polar ice caps made of frozen carbon dioxide and water ice.
- It has 2 small moons. (Phobos and Deimos)
- It has a thin atmosphere, less than 1% of Earth's.
- Huge dust storms sometimes cover the surface.
- Rotation: 24.6 hours
- Revolution: 687 Earth day
- 1.52 AU's

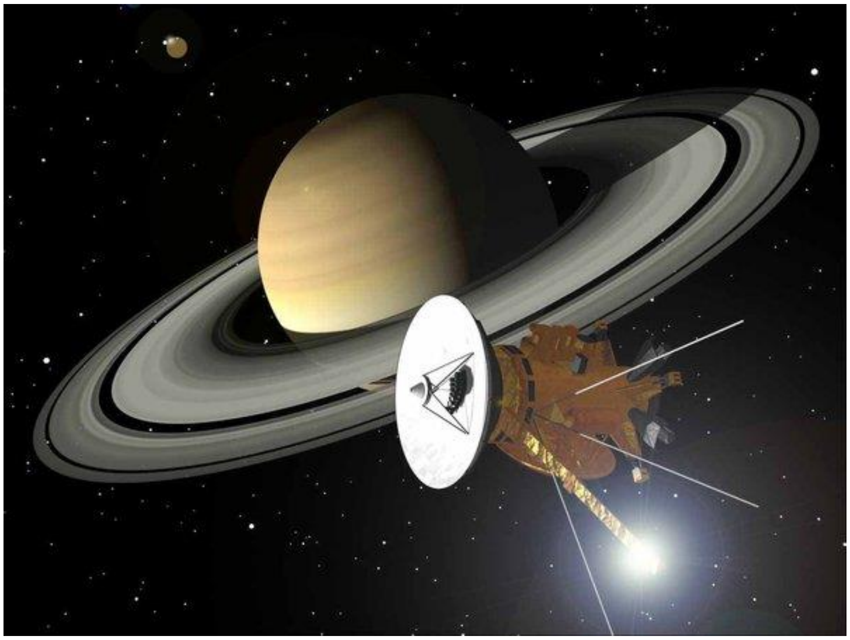
Phobos and Deimos



This is a photograph of the surface of Mars, taken in 2012 by the rover called Curiosity. Can you see all the rocks? There are some small and some very big valleys on Mars. The largest rocks of them all may have been caused by the crust cracking and wind erosion. On Earth, many valleys are caused by erosion when water flows downhill, so we can make an **inference**—a conclusion based on evidence and reasoning--that there was a lot of water on the planet long ago. There are areas in the southern hemisphere of Mars where this is the case. Our robotic spacecraft have confirmed what visual evidence suggests. If there was water, perhaps there were living things on Mars too, but we cannot be sure. Scientists have sent another spacecraft to look carefully at the rocks and sand for the six elements necessary to all life on earth. These include: carbon, hydrogen, nitrogen, oxygen, phosphorus, and sulfur.

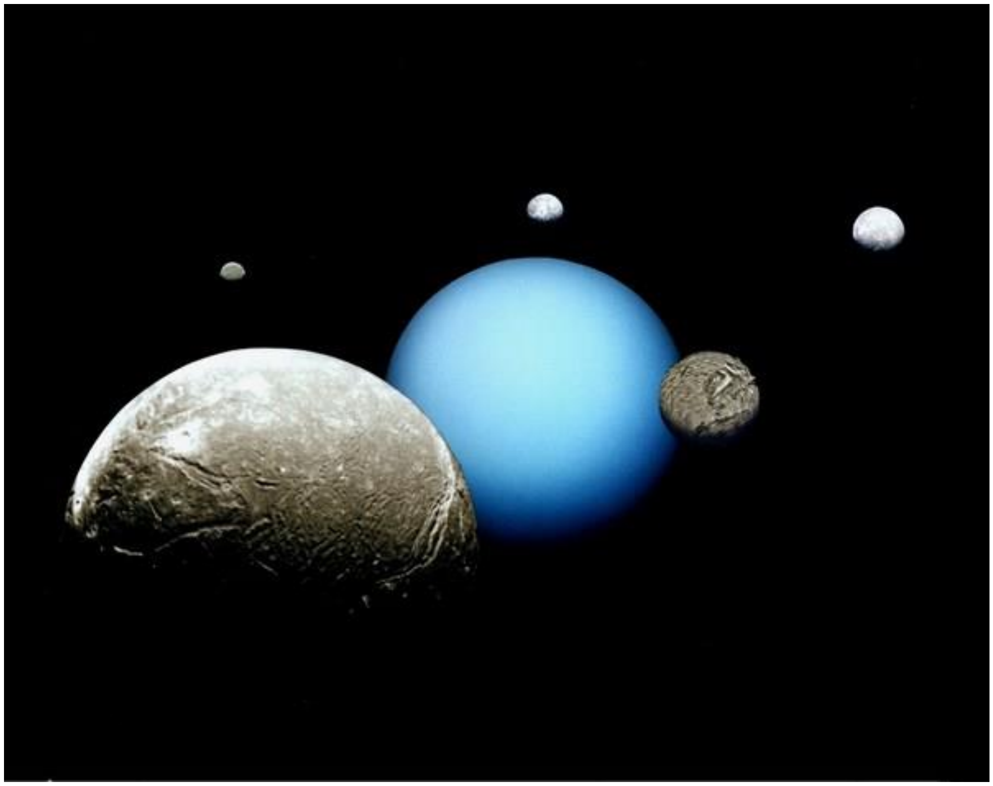
Jupiter:

- It is the fifth planet from the sun.
- Its atmosphere is made mostly of hydrogen, helium and methane.
- Its Great Red Spot is a storm, which has lasted for at least 400 years.
- It has a very small and faint ring system.
- It has 4 large and 59 small moons for a total of 63 moons. Historically, each time humans sent another space probe to Jupiter, more moons were discovered!
- It is the largest planet in our solar system.
- Rotation: 9.9 hours
- Revolution: 11.9 Earth years
- 5.2 AU's



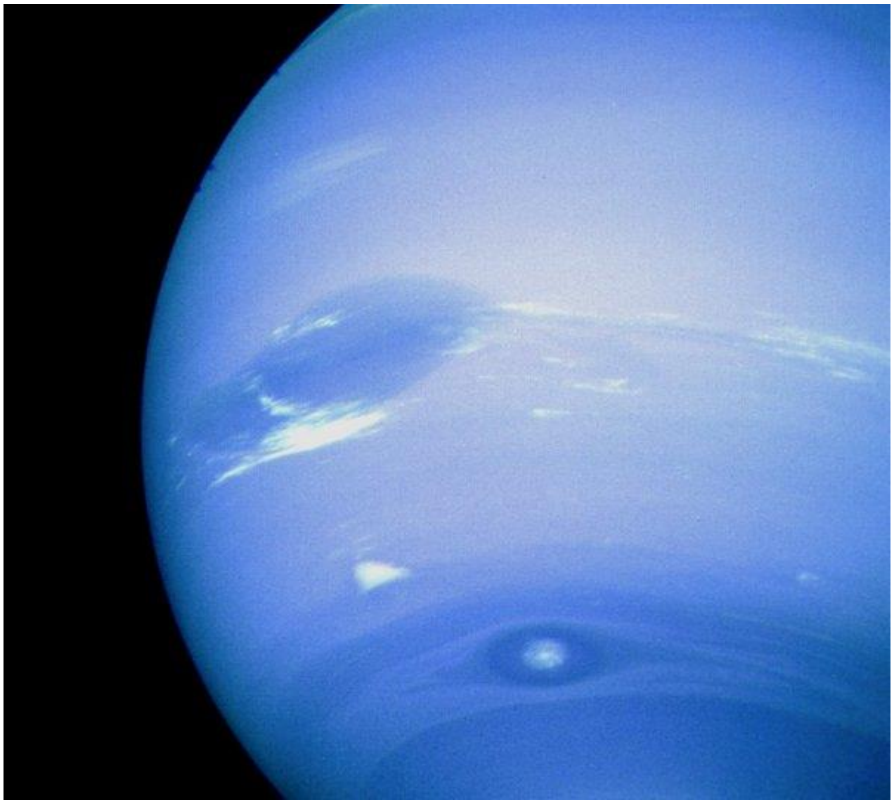
Saturn:

- It is the sixth planet from the sun.
- It is the second largest planet.
- It has an atmosphere of hydrogen, helium and methane.
- It has 63 moons.
- The largest moon, Titan, is larger than Mercury.
- It is not very dense, so if it were set upon Earth's oceans, it would float.
- It has a large ring system.
- Rotation: 10.7 hours
- Revolution: 29.4 Earth years
- 9.58 AU's



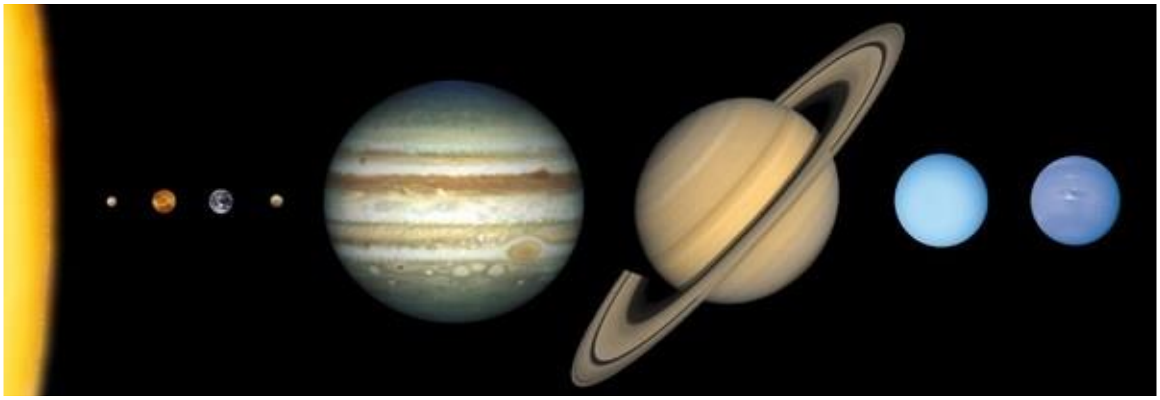
Uranus

- It is the seventh planet from the sun.
- It is the third largest planet in our solar system.
- It has a small faint ring system.
- Its axis points toward the sun, so it rotates on its side
- It has 27 moons.
- It has an atmosphere of hydrogen, helium, and methane.
- Methane causes Uranus to appear blue in color.
- Rotation: 17.2 hours
- Revolution: 83.7 Earth years
- 19.20 AU’s



Neptune

- It is the eighth planet from the sun.
- It sometimes has a Great Dark Spot that is a huge storm system as large as Earth.
- It has the fastest winds in the solar system.
- Its atmosphere is made of hydrogen, helium and methane.
- Methane causes Neptune to appear blue in color.
- It has 13 moons.
- Its moon, Triton, has an atmosphere.
- It has a small faint ring system.
- Rotation: 16.1 hours
- Revolution: 163.7 Earth years
- 30.05 AU's



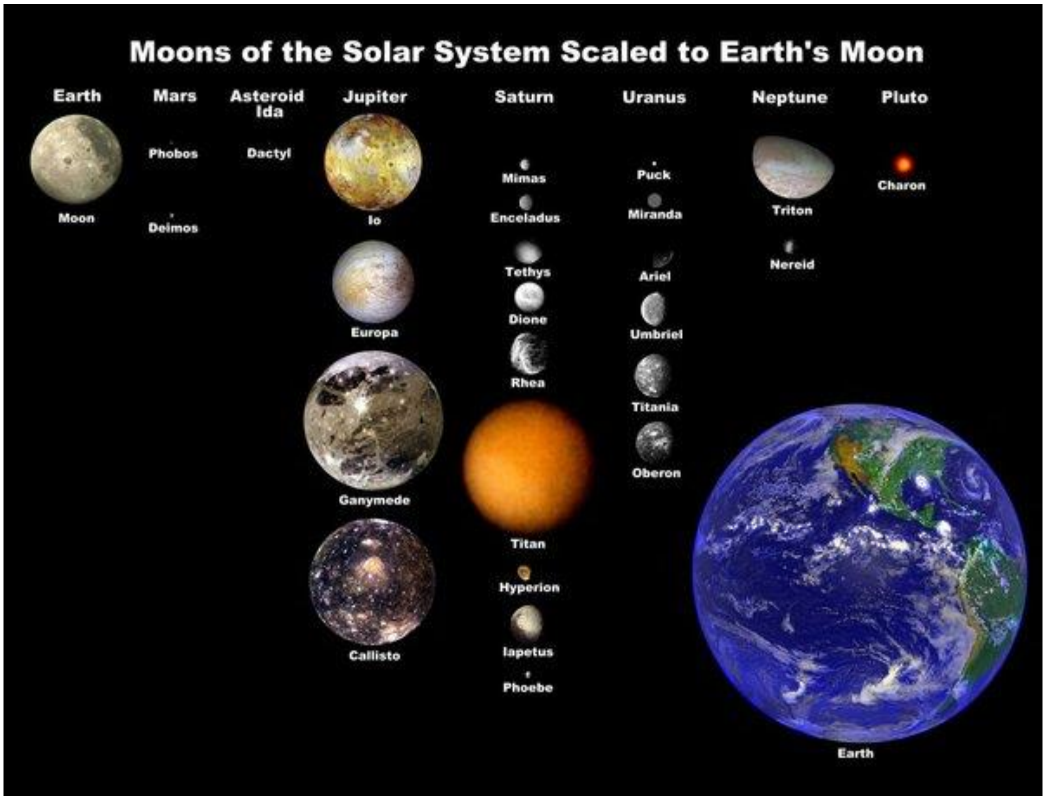
The sizes of the planets in this picture are shown to **scale**—objects compared to a standard for accurate size perception. The distances between the planets are NOT to **scale**.

Comparing these objects to a standard helps to show how big and how small the planets are compared to Earth. It can be difficult to understand how big and how small the planets are. We have some ideas of how large Earth is because we live and travel on it. We get a sense of how vast it is as we travel to distant cities around the country and the world. It may take many hours or even many days to reach a destination depending on the type of transportation we use. Our knowledge of Earth will help us understand the sizes of the planets.

Moons of other planets

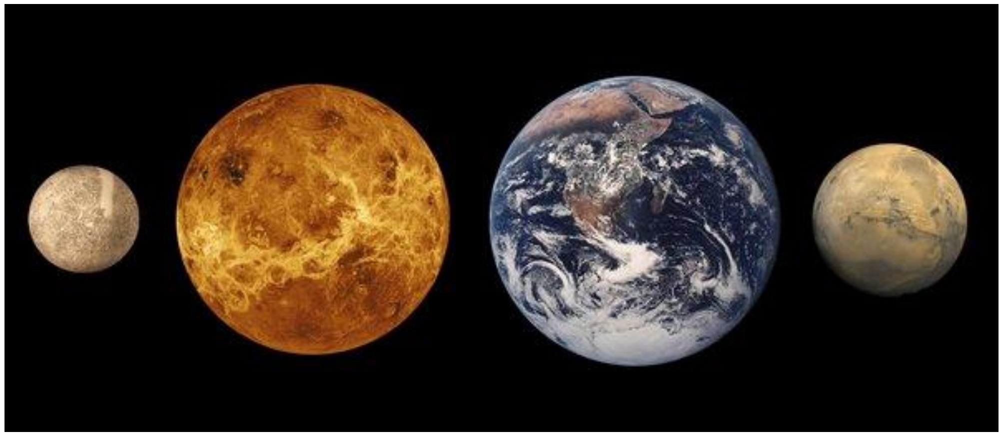
Video: Quick tour of planets and their moons systems. http://goo.gl/oidMVi

Other planets have moons, too. Below is an image showing some of the moons in our solar system. Not all of them are shown here. They are at the correct size scale so they can be compared to Earth and our Moon.



A Closer Look at the Eight Planets

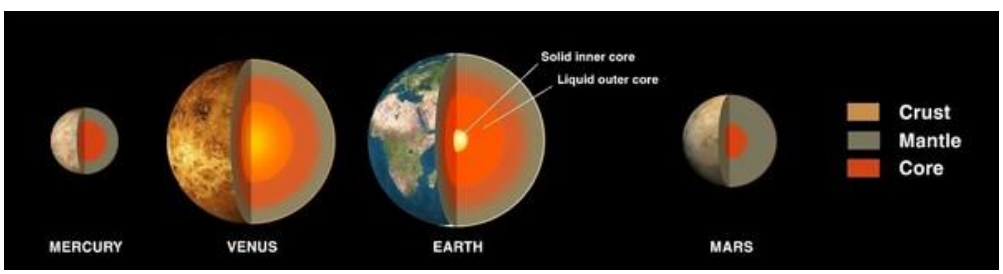
The four inner planets are rocky.



Look at the picture of the solar system again. The four planets closest to the Sun are called the inner planets of the solar system. They all are made of rock; some of them have a thin layer of gas on the outside. Earth has a very thin layer of water too.

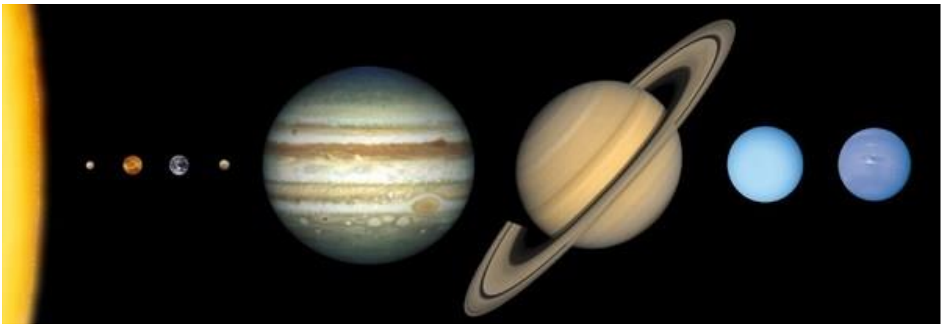
These are the four inner rocky planets. This shows their sizes compared to each other. Can you name them?

The next image shows us what the core of each of the rocky planets may look like. The core is the inner part of the planet and it is made up of different layers.

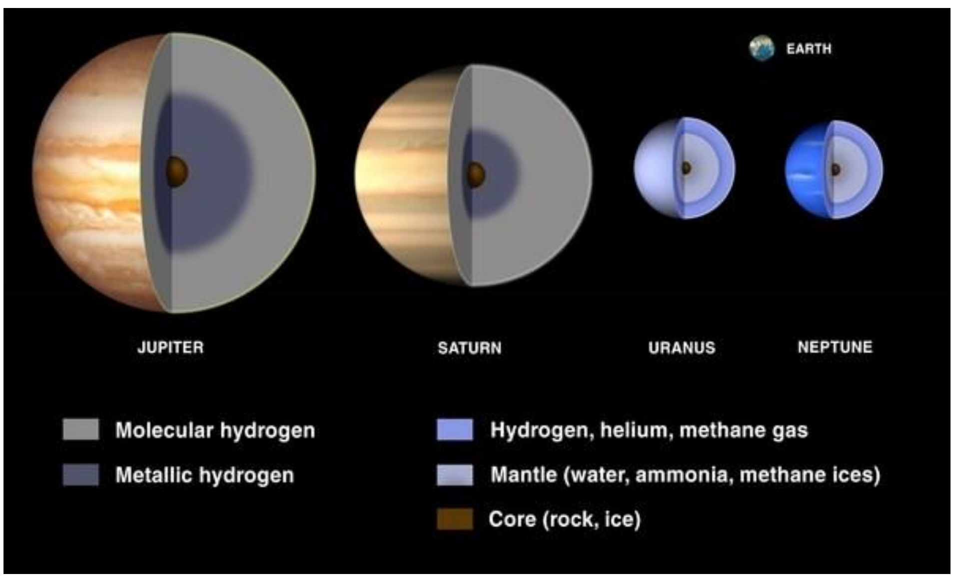


The predicted core of each of the four inner rocky planets of our solar system.

The four outer planets are gas giants.

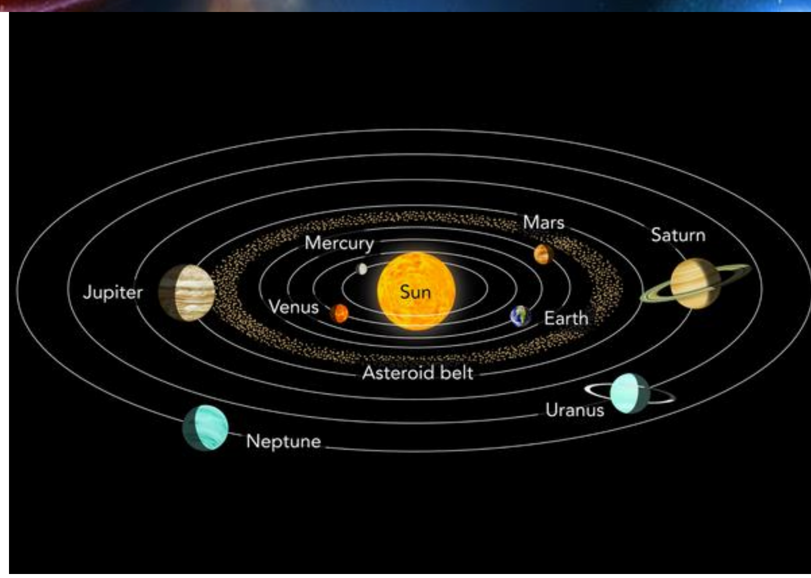


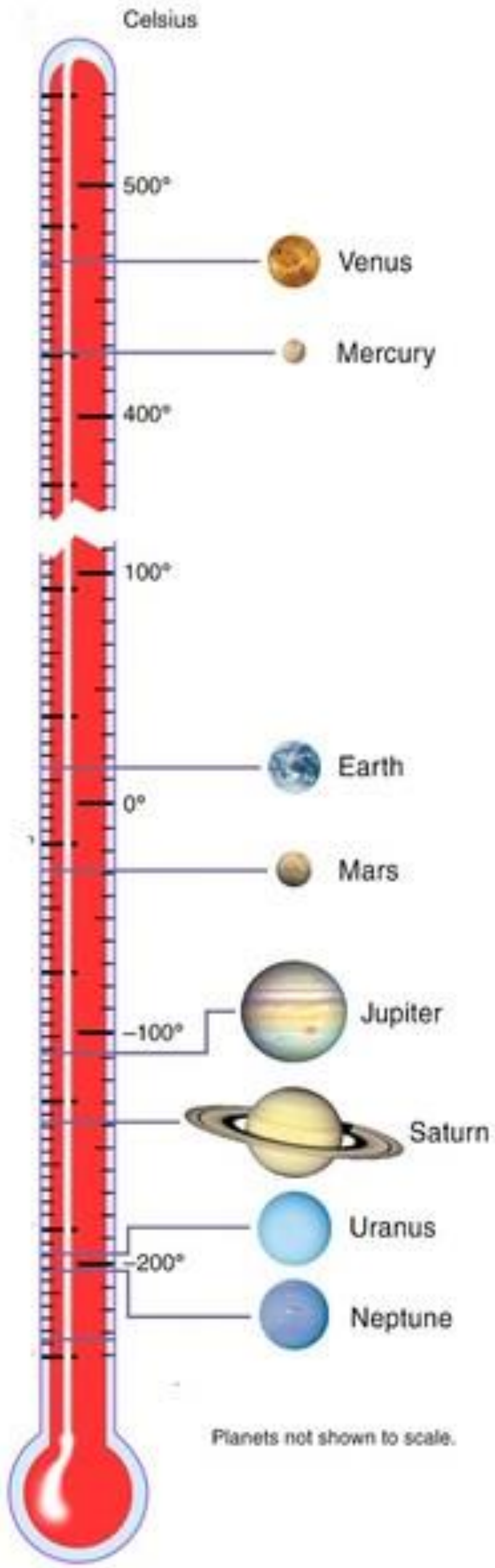
These planets are very far from the Sun compared to the inner planets. They don't have a hard surface that a spacecraft can land on. Instead, they are giant balls of very cold gases. Astronomers think that these planets have hot, solid cores, deep down inside them.



The solar system consisting of the Sun and 8 planets.


Neptune
Uranus
Saturn
Mars
Earth
Jupiter
Venus
Mercury

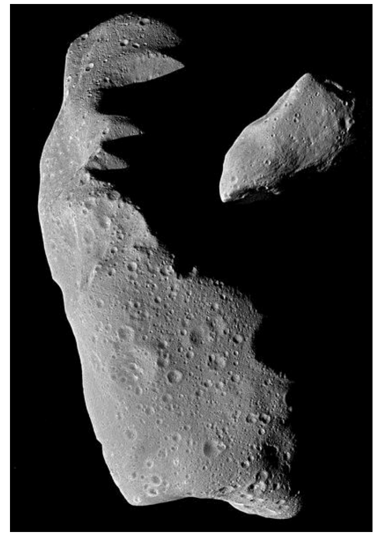

Mars
Saturn
Mercury
Jupiter
Sun
Venus
Earth
Asteroid belt
Uranus
Neptune



Here is an image showing the average temperatures of the planets. Mercury is the closest to the Sun, but Venus is actually hotter than Mercury. This is because of the dense atmosphere of Venus which acts like a greenhouse and traps the Sun's energy in the atmosphere.

Other objects in the Solar System

Asteroids--are irregular pieces of rock that move through space. Their **mass--**the amount of matter in something--can be as small as tiny particles or as large as 1000 km in diameter. Most of the **asteroids** in our solar system are found in the asteroid belt between Mars and Jupiter. Most asteroids in this belt revolve around the sun. Other asteroids are scattered throughout our solar system.



http://commons.wikimedia.org/wiki/File:ESO_-_The_double_asteroid_Antiope_%28by%29.jpg

Comets--are composed of ice, dust and gasses, which orbit the sun in large elliptical orbits. They are often described as “dirty snowballs” but a more accurate description might be “snowy dirtballs.” As **comets** approach the sun, the ice vaporizes, releasing dust and gasses that follow behind, creating tails. The tail may reflect enough of the sun’s light to be visible without a telescope. The tails always stretch away from the sun hundreds of millions of kilometers. Each time they orbit the sun, comets get smaller and smaller as they lose their ices and disappear from view.

Is a shooting star really a star flying across the sky?

When a **meteor**– the streak of light made by a small particle of matter that is seen when it falls into Earth’s atmosphere at a very high velocity–shoots through the atmosphere it burns and glows. When we look up and see one, we call it a shooting star. . When the particles hit Earth’s atmosphere, friction makes them burn up and produce a streak of light. When Earth travels through the debris left by a comet's tail,

we see a **meteor** shower.

Sometimes the rock chunk is so large that it won’t burn completely, so it strikes Earth. These are called **meteorites–**a meteor that falls to the surface before burning up in the atmosphere. Some **meteorites** can create large holes on Earth’s surface, but most are very small.

Song “What is a shooting star?”
https://www.youtube.com/watch?v=JqBChyNyLhU

Photo of Barringer Crater, Arizona
To find out about a very large crater left by a meteorite, watch this video about Barringer Crater in Arizona:

http://goo.gl/wK4z16

Summary

- The planets of the solar system, with increasing distance from the Sun, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune. The five known dwarf planets are Ceres, Pluto, Makemake, Haumea, and Eris.

- Solar system distances can be measured as multiples of the distance between Earth and Sun, which is defined as one astronomical unit (AU).

- All planets and dwarf planets orbit the Sun and rotate on their axes.

Science Language Students Need to Know and Use

- **asteroids:** irregular large pieces of rock that move through space
- **celestial objects:** Any natural objects in space that make up our universe
- **comets:** objects made up of ices, dust, and gases that orbit the sun in a large,
- elliptical orbit
- **distance:** a measure of the amount of space between objects

- **gravitational force:** the measurement of the pull of gravity
- **gravity:** the attraction of one mass to another
- **inference:** a conclusion reached on the basis of evidence and reasoning
- **mass:** the amount of matter in something
- **meteor:** the streak of light produced by a small piece of matter in space that is visible when it falls into Earth's atmosphere
- **meteorite:** a meteor that falls to the surface before burning up in the atmosphere
- **planet:** a celestial object, larger than asteroids or comets that revolve around a star without giving off its own light. See IAU definition of a planet here: http://en.wikipedia.org/wiki/IAU_definition_of_planet
- **satellite:** a natural or man-made object that revolves around larger objects in space
- **scale:** objects compared to a standard for accurate size perception
- **solar system:** the system made up of the eight unique planets, and many smaller objects that orbit the sun
- **stars:** celestial objects that consist of gases, which are so massive that fusion within their cores generate light and heat
- **sun:** the star in our solar system that sustains most life on Earth and is the primary source of heat and light
- **telescope:** an instrument that gathers light and magnifies, or makes distant objects appear larger

Online Interactive Activities

- This interactive will allow students to click on celestial objects in the solar system and learn facts about the objects. It also has games about the solar system.
  http://tinyurl.com/ut6th3-1

- This interactive will allow students can click on various celestial objects in the solar system to learn fun facts, play games, and receive homework helps.
  http://tinyurl.com/ut6th3-1b

- This interactive will allow students can view the solar system from different angles and perspectives.
  http://tinyurl.com/ut6th3-1c

Think Like a Scientist

1. Explain the different components that make up the Solar System.
2. Compare the inner planets with the outer planets. How are they the same? How are they different? Write a paragraph describing your answer.
3. Which planet is closest to the sun?
4. Write the names of the planets in order beginning from the one that is closest to the sun.
5. Which planet is the coldest and why?
6. Why do the planets all keep moving in orbits around the sun?
7. Mars is smaller than the Earth and if you went there, your weight would be only about a third (1/3) of your weight on Earth. If your mass is 45 kg on earth, you weigh 450 newtons (N). If you went to Mars, what would your weight be?
8. What is the difference between a meteor and a meteorite?

Additional Recommended Resources:

- The wonders of Earth (video) http://goo.gl/LvNkC
- Rock around the World http://ratw.asu.edu/
- A video from NASA about the surface of Mars http://goo.gl/mS9Uq
- NASA video on Valles Marineris http://goo.gl/9BHRYI
- A video on Jupiter http://goo.gl/tDztYJ

How has technology helped us understand the solar system?

Standard 3, Objective 2,
6th Grade
Text Structure: Description; Compare and Contrast

The moon is considered a natural **satellite**–natural or man-made objects that revolve around a larger object in space–because it formed at roughly the same time as Earth and it revolves around Earth. Scientists use rockets to place man-made **satellites** in space to orbit Earth. Man-made satellites are lifted above the atmosphere into different height orbits for different purposes. They can gather scientific data about Earth that can't be obtained from Earth's surface. They take photographs of large areas of Earth and huge weather systems. The satellites measure Earth's atmosphere, land, and oceans; and the military uses satellites to photograph buildings and troop movement all over the world. Man-made satellites also help with communications by relaying telephone calls and e-mail messages anywhere in the world. We can hear radio and see television programs that keep us current on world events. Satellites have brought people in the world closer together. We have launched satellites that orbit Mars and Venus taking pictures of them.

Technology and space exploration have made it possible for astronomers and scientists to gather more accurate information about our solar system than we can ever imagine. We can answer questions people have asked for centuries. However, many more questions have been generated because of the information gathered. When you grow up, you may be the scientist who finds answers to these questions.

Galileo was one of the first scientists to observe objects in the sky using a **telescope--**an instrument that magnifies or makes distant objects appear larger. His observation led to the understanding that we do not live in an Earth-centered universe. Galileo's **telescope** had a curved lens at each end. He observed the moon's mountains, valleys, and craters. He was also able to observe nearby planets and their moons. In 1668, Sir Isaac Newton improved on Galileo's telescope. Newton's telescope used mirrors and only one lens to sharpen the images. However, even though the telescope had been improved, many early observations were not very detailed.

Since the time of Sir Isaac Newton, telescopes have improved. Modern observers see objects more clearly and at greater distances. Telescopes are often housed in observatories. Observatories are placed on top of mountains where the air is thin and fewer city lights exist. As technology has improved and aided in space exploration, NASA has launched satellites that contain telescopes. Images observed from space can be clearer than those on Earth because they are above the atmosphere. One such satellite-telescope, the Hubble Space Telescope, was launched in 1990. When the Hubble Telescope needed repairs, we sent astronauts in a space shuttle to resolve the problem. Now that the space shuttle

Hubble Telescope in Orbit around Earth

doesn't fly anymore, it is unlikely we will attempt to repair its failures in the future.

Another type of space exploration takes place here on Earth. Scientists have found that celestial objects give off energy in the form of radio waves. Radio Telescopes use that technology to create different pictures of the universe. They can show energy-producing objects that do not give off visible light. Huge dish-shaped structures have been made to collect radio waves generated by a distant object or from deep space itself. By listening to radio waves, scientists are making new

maps of the universe and listening for signals from space that might one day indicate the existence of life elsewhere.

One way scientists have been able to learn more about space is by working in a space shuttle. A space shuttle takes off like a rocket with large fuel tanks supplying the energy. After launch, the tanks eject and the shuttle flies like a rocket in space. While in space, scientific experiments are performed by the astronauts. Most astronauts have scientific training but others are needed to fly the shuttle. U.S. shuttles do not fly anymore.

The space shuttle does not stay in space more than a short period. For long-term experiments, a space station is used. In 1973, the United States launched the Sky Lab Space Station where astronauts lived and worked for 84 days. The former Soviet Union space station, Mir, stayed in space for a long time and supported astronauts for up to 438 days at a time. One of the interesting findings is that people can't live in space and be weightless for long periods of time without harmful side effects. Living without gravity causes muscles to weaken enormously and calcium to be drawn out of bones, even with rigorous exercise.

One of NASA’s most exciting projects is the International Space station (ISS). The station was built in space with resources from sixteen nations. The parts were lifted into space by American and Russian rockets. The parts were assembled in space. The ISS is designed as a permanent laboratory for long-term research projects.

International Space Station ISS

Can humans take a field trip through the solar system?

A field trip through the solar system would take a long time. It took 12 years for the Voyager spacecraft to get from Earth to Neptune (one way). If a human was on board, he or she would probably want to come back! Fortunately, unmanned spacecraft can send back images of far distant places in the solar system and use other scientific instruments to collect data.

We have talked about objects on Earth and objects that orbit Earth that are used to gather information about our solar system. Another way to collect information requires the use of space probes that are sent to celestial objects we want to know more about. Space probes carry cameras, radio transmitters and receivers, and other instruments. Scientists use radios to communicate with space probes. Programmers tell probes what to do as they pass selected celestial objects and the spacecraft run complex computer programs so that all mission goals can be achieved in an ever increasingly autonomous fashion. If a probe were passing Venus, the programmers could command it to take pictures or the temperature of the atmosphere.

The probe, Galileo, which was launched in 1989 reached Jupiter in 1995. It returned some of the most exciting photographs of Jupiter and its moons ever seen. Some probes such as Pioneer 10, Voyager 1, and Voyager 2, have been launched to fly past the outer planets and venture into outer space. These probes have traveled past the asteroid belt and have taken pictures of Jupiter, Saturn, Uranus and Neptune. As the probes travel toward the edge of our solar system, they continue to transmit data to Earth for a few years. By the year 2000, the space probe, Pioneer 10, had traveled more than 11 billion km. On board is a metal plate with an engraving of a man, a woman, and Earth's position in the Milky Way Galaxy. The Voyager 1 and Voyager 2 spacecraft are the most distant man-made objects in our solar system. You can find out where they are today by going here: http://goo.gl/ldEiW

Computers have made a huge difference in our ability to organize, compute and analyze information received from space. You may think the only computers astronauts and scientists use are those that are on their desks. All the satellites and probes that we previously talked about have computers placed in them. The scientists use the computers on their desks to plan communications with the satellites and probes. Commands are given to satellites to position telescopes. Commands are given to probes to tell them where to journey and how to position cameras for taking pictures. The computers on Earth decode these pictures allowing scientists to interpret their findings. When samples of gasses or material are taken by a probe, their computers analyze the gasses or materials of celestial objects and send the information back to Earth. Computers are also helpful in predicting the motion of planets, the phases of the moon, and tracking the course of comets and asteroids. They often allow very detailed models of objects and orbits to be created.

Summary

- Technology and space exploration have made it possible for astronomers and scientists to gather more accurate information about our solar system than we can ever imagine.
- Computers have made a huge difference in our ability to organize, compute and analyze information received from space.
- Another way to collect information requires the use of space probes that are sent to celestial objects we want to know more about.

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- **sun:** the star in our solar system that sustains most life on Earth and is the primary source of heat and light
- **telescope:** an instrument that gathers light and magnifies, or makes distant objects appear larger

Think Like a Scientist

1. How has modern technology aided in the study of space?
2. Name at least two inventions that have helped scientists learn about space.
3. Find and report on ways technology has been and is being used to investigate the solar system.

Additional Recommended Resources:

- A video about how satellites help us study the earth http://goo.gl/f6YYsl
- A video about the International Space Station http://goo.gl/sXsRhV
- CK-12 Education resources http://goo.gl/cRRYST

What keeps the solar system together?

Standard 3, Objective 3,
6th Grade
Text Structure: Description; Compare and Contrast

Most of the celestial objects that are part of our solar system are constantly circling our sun. These circling paths are called orbits. All objects have some amount of **gravity--**the attraction of one particle or body to another. Large masses have a stronger **gravitational force**–the measurement of the pull of gravity-- than small ones. If a small object is trapped by the gravity of a larger object, it must move fast enough not to be “captured” by the gravity of the larger object. If it slowed down enough, it would fall into the larger object. For example, the moon moves around Earth in an orbit. If the moon moved a lot slower, Earth’s gravity would pull it into Earth. If the moon moved a lot faster, it would escape into space.

Since the sun is the largest mass in our solar system, its gravitational force holds Earth and other planets in orbit around it.

In the solar system, each object's gravity pulls on all the other objects. Gravity is a force of attraction between objects. The Sun is the biggest and heaviest object in our solar system and so it exerts the greatest force of gravity on all the planets. This force of gravity makes all the planets move in orbits around the Sun instead of moving in a straight line.
The Role of Gravity

Isaac Newton first described gravity as the force that causes objects to fall to the ground and also the force that keeps the Moon circling Earth instead of flying off into space in a straight line. Newton defined the Universal Law of Gravitation, which states that a force of attraction, called **gravity**, exists between all objects in the universe. The strength of the gravitational force depends on how much mass the objects have and how far apart they are from each other. The greater the objects' mass, the greater the force of attraction; the greater the distance between objects, the smaller the force of attraction.

The distance between the Sun and each of its planets is very large, but the Sun and each of the planets also have a very large mass. Gravity keeps each planet orbiting the Sun because the star and its planets have very large mass. The force of gravity also holds moons in orbit around planets.

Summary

- Newton developed the Universal Law of Gravitation, which recognizes the gravitational attraction between objects.
- All objects have a force of attraction between them that is proportional to their mass and distance from each other.
- Gravity keeps the planets orbiting the Sun because it has a very large mass, just as gravity keeps satellites orbiting the planets.

Science Language Students Need to Know and Use

- **asteroids:** irregular large pieces of rock that move through space
- **celestial objects:** Any natural objects in space that make up our universe
- **comets:** objects made up of ices, dust, and gases that orbit the sun in a large,
- elliptical orbit
- **distance:** a measure of the amount of space between objects
- **gravitational force:** the measurement of the pull of gravity
- **gravity:** the attraction of one mass to another
- **inference:** a conclusion reached on the basis of evidence and reasoning
- **mass:** the amount of matter in something
- **meteor:** the streak of light produced by a small piece of matter in space that is visible when it falls into Earth's atmosphere
- **meteorite:** a meteor that falls to the surface before burning up in the atmosphere
- **planet:** a celestial object, larger than asteroids or comets that revolve around a star without giving off its own light. See IAU definition of a planet here: http://en.wikipedia.org/wiki/IAU_definition_of_planet
- **satellite:** a natural or man-made object that revolves around larger objects in space
- **scale:** objects compared to a standard for accurate size perception
- **solar system:** the system made up of the eight unique planets, and many smaller objects that orbit the sun
- **stars:** celestial objects that consist of gases, which are so massive that fusion within their cores generate light and heat
- **sun:** the star in our solar system that sustains most life on Earth and is the primary source of heat and light
- **telescope:** an instrument that gathers light and magnifies, or makes distant objects appear larger

Online Interactive Activities

- This interactive will allow students to see various activities on Earth and then they choose what would happen on the moon based on the moon's gravity. http://tinyurl.com/ut6th3-3

Think Like a Scientist

1. Describe the forces holding Earth in orbit around the sun, and the moon in orbit around Earth.
2. How is a celestial object's mass related to its gravitational force on other objects?
3. What role does gravity play in the structure of the solar system?

Additional Recommended Resources:

- The universal law of gravity http://goo.gl/Qf4rQL
- CK-12 Gravity resources http://goo.gl/Jn8lP6

The universe

chapter 4

How Big Is Our Universe?

Standard 4, Objective 1
Grade 6
Text Structure: Compare and Contrast

How many times have you wondered about all the things that we see in the universe? The Universe - contains all of the star systems, galaxies, gas, and dust, plus all the matter and energy that exist.

Stars-huge balls of gas held together by gravity-are so far away that our present mode of space travel would take more than a lifetime to reach the nearest star, outside of our Solar System. Planets, -spherical balls of rock and/or gas that orbit a star have enough of their own gravity to become round. In our solar system, planets take from months to years to reach, depending on the planet you want to visit. Robot spacecraft take 7 to 9 months to travel to Mars. The fastest spacecraft ever launched, sped away from Earth at 36,000 miles per hour (58,000 kilometers per hour). It is the New Horizons spacecraft, a robot, on its way to Pluto. Even after a gravity-assist from Jupiter to increase its speed, New Horizons will take 9.5 years to reach Pluto. It will fly by Pluto in July 2015.

Since stars and galaxies are so far away from each other, measuring distances -how far one object is from another- in miles or kilometers is difficult for our minds to comprehend, because the numbers are so large. Scientists and astronomers sometimes use a light-year- the distance light travels in one year- to measure these distances. Let's begin with the Earth's distance from the Sun, -the only star in our solar system- to see how this works. Earth is about 93,000,000 miles (150,000,000 kilometers) away from the Sun. A beam of light from the Sun takes 8.3 minutes or about 500 seconds to reach the Earth. Speed of light -the time it takes light to travel- is a speed of about 186,000 miles per second (300,000 kilometers per second)-. The speed of light is much faster than rockets can travel today.

Light-Year Calculation
60 seconds per minute (x) 60 minutes per hour = 3,600 seconds per hour.
3,600 seconds per hour (x) 24 hours per day = 86,400 seconds per day.

86,400 seconds per day (x) 365 days a year = 31,536,000 seconds per year.
31,536,000 seconds per year (x) 186,000 miles per second =
5, 865,696,000,000 miles per year = 1 light-year in miles.
or
31,536,000 seconds per year (x) 300,000 kilometers per second =
9,469,800,000 kilometers per year = 1 light-year in kilometers.

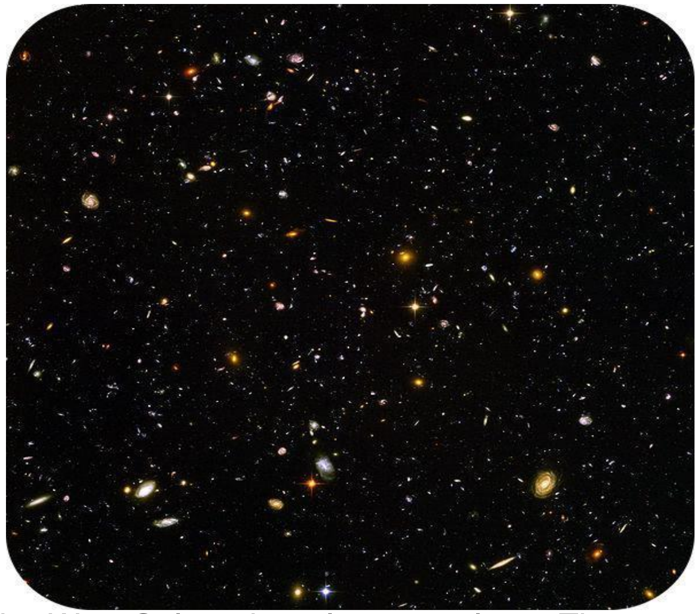
The closest star, other than our sun, is Proxima Centauri, a red dwarf star that is probably in a distant orbit around Alpha Centauri* which is over 40 million kilometers away or 4.36 light-years away. This means it would take about 4 years and 4 months to reach it from Earth if you were traveling at the speed of light.

** Alpha Centauri is in reality two stars that are slightly smaller that the Sun. They orbit each other at an average distance that is about the same as the distance between the Sun and Uranus.*

Distance from the Sun in Light Years to the Planets

Planet	Light-Years
Mercury	0.000006 (3.2 light minutes)
Venus	0.000011 (6 light minutes)
Earth	0.000016 (8.3 light minutes)
Mars	0.000024 (12.7 light minutes)
Jupiter	0.000082 (43.3 light minutes)
Saturn	0.000151 (79.5 light minutes)
Uranus	0.000304 (2.7 light hours)
Neptune	0.000476 (4.2 light hours)
Pluto	0.000625 (5.5 light hours)
Proxima Centauri	4.22
Alpha Centauri	4.36

Most stars belong to a **galaxy**-a group of hundreds of billions of stars held together by gravity. Our solar system lies about two-thirds of the way out from the center of a **galaxy** called the **Milky Way** -a group of about 100 to 400 billion stars formed in a disk-shaped spiral. Our solar system is a tiny dot compared to the Milky Way Galaxy. The **Milky Way Galaxy** is about 100,000 light-years from one end to the other. This is how many years it would take light or a radio signal to cross the Milky Way. The diameter of our solar system is about 0.004 light-years. You can see how small our solar system is compared to the Milky Way. If the Milky Way were about as wide as the United States (3000 miles), then the orbit of Neptune would be slightly less than 2 inches in diameter!



The Milky Way Galaxy is only one galaxy. There are billions of galaxies that span the **universe**- all existing matter and space as a whole; the cosmos. One of the Milky Way's neighboring galaxies is Andromeda. It is about 2.5 million light years away. It is so far away that you can't see its individual stars without a large telescope. You can only see a fuzzy spot in the night sky produced by the combined light of its many stars. The following picture was taken by the Hubble Space Telescope. There are many galaxies within this picture. The amount of sky in this picture would be covered by a grain of sand held at the end of your arm. Even though our world seems big to us, in the **universe** we are very, very small.

What's at the edge of the Universe?

While the Universe does not really have an "edge" in space that we know of, this image shows some of the farthest objects in the Universe. It was taken by the Hubble Space Telescope. The many galaxies in this image are at different distances from Earth. Some of the very small galaxies that look almost like points of light are about 13 billion light-years away. They are some of the most distant galaxies that we can see.

"I have not as yet been able to discover the reason for these properties of gravity from phenomena, and I do not feign hypotheses." - Isaac Newton, in *Philosophiae Naturalis Principia Mathematica*, 1687.

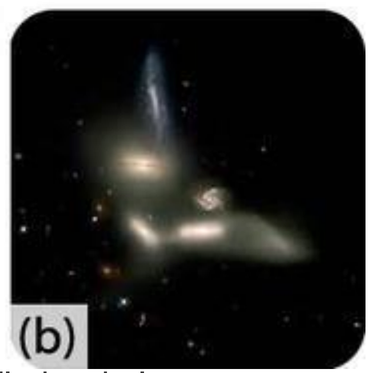
The Role of Gravity

Isaac Newton was the first to describe gravity- the force (-push or pull on an object-) that causes objects to fall to the ground and also the force that keeps the moon circling Earth instead of flying off into space in a straight line. Newton defined the Universal Law of Gravitation, which states that a force of attraction, called gravity, exists between all objects in the universe (See next Figure). The strength of the gravitational force depends on how much mass -the amount of matter in an object- the objects have and how far apart they are from each other. The greater the objects' mass, the greater the force of attraction; in addition, the greater the distance between objects, the smaller the force of attraction.

Human Understanding of the Universe

What did the ancient Greeks recognize as the Universe? Their Universe had Earth at the center, the sun, the moon, five planets, and a sphere to which all the stars were attached. This idea held for many centuries. Galileo used his **telescope**- an instrument used to view distant objects- to find out that there are many more stars in the sky than are visible to the naked eye. Later, astronomers found that all these stars were in what we call the **Milky Way Galaxy**- a huge, disk-shaped group of stars. They also observed many fuzzy, cloudy looking patches in the sky that they called nebulae, the Latin word for clouds. While some of them appeared to be giant clouds of gas and dust within the Milky Way, many were round, oval, or spiral in shape. Astronomers debated whether these nebulae were within the Milky Way or outside.

In the early 20th century, an astronomer named Edwin Hubble was able to identify individual stars in a nebula in the constellation of Andromeda. One particular type of star allowed him to calculate its distance. He showed that the Andromeda Nebula was far outside our Milky Way Galaxy. Hubble realized



that many of the objects that astronomers called nebulae were not actually clouds of gas. They were what we now call galaxies- collections of billions of stars.

The image on the left (image a) is Edwin Hubble. He used the 100 inch reflecting **telescope** at the Mount Wilson Observatory in California to show that some distant specks of light wer **galaxies**. Hubble's telescope spotted the six galaxy group pictured in the image on the left (image b).

Hubble showed that the universe is much larger than our own galaxy. Today, we know that the universe contains hundreds of billions of galaxies. That is about the same number of galaxies as there are stars in the Milky Way Galaxy.

Science Language Students Need to Understand and Use

- codistance: how far one object is from another
- force: a push or pull on an object
- galaxy: a group of hundreds of billions of stars held together by gravity
- gravity: the **force** (-push or pull on an object-) that causes objects to fall to the ground and also the **force** that keeps the Moon circling Earth instead of flying off into space in a straight line
- light-year: the distance light travels in one year
- mass: amount of matter in an object
- Milky Way Galaxy: a group of about 100 to 400 billion stars formed in a disk-shaped spiral that contains our solar system
- planets: spherical balls of rock and/or gas that orbit a star that have enough of their own gravity to become round
- scale: used to measure relative distances in space; in light years
- solar system: the collection of eight planets and their moons in orbit around the sun, together with smaller bodies in the form of asteroids, meteoroids, and comets
- speed of light: about 186,000 miles per second (300,000 kilometers per second)
- star: huge balls of gas held together by gravity
- sun: a star (see definition)
- telescope: an instrument used to view distant objects
- universe: Everything that exists; all matter and energy; also includes all of space and time.

Supporting language for ELL

- object: a thing that can be seen or touched
- represent: to serve as an example or model of something

Online Interactive Activities

- This interactive will allow students to see the scale of size of objects in the universe from microscopic to the whole universe. Students will also be able to click on objects in the universe to learn more about them. http://tinyurl.com/ut6th4-1

Think Like a Scientist

1. How are distances measured in the Solar System, Milky Way Galaxy, and the Universe
2. Why is it difficult to travel distances within our Solar System?
3. Compare the relative sizes of the solar system, galaxy, and Universe. Place them in order from smallest to largest in size.
4. Why can't we observe everything in the Universe?

Additional Recommended Resources

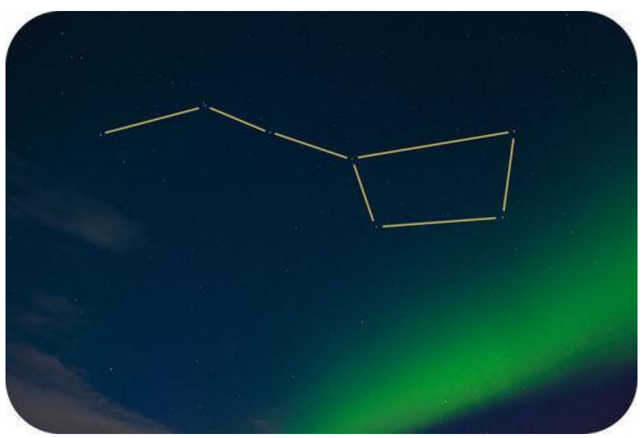
- Scale of the Solar System: http://youtu.be/-6szEDHMxP4; http://goo.gl/G8OkQU
- Speed of Light: http://goo.gl/O5VDiv
- Objects in Our Solar System: http://goo.gl/EfPAJL
- Our Universe: http://goo.gl/MRv132
- Scale of the Universe: http://htwins.net/scale2/

Near or Far- How are the patterns that stars form helpful to us during a year?

Standard 4, Objective 2
Grade 6
Text Structure: Description (Information)

How have the understanding and use of constellations changed throughout history?

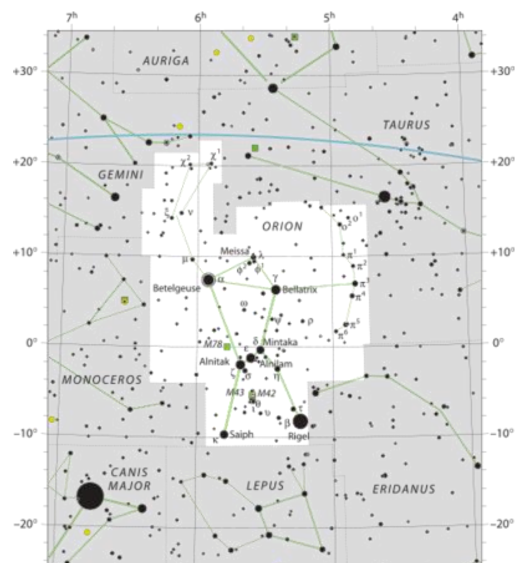
Stars in the sky have fascinated people throughout the ages. Many years ago when people were out tending their flocks, sailing their ships, traveling, or stargazing, they had plenty of time to look at the stars. In hot weather, many people slept on the roofs of their houses. They observed how the stars moved across the sky during the night and they invented patterns of stars in the sky. The patterns were fixed (they did not change over time). While some stars were visible all night long, other stars would rise and set throughout the night. People imagined patterns or pictures in the stars. They used these stars and star patterns to tell direction and also to tell time during the night. Sky watchers noticed that different stars and star patterns were visible during different times of the year. Certain patterns appeared during spring, summer, fall, and winter, and other patterns disappeared during particular seasons. With this knowledge, they were able to use the stars as a kind of calendar.



The Big Dipper is an example of a star pattern. You can find the Big Dipper if you look towards the North. You can see it in the photo below. The photo shows white lines to help you to imagine the Dipper. It always looks the same because the stars are always the same distance apart. The Big Dipper can be found in the same general direction as it appears to move across our nighttime sky.

Is this pattern of stars meaningful?

This is a **constellation**–a pattern of stars in the night sky. This **constellation** is called Orion. The features you can see best are his belt and sword. You can see Orion's belt in the sky from many locations. These stars are very bright. For many constellations, the stars are not near each other. They just happen to appear near each other in our sky.



Orion has three stars that make up his belt. Orion's belt is fairly easy to see in the night sky.

Constellations

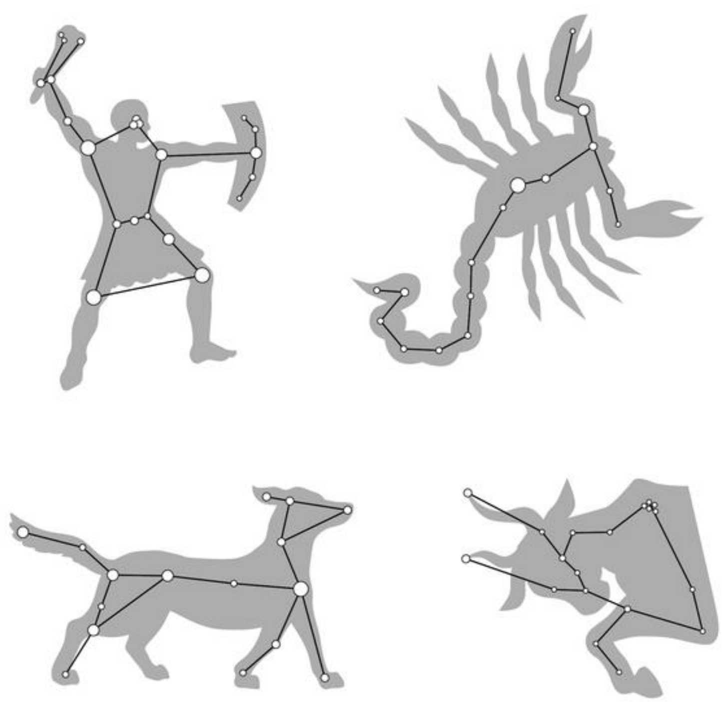
The stars that make up a **constellation** appear close to each other from Earth. In reality, they may be very distant from one another. Constellations were important to people, like the Ancient Greeks. People who spent a lot of time outdoors at night, like shepherds, named the constellations. They told stories about them. Pictured below is one of the most easily recognized constellations (Figure next). The ancient

Greeks thought this group of stars looked like a hunter. They named it Orion, after a great hunter in Greek mythology.

The constellations stay the same night after night. The patterns of the stars never change. However, each night the constellations move across the sky. They move because Earth is spinning on its axis. The constellations also move with the seasons. This is because Earth revolves around the Sun. The constellations in the winter are different from those in the summer. For example, Orion is high up in the winter sky. In the summer, it's only up in the early morning.

Constellations are useful. They help astronomers and other observers orient in the night sky. The star Betelgeuse, for example, is Orion's right shoulder. Betelgeuse is the eighth brightest star in the sky. The star is an excellent example of a red supergiant.

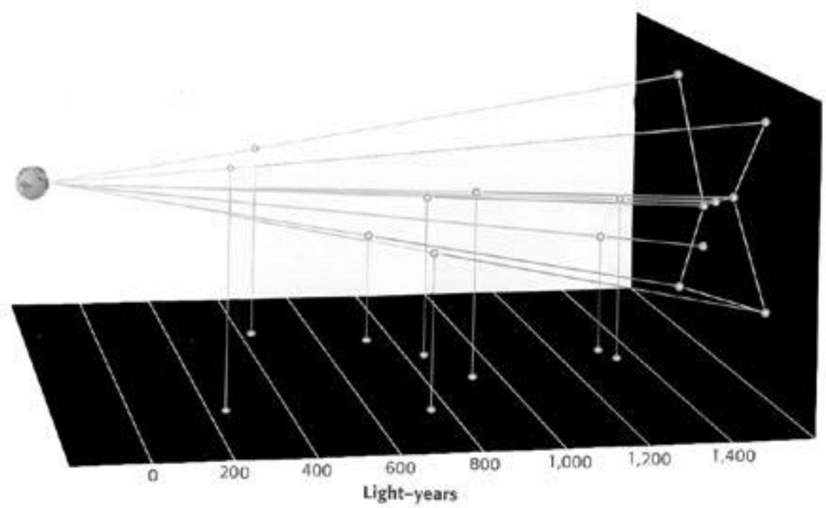
Many patterns of stars in the sky are called constellations



Many ancient civilizations like the Egyptians, Babylonians, Chinese and Greeks made careful observations of the stars.

Each civilization created its own star patterns. They associated them with objects, beasts, or people. (The Big Dipper is an example of a star pattern that is not a constellation. It is part of a larger constellation called Ursa Major). They would sometimes connect several nearby constellations with stories related to heroes, heroines, and beasts of their time and culture. Since those ancient times, astronomers have made up additional constellations, naming some of them after scientific instruments.

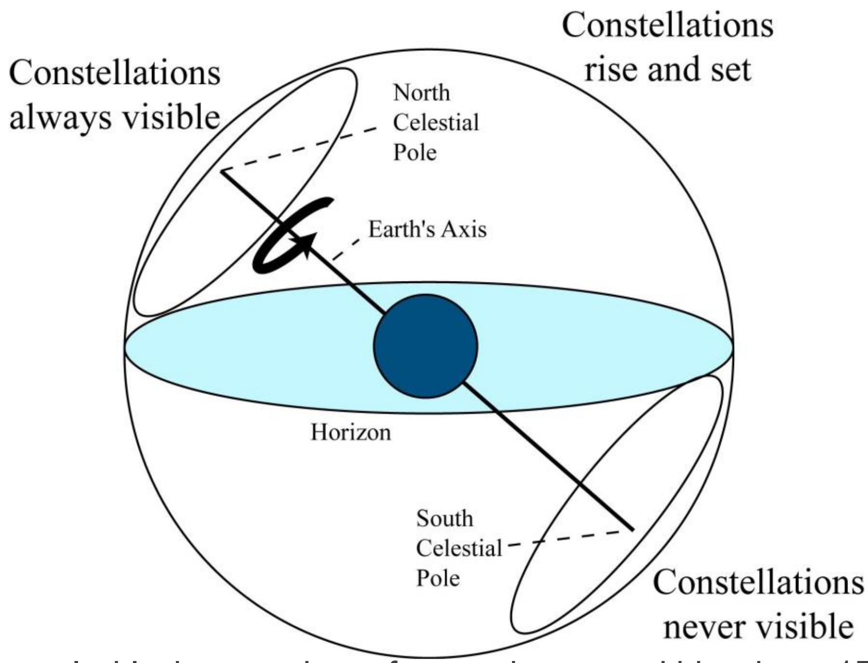
Stars in a constellation may look like they are close together. Actually, stars that make up constellations may be at very different distances from Earth. While the stars in the constellation Orion may appear to be near each other when viewed from Earth, they are actually very far apart from one



another.

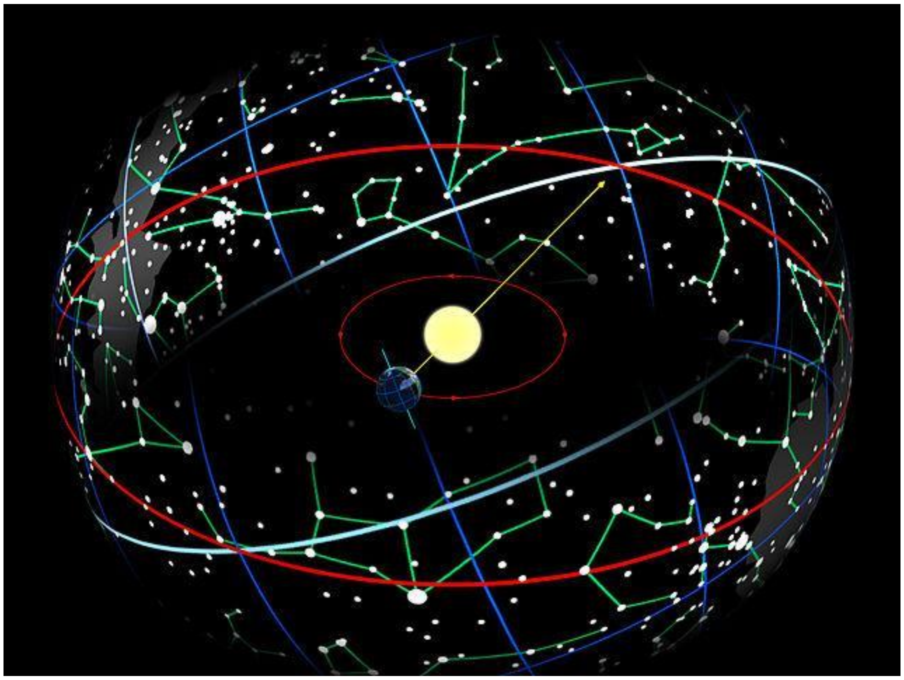
The portion of the sky that we can see depends on our location on Earth and Earth's location in its orbit around the Sun. From Utah, there is a portion of the sky that we never see. This is a small part of the sky above the South Pole. Stars in that part of the sky are never visible to us. Exactly opposite to that, there is a region of the sky where stars are visible all night long and all year long, weather permitting. These are stars that are close to the North Star. The North Star, or Polaris, is almost directly above the North Pole. Stars that are not in this part of the sky will appear to rise and set as Earth rotates.

Earth’s rotation allows us to see most of the stars in the sky during the night. The only stars we cannot see at some time during the night are those in that part of the sky never visible to us, and those hidden behind the Sun. How many stars are hidden by the Sun? While it may seem like the Sun’s light blocks half of the sky, that idea is not correct. When the Sun is above the horizon, a portion of its light is scattered by the air in all directions. This gives the sky a blue color and makes it too bright for us to see the dimmer stars. The stars are there, but the sky is too bright for us to see them. However, soon after the Sun sets, stars that were previously hidden by scattered sunlight become visible. It turns out that the Sun’s



light only blocks our view of stars that are within about 15 degrees of it.

As Earth moves around the Sun, stars that were hidden by the Sun’s light slowly become visible to us while other stars that were visible to us become hidden. As Earth orbits the Sun, the Sun will appear to move in front of 12 different constellations. These are known as the zodiac constellations. The Sun’s light blocks our view of each zodiac constellation for about a month.

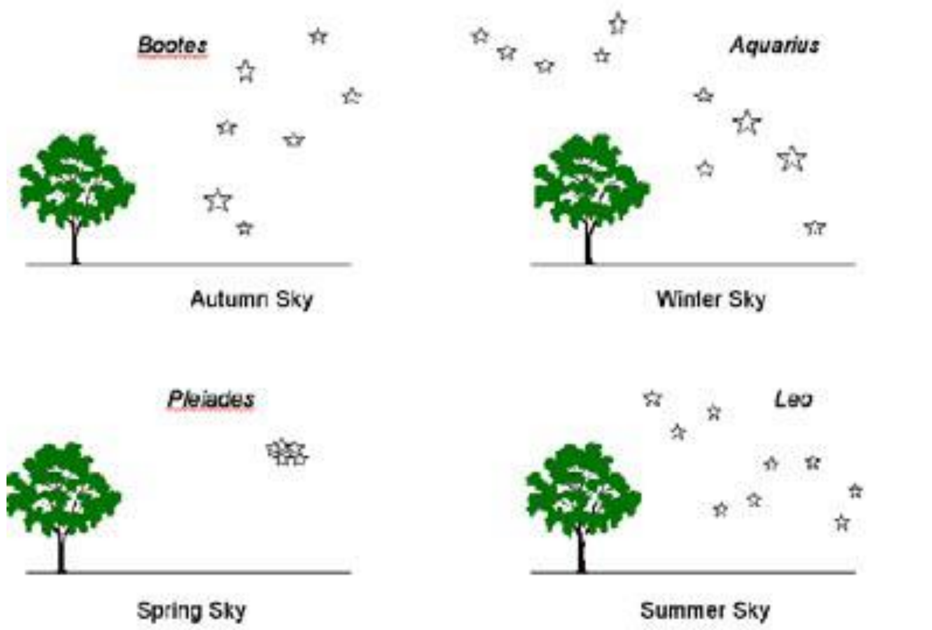


As Earth orbits the Sun, it causes the Sun to appear to move in front of the constellations of the zodiac.
[Image source: http://en.wikipedia.org/wiki/File:Ecliptic_path.jpg]

People throughout the ages have discovered that constellations can be used as reference points. Sailors used them to help guide their ships at night. African-Americans fleeing slavery sought what they called the Drinking Gourd, or Big Dipper, found near the North Star, as a guide to freedom. Pioneers migrating west used constellations as a guide while traveling on the Oregon Trail. Constellations have been important, not only in the development of ancient civilizations, but in the development of modern ones as well.

Ancient people noticed that some bright objects did not behave like the others. These objects might be close to a star one night and then the next night, the object has moved slightly away from that star. Night after night, these objects appear in new positions among the stars.

The Greeks of those times called these objects "wandering stars" because they were in a slightly different position each night. The Greek word for wanderer is "planetes" and so we get the English word "planet". A person who wanders is someone who walks around wherever he feels like going.



Science Language Students Need to Understand and Use

- constellation: a pattern in the stars that has been identified and named
- distance: how far one object is from another
- galaxy: a group of hundreds of billions of stars held together by gravity
- light-year: the distance light travels in one year
- scale: used to measure relative distances in space; in light years
- star: huge balls of gas held together by gravity
- sun: a star (see definition)
- telescope: an instrument used to view distant objects
- universe: Everything that exists; all matter and energy; also includes all of space and time.

Supporting language for ELL

- object: a thing that can be seen or touched
- represent: to serve as an example or model of something

Online Interactive Activities

- This interactive will allow students can view the solar system from different angles and perspectives. http://tinyurl.com/ut6th3-1c
- http://tinyurl.com/ut6th4-2

Think Like a Scientist

1. Why were the stars important to cultures long ago?
2. How has the use of constellations helped people years ago and today?
3. What do the stars in a constellation have in common?
4. Compare the sizes and distances of the stars contained within a given constellation.
5. Why do constellations appear to rise and set at different times of the year?
6. Why can we not see the same stars year round?

Additional Recommended Resources

- Scale of the Solar System http://youtu.be/-6szEDHMxP4; http://goo.gl/G8OkQU
- Our Universe http://goo.gl/MRv132
- Constellations http://stardate.org/nightsky/constellations
- Constellation http://www.iau.org/public/themes/constellations/

chapter 5

microorganisms

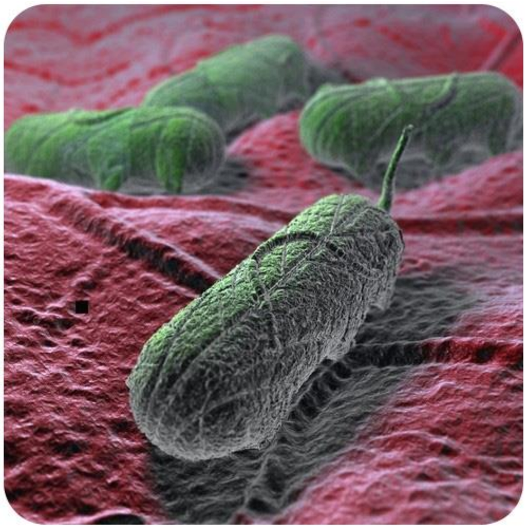
What are the characteristics of microorganisms?

Standard 5, Objective 1
Grade 6
Text structure: Description (Information)

Some microorganisms are producers—living things that make their own food from simple substances usually using sunlight, as plants do. Others are consumers and eat other organisms to get their food. Most microorganisms do not cause disease and many are helpful. There are many different kinds of microorganisms. Scientists observe and classify microorganisms just as they do plants and animals. These classifications are determined by the microorganism’s shape, structure, how they get food, where they live and how they move. The microorganisms you will study in this unit include bacteria, fungi, and protists.

All **microorganisms**–living things too small for the human eye to see–are **organisms**–living things. **Microorganisms** may be unicellular or **single-celled**–any living thing that has only one cell. Some microorganisms are multicellular, having more than one cell. Microorganisms require food, air, water, ways to dispose of waste and an environment in which they can live. Some microorganisms are **producers**–living things that make their own food from simple substances usually using sunlight, as plants do. Some microorganisms are **consumers**–eat other organisms to get their food. Most microorganisms do not cause disease and many are helpful. There are many different kinds of microorganisms. Scientists observe and classify microorganisms just as they do plants and animals. These classifications are determined by the microorganism’s shape, structure, how they get food, where they live and how they move. The microorganisms you will study in this unit include **bacteria**, **fungi**, and **protists**.

Bacteria



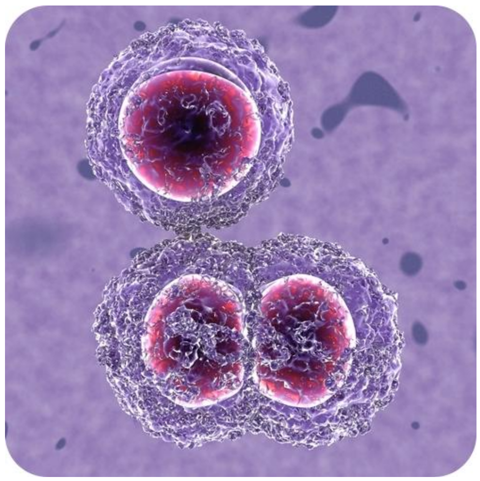
Can you guess which organisms are pictured here?
Are they fat green worms on a red leaf? Here's a clue: There are more organisms like these than any other on Earth. Here's another clue: Each organism consists of a single cell without a nucleus.

The organisms are bacteria—the smallest and simplest type of living thing, single-celled, and having no nucleus—called *Salmonella*. If the word Salmonella rings a bell, that's probably because *Salmonella* causes human diseases such as food poisoning. Many other types of bacteria also cause human diseases. But not all bacteria are harmful to people. In fact, we could not survive without many of the trillions of bacteria that live in or on the human body.

Where is bacteria found?
Bacteria are the most diverse and abundant group of organisms on Earth. They live in almost all environments. They are found in the ocean, the soil, and the intestines of animals. They are even found in rocks deep below Earth's surface. Any surface that has not been sterilized is likely to be covered with bacteria. The total number of bacteria in the world is amazing. It's estimated to be 5×10^{30}, or five million trillion trillion! You have more bacteria in and on your body than you have body cells!

Thousands of species of bacteria have been discovered, and many more are thought to exist. The known species can be classified on the basis of various traits.

Are bacteria living things? Bacteria are individual living cells. Bacteria cells are similar to your cells in many ways; yet, they also have distinct differences. Bacteria have many unique adaptations allowing them to live in many different environments. Bacteria have a wide range of metabolism, and this determines where they live. They live in a particular habitat because they are able to “obtain energy” from whatever is around them. Bacteria can live and grow in practically any environment. It is this ability that has made bacteria the most numerous species on the planet.



How do bacteria reproduce?

Bacteria grow to a fixed size and then reproduce through binary fission. Binary fission is a type of asexual reproduction. It occurs when a parent cell splits into two identical daughter cells. This can result in very rapid population growth. For example, under ideal conditions, bacterial populations can double every 20 minutes. Such rapid population growth is an adaptation to an unstable environment.

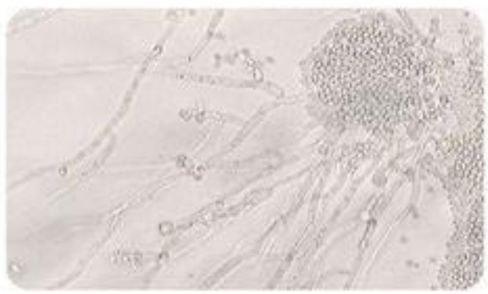
Fungi

What exactly is a fungus?
Ever notice blue-green mold growing on a loaf of bread? Do you like your pizza with mushrooms? Has a physician ever prescribed an antibiotic for you? If so, then you have encountered **fungi**—a group of organisms that absorbs its nutrients from its surroundings. **Fungi** are organisms that belong to the Kingdom Fungi. They're not animals or plants, so they cannot photosynthesize or eat, they absorb!

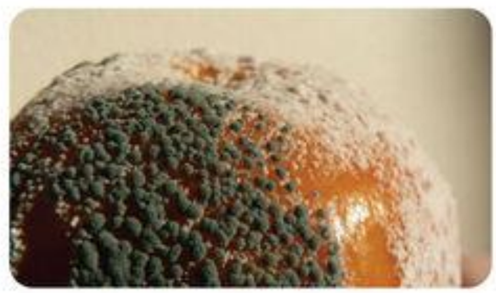
Most fungi are multicellular, but some exist as single cells. They are much more than mushrooms.

Yeasts, molds, and mushrooms are all different kinds of fungi. There may be as many as 1.5 million species of fungi. You can easily see bread mold and mushrooms without a microscope, but most fungi you cannot see. Fungi are either too small to be seen without a microscope, or they live where you cannot see them easily—deep in the soil, under decaying logs, or inside plants or animals. Some fungi even live in, or on top of, other fungi.

Mushrooms



Yeast



Mold

Several examples of fungi are pictured here.

Molds growing on foods are some of the most common fungi in our everyday lives. These organisms may seem useless, gross, and costly. But fungi play very important roles in almost every ecosystem on Earth.

The mold growing on this bread is a common fungus.

Our environment needs fungi. Fungi help decompose matter to release nutrients and make nutritious food for other organisms. Fungi are all around us and are useful in many ways.

Habitats of Fungi

Fungi are found all around the world, and grow in a wide range of habitats, including deserts. Most grow in land environments, but several species live only in aquatic habitats. Most fungi live in soil or dead matter and in symbiotic relationships with plants, animals, or other fungi. Fungi, along with bacteria that are found in soil, are the primary decomposers of organic matter on earth. The decomposition of dead organisms returns nutrients to the soil, and the environment.

Bracket fungus

What does this fungus have in common with mold?

This colorful bracket fungus doesn't look much like mold. But they have a lot in common. They both break down organic matter to obtain nutrients. They both reproduce by spores. They are both **eukaryotic**–cells that contain a nucleus and other cell parts–, but they are not plants, and they are definitely not animals. They are both fungi.

These many different kinds of organisms demonstrate the huge diversity within the Kingdom Fungi.

Fungi are Good Consumers

The main difference between plants and fungi is how they obtain energy. Plants are **autotrophs**—organisms that make food for themselves and other organisms usually through photosynthesis—or producers. Fungi are **heterotrophs**—organisms that obtain their "food" from outside of themselves—or consumers. In other words, they must consume their food like animals do. But they don't really eat, they absorb their nutrients.

Fungi can grow fast because they are such good eaters. Fungi have lots of surface area, and this large surface area “eats” or absorbs. Surface area is how much exposed area an organism has, compared to their overall volume. Most of a mushroom's surface area is actually underground. If you see a mushroom in your yard, that is just a small part of a larger fungus growing underground.

These are the steps involved in fungi "eating":

- Fungi squirt special enzymes into their environment.
- The enzymes help digest large organic molecules, similar to cutting up your food before you eat.
- Cells of the fungi then absorb the broken-down nutrients.

So what do fungi consume?

Fungi consume just about anything. This includes things from dead plants to rotting fruit. Shown here are fungi sprouting from dead material in the woods. Fungi perform an essential role in the decomposition of organic matter and have fundamental roles in recycling nutrients back into the environment.

Fungi obtain nutrients in three different ways:

- They decompose dead organic matter.
- They feed on living hosts.

- They live mutualistically, in a mutually beneficial relationship, with other organisms.

Type of Fungi	Examples	
Molds Common Types of Fungi		Penicillium
Mushrooms		Morels, Shitake, Cremini, Oyster
Single-celled yeasts		baker's yeast

Protist Kingdom

Animal? Bacteria? Plant? Fungi?

Protists are none of the above! These organisms may be **single-celled** like bacteria, and they may look like a fungus. They also may hunt for food like an animal or photosynthesize like a plant. And, yet, they do not fit into any of these groups. These organisms are **protists**– a large and diverse group of **eukaryotic** organisms.

Kingdom Protista

Protists are a group of all the eukaryotes that are not fungi, animals, or plants. As a result, it is a very diverse group of organisms. The eukaryotes that make up this kingdom, Kingdom Protista, do not have much in common except that they don't fit the classifications of other kingdoms. They are relatively simple and the rule breakers in the other kingdoms of life. Protists can look very different from each other. Some are tiny and unicellular, like an amoeba, and some are large and multicellular, like seaweed. However, multicellular protists are structurally simple compared to plants.

Protist Habitats

Most protists are aquatic organisms. They need a moist environment to survive. They are found mainly in damp soil, marshes, puddles, lakes, and the ocean. Some protists are free-living organisms. Others are involved in symbiotic relationships. They live in or on other organisms, including humans.

The Movement of Protists

Most protists have the ability to move. Protists have three types of appendages for movement. They may have flagella, cilia, or pseudopods. There may be one or more **flagella**– whip-like structures used to propel an organism through water. **Cilia**–small, hair-like structures used to move–are similar to **flagella**, except they are shorter and there are more of them. They may completely cover the surface of the protist cell. **Pseudopods**–temporary, foot-like extensions of the cytoplasm–are also used to help an organism move.

Animal-like Protists

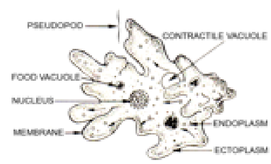
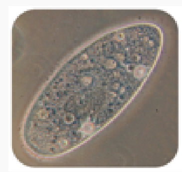
Protozoa–animal-like protists–are single-celled eukaryotes that share some traits with animals. Like animals, they can move, and they are **heterotrophs**- consumers. That means they eat things outside of themselves instead of producing their own food.

Different Kinds of Animal-like Protists

There are many different types of animal-like protists. They are different because they move in different ways.

- **Pseudopods**, which are like temporary feet. The cell surface extends out to form feet-like structures that propel the cell forward.
- **Ciliate** are thin, very small hair-like projections that extend outward from the cell body. Cilia beat back and forth, moving the protist along. *Paramecium* has cilia that propel it.

- Flagellates have long flagella, or tails. Flagella rotate in a propeller-like fashion, pushing the protist through its environment

Type of Protozoa	How It Moves	Example (Genus)
Amoeboid	pseudopods	*Amoeba* 
Ciliate	cilia	*Paramecium* 
Flagellate	flagella	*Giardia* 

Plant-like Protists

Plant-like protists are known as algae. They are a large and diverse group. Like plants, plant-like protists are autotrophs or producers. This means that they produce their own food. They perform photosynthesis to produce sugar by using carbon dioxide and water, and the energy from sunlight, just like plants. Unlike plants, however, plant-like protists do not have true stems, roots, or leaves.

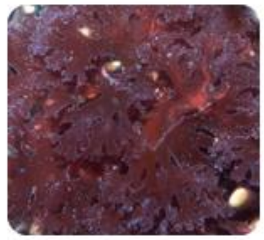
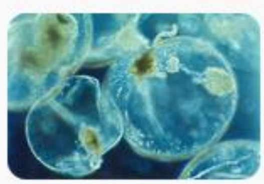
Most plant-like protists live in oceans, ponds, or lakes. Protists can be unicellular (single-celled) or multicellular (many-celled). Seaweed and kelp are examples of multicellular, plant-like protists. Kelp can be as large as trees and form a "forest" in the ocean.

Plant-like protists are essential to the ecosystem. They are the base of the marine food chain, and they produce oxygen through photosynthesis for animals to breathe. They are classified into a number of basic groups.

Diatoms are single-celled algae. Other forms of algae are multicellular.

Algae

Why is **algae** considered plant-like? The main reason includes the presence of chloroplasts and production of food through photosynthesis. However, they lack many other structures of true plants. For example, algae do not have roots, stems, or leaves. Some algae also differ from plants in being able to move. They may move with pseudopods or flagella. Although not plants themselves, algae were probably the ancestors of plants. Types of algae include red and green algae, euglenids, and dinoflagellates.

Type of Algae
Red algae 
Green algae 
Euglenids 
Dinoflagellates 

Fungus-like Protists

What's shrouding this dead insect? The thin filaments growing out of this dead insect look a little like a fungus. Also this mystery organism, like a fungus, is feeding on decaying matter. However, this is not a fungus. This organism is a type of fungus-like protist, known as water mold.

Fungus-like Protists

Fungus-like protists share many features with fungi. Like fungi, they are heterotrophs or consumers, meaning they must obtain food outside themselves. They also have cell walls and reproduce by forming spores, just like fungi. Fungus-like protists usually do not move, but a few develop movement at some point in their lives. Two major types of fungus-like protists are slime molds and water molds.

This slime mold, shown growing on dead wood, is a fungus-like protist. Though this mold does not have a mouth, essentially it is still "eating" this decaying material.

Fungus-like protists are absorptive feeders on decaying organic matter. They resemble fungi, and they reproduce with spores as fungi do. However, in other ways, they are quite different from fungi and more like other protists.

Viruses

Many people may assume that a virus is a microorganism, but they are not. A virus is essentially genetic material surrounded by protein. That's it. Viruses are tiny particles that may cause disease. Human diseases caused by viruses include the common cold and flu. Viruses are not cells at all. Viruses contain DNA but not much else. They lack the other parts shared by all cells, including a plasma membrane, cytoplasm, and ribosomes. Therefore, viruses are not cells, but are they alive? All living things not only have cells; they are also capable of reproduction. Viruses cannot reproduce by themselves. Instead, they infect living hosts, and use the hosts' cells to make copies of their own DNA. For these reasons, most scientists do not consider viruses to be living things.

Science Language Students Need to Know and Use

- **algae**: a plant-like protest without roots, stems, or leaves
- **autotrophs**: organisms that make food for themselves through photosynthesis, also known as producers
- **bacteria:** the smallest and simplest type of living thing, single-celled, and having no nucleus
- **cilia:** small, hair-like structures used to move
- **eukaryotic:** cells that contain a nucleus and other cell parts
- **flagella:** whip-like structures used to propel an organism through water
- **fungi**: a group of organisms that absorbs its nutrients from its surroundings
- **heterotrophs**: organisms that obtain their "food" from outside of themselves, also known as consumers
- **microorganisms**: a living thing too small for the human eye to see
- **organism:** a living thing
- **producers**: living things that make their own food from simple substances usually using sunlight, as plants do
- **protists:** a large and various group of eukaryotic organisms
- **protozoa**: animal-like protists
- **pseudopod**: temporary, foot-like extensions of the cytoplasm
- **single-celled**: any living thing that has only one cell

Additional Language for ELL

- **decompose**: to break things down into simpler materials
- **mutualistically**: a relationship in which two different species both benefit

Online Interactive Activities

- This interactive will allow students to learn about the characteristics of bacteria, fungi, protozoa, and viruses. http://tinyurl.com/ut6th5-1

- This interactive will allow students to identify common locations of microorganisms, and learn more about them, and sort them into helpful or harmful. (Simple) http://tinyurl.com/ut6th5-1b

- This interactive will allow students to identify germs that cause disease, take quizzes, explore the history of infectious disease, and read profiles about "Disease Detectives". (A

great resource for microorganism reports.)
http://tinyurl.com/ut6th5-1c

Think Like a Scientist

1. Compare and contrast the characteristics of bacteria, fungi, and protists.

2. What is the difference between an autotroph (producer) and a heterotroph (consumer)?

3. What are the three main types of protists?

4. Why are viruses not considered to be a living thing?

Additional Recommended Resources

- HippoCampus.org, http://www.hippocampus.org/Biology Biology for AP∗ Search: Characteristics of Fungi
- For a discussion of exponential growth and bacteria see http://goo.gl/8EvBiU

Are microorganisms good or bad for us?

Standard 5, Objective 2
Grade 6
Text structure: Description (Information)

Bacteria and humans have many important relationships. Bacteria make our lives easier in a number of ways. In fact, we could not survive without them. On the other hand, bacteria can also make us sick.

Can we survive without bacteria? Could bacteria survive without us? No and yes. No, we could not survive without bacteria. And yes, bacteria could survive without us.

Foods
Bacteria can be used to make cheese from milk. The bacteria turn the milk sugars into lactic acid. The acid is what causes the milk to curdle to form cheese. Bacteria are also involved in producing other foods. Yogurt is made by using bacteria to ferment milk. Fermenting cabbage with bacteria produces sauerkraut.

Medicines
In the laboratory, bacteria can be changed to provide us with a variety of useful materials such as a medicine to treat diabetes, antibiotics, and vaccines.

Digestion
There are billions of bacteria inside the human intestines. They help digest food, make vitamins, and play other important roles. Several species of bacteria, such as *E. coli*, are found in your digestive tract. In fact, in your gut, bacteria cells outnumber your own cells!

Decomposers
Bacteria are important because many bacteria are **decomposers**–organisms that break down dead or decaying things into simpler substances. They break down dead materials and waste products and recycle nutrients back into the environment. This recycling of nutrients, such as nitrogen, is essential for living organisms. Organisms cannot produce nutrients, so they must come from other sources.

We get nutrients from the food we eat; plants get them from the soil. How do these nutrients get into the soil? One way is from the actions of **decomposers**. Without decomposers, we would eventually run out of the materials we need to survive. We also depend on bacteria to decompose our wastes in sewage treatment plants.

Other Benefits of Bacteria

Humans also use bacteria in many other ways, including:

- Creating products, such as ethanol and enzymes.
- Making biogas, such as methane.
- Cleaning up oil spills and toxic wastes.
- Killing plant pests.
- Transferring normal genes to human cells in gene therapy.

Fermentation is a type of respiration that doesn't use oxygen. Fermentation by bacteria is used in brewing and baking. It is also used to make the foods pictured here.

Harmful Bacteria

With so many species of bacteria, some are bound to be harmful. Harmful bacteria can make you sick. They can also spoil food and be used to hurt people.

Diseases

You have ten times as many bacteria as human cells in your body. Most of these bacteria are harmless. However, bacteria can also cause disease. Bacteria are responsible for many types of human illness, including:

- Strep throat
- Tuberculosis
- Pneumonia
- Leprosy
- Lyme disease

Luckily most of these can be treated with antibiotics.

Bacteria may spread directly from one person to another. For example, they can spread through touching, coughing, or sneezing. They may also spread via food, water, or objects.

Food Contamination

Bacterial contamination of foods can lead to digestive problems, an illness known as food poisoning. Raw eggs and undercooked meats commonly carry the bacteria that can cause food poisoning. Food poisoning can be prevented by cooking meat thoroughly and washing surfaces that have been in contact with raw meat. Washing your hands before and after handling food also helps prevent contamination.

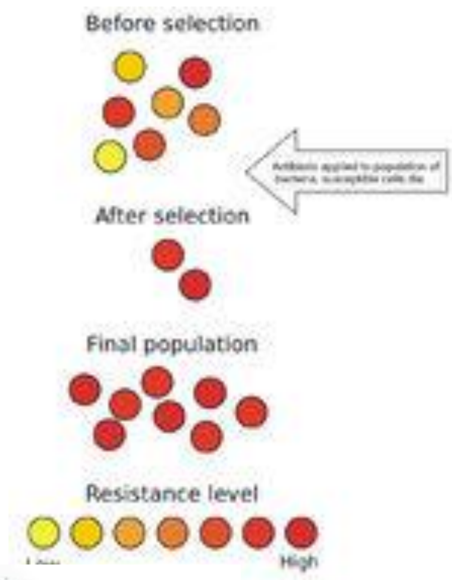
Weapons

Some bacteria also have the potential to be used as biological weapons. An example is anthrax, a disease caused by the bacterium Bacillus anthracis. Inhaling the spores of this bacterium can lead to a deadly infection, and, therefore, it is a dangerous weapon. In 2001, an act of terrorism in the United States involved B. anthracis spores sent in letters through the mail.

Controlling Bacteria

Bacteria in food or water usually can be killed by heating it to a high temperature (generally, at least 71°C, or 160°F). Bacteria on many surfaces can be killed with chlorine bleach or other disinfectants. Bacterial infections in people can be treated with antibiotic drugs. For example, if you have ever had “strep” throat, you were probably treated with an antibiotic.

Antibiotics have saved many lives. However, misuse and over-use of these medicines have led to antibiotic resistance in bacteria. Some strains of bacteria are now resistant to most common antibiotics. These infections are very difficult to treat once the bacteria becomes resistant to an antibiotic.



Evolution of Antibiotic Resistance in Bacteria. This diagram shows how antibiotic resistance evolves by natural selection.

Helpful Fungi

What's growing on this lemon?

Would you believe penicillin? Penicillin is a mold, which of course is a fungus, one that has helped millions, if not billions, of people.

Fungi for Food

Humans have collected and grown mushrooms for food for thousands of years. Whenever you eat pizza, you eat fungi, even if you don't like your pizza with mushrooms. That's because pizza dough contains yeast. Yeasts are used in bread baking and brewing alcoholic beverages. Other fungi are used in fermenting a wide variety of foods, including soy sauce and cheeses. Blue cheese has its distinctive appearance and flavor because of the fungus growing through it. These are just a few of the many species of edible

mushrooms consumed by humans.

Blue Cheese. The dark blue strands running through this cheese are a fungus. In fact, this cheese is moldy! The fungus is Penicillium Roqueforti, a type of mold.

Fungi for Pest Control

Harmless fungi can be used to control pathogenic bacteria and insect pests on crops. Fungi compete with bacteria for nutrients and space, and they parasitize insects that eat plants. Fungi reduce the need for pesticides and other toxic chemicals.

Other Uses of Fungi

Fungi are useful for many other reasons.

- They are a major source of citric acid (vitamin C).
- They produce antibiotics such as penicillin, which has saved countless lives.
- They can be genetically engineered to produce insulin and other human hormones.

- They are model research organisms. To see how one lab is using yeast in cancer research, watch the video at this link: http://goo.gl/4cLwgb

Harmful Fungi

Would you eat these mushrooms? I would not recommend it. But certain red mushrooms, Ganoderma Lucidum, have been found to be good for you. Red Mushrooms comprise a family of more than 200 mushroom species, which are good for our health. Of these, 6 species have a particularly high therapeutic effect.

Fungi and Human Disease

Fungi cause human illness in three different ways: poisonings, parasitic infections, and allergic reactions.

Fungal Poisoning

Many fungi protect themselves from parasites and predators by producing toxic chemicals. If people eat toxic fungi, they may experience digestive problems, hallucinations, organ failure, and even death. Most cases of mushroom poisoning are due to mistaken identity. That's because many toxic mushrooms

look very similar to safe, edible mushrooms.

Poisonous or Edible? The destroying angel mushroom on the left causes liver and kidney failure. The puffball mushroom on the right is tasty and harmless. Do you think you could tell these two species of mushrooms apart?

Fungal Parasites
Some fungi cause disease when they become human parasites. Two examples are fungi in the genera *Candida* and *Trichophyton.*

- *Candida* are yeast that cause candidiasis, commonly called a “yeast infection.” The yeast can infect the mouth, throat, blood. or skin. If yeast enter the blood, they cause a potentially life threatening illness. However, this is rare, except in people with a depressed immune system.
- *Trichophyton* are fungi that cause ringworm. This is a skin infection characterized by a ring-shaped rash. The rash may occur on the arms, legs, head, neck, or trunk. The same fungi cause athlete’s foot when they infect the skin between the toes. Athlete’s foot is the second most common skin disease in the U.S.


Ringworm


Athlete’s Foot

Ringworm produces a ring-shaped rash, but it isn’t caused by a worm. It’s caused by the same fungus that causes athlete’s foot.

Fungal Allergies
Mold allergies are very common. They are caused by airborne mold spores. When the spores enter the respiratory tract, the immune system responds to them as though they were harmful microbes. Symptoms may include sneezing, coughing, and difficulty breathing. The symptoms are likely to be more severe in people with asthma or other respiratory diseases. Long-term exposure to mold spores may also weaken the immune system.

Molds grow indoors as well as out. Indoors, they grow in showers, basements, and other damp places. Homes damaged in floods and hurricanes may have mold growing just about everywhere. Indoor mold may cause more health problems than outdoor mold because of the closed, confined space. Most people also spend more time indoors than out.

The mold growing on the walls and ceiling of this storm-damaged home may be harmful to human health.

Protists and Human Disease

Can such little creatures make you sick?

They sure can. Not all of them, but some of them. And without proper medical treatment, the person may never recover. Most protist diseases in humans are caused by animal-like protists, or protozoa. Protozoa make us sick when they become human parasites. Several diseases caused by Protists include *Giardia,* African Sleeping Sickness, and Malaria.

Science Language Students Need to Know and Use

- **Decomposers:** organisms that break down dead or decaying things into simpler substances.

Online Interactive Activities

- This interactive will allow students to distinguish between helpful and harmful bacteria: http://tinyurl.com/ut6th5-2

- This interactive will allow students to identify common locations of microorganisms, and learn more about them, and sort them into helpful or harmful. (Simple): http://tinyurl.com/ut6th5-1b

- This interactive will allow students to identify germs that cause disease, take quizzes, explore the history of infectious disease, and read profiles about "Disease Detectives". (A great resource for microorganism reports.) http://tinyurl.com/ut6th5-1c

Think Like a Scientist

1. What are some positive and negative effects of microorganisms?
2. Explain why you should never eat mushrooms you find in the woods unless you know for certain which type of mushrooms they are.
3. Why are decomposers important?
4. Compare and contrast ringworm and athlete's foot.
5. Describe two ways that humans use bacteria and fungi.

Additional Recommended Resources

- Kids Health, http://goo.gl/uJvw1g
- HippoCampus.org, http://www.hippocampus.org/Biology Non-Majors Biology Search: Fungi and People
- QUEST-Science on the SPOT: Fungus Fair, http://goo.gl/7w690U

Heat, light & sound

chapter 6

What are the three different ways heat moves?

Standard VI, Objective 1
Grade 6
Text Structure: Compare and Contrast

Do you enjoy standing outside on a warm summer day and feeling the warmth from the sun on your skin? What about warming your hands on a frosty cold morning in front of a fire? You are feeling heat! The sun provides us with light, but it also provides us with heat.

Look at these lions enjoying lying in the heat from the sun!

Heat can be found in many different places. Anything that provides us with heat is a source of heat. Let's look more closely at heat energy.

http://goo.gl/vINoYw

This chef is placing cookie dough in a hot oven. What will happen to the dough after he closes the oven door? Will the hot oven add “heat energy” to the dough?

What is heat? **Heat** – the transfer of thermal energy between substances- always moves from warmer to cooler substances. Thermal energy is the measurement of the amount of kinetic energy, or movement of particles in matter, which is measured by temperature.

Faster-moving particles of the warmer substance bump into and transfer some of their energy to slower-moving particles of the cooler substance. Thermal energy is transferred in this way until both substances have the same thermal energy and temperature.

If you go camping, you usually build a fire to sit around at night. You may make S’mores, a delicious campfire treat made by roasting marshmallows squished between layers of graham crackers and chocolate, have hot chocolate, and stay warm. Have you ever wondered why a marshmallow cooks without touching the flame, why the smoke rises, or why water in a pan boils? Heat can move from one object to another in three different ways: conduction, convection and radiation.

The first form of heat transfer presented is conduction—the transfer of heat from a substance to another substance by direct contact. Everything is made up of small particles. When the particles are moving faster, there is more energy and the temperature is higher. As fast-moving particles touch slow-moving particles, the energy is transferred. This causes slower particles to speed up and the faster particles to slow down. You can demonstrate this by rubbing your hands together very fast for 30 seconds. Now touch them to your ears. Can you feel the heat transfer from your hands to your ears? As your ears warm, your hands will cool until the particles in each are moving at the same speed.

Another example of conduction is a pan on the stove. The stove is heated by gas or electricity. The pan is touching the stove. Then, the pan gets hot. Heat travels through conductors—substances that transfer heat better than others. When we do not want heat energy to transfer easily, we use an insulator—substances that do not conduct heat easily. Glass, wood, plastic and rubber are all insulators. Pans have plastic or wood handles to keep the pan from conducting heat to your hand and burning it. Can you think of other examples

of insulators?

Yummy! These cookies look delicious. But watch out! They just finished baking in a hot oven, so the cookie sheet is too hot to handle without an oven mitt. Touching the cookie sheet with bare hands could cause a painful burn. Do you know why? The answer is conduction.

In the opening photo above, conduction occurs between particles of metal in the cookie sheet and anything cooler that comes into contact with it—hopefully, not someone's bare hands!

Examples of Conduction

The cookie sheet above transfers thermal energy to the cookies and helps them bake. There are many other common examples of conduction. The figure below shows a few situations in which thermal energy is transferred in this way.

Q: How is thermal energy transferred in each of the situations pictured above?
A: Thermal energy is transferred by conduction from the hot iron to the shirt, from the hot cup to the hand holding it, from the flame of the camp stove to the bottom of the pot as well as from the bottom of the pot to the food inside, and from the feet to the snow. The shirt, hand, pot, food, and snow become warmer because of the transferred energy through direct contact or touch. Because heat moves from warmer matter to cooler matter, the feet lose thermal energy, and they feel colder.

Conduction Summary

- Conduction is the transfer of thermal energy between particles of matter that are touching.
- Thermal energy always moves from particles of warmer matter to particles of cooler matter.
- When particles of warmer matter collide with particles of cooler matter, they transfer some of their thermal energy to the cooler particles.

Convection

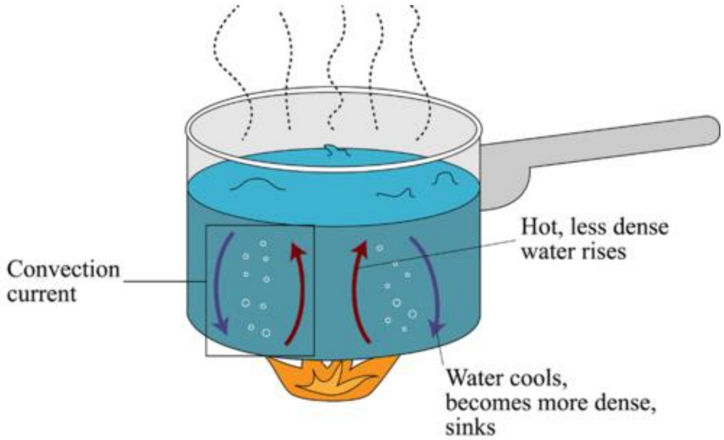
The second form of heat transfer presented is **convection**- the transfer of heat in liquids and gases as particles circulate in currents. In heat transfer by **convection**, the particles in a liquid or gas speed up as they are heated. This causes the particles to move apart and the substance becomes lighter. As

the heated substance rise, the cooler, heavier substance moves down. These currents exchange heat through this movement. You can observe convection in a simple experiment. Get two baby food jars. Fill one with hot water and a drop of red food color. Fill the other with cold water and a drop of blue food coloring. Place a card over the mouth of the cold water jar and turn it upside down on top of the warm water. Carefully pull out the card. You should see warm, red water rising and cold, blue water sinking.

Do you see the water bubbling in this pot? The water is boiling hot. How does all of the water in the pot get hot when it is heated only from the bottom by the gas flame? The answer is convection.

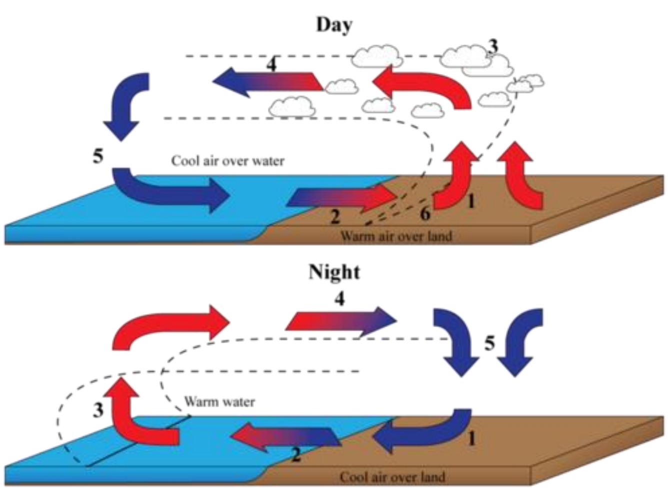
How Does Convection Occur?

The figure below shows how convection occurs, using hot water in a pot as an example. When particles in one area of a fluid (in this case, the water at the bottom of the pot) gain thermal energy, they move more quickly, have more collisions, and spread farther apart. This decreases the density - the amount of mass per unit volume; determines whether an object will sink or float - of the particles, so they rise up through the fluid. As they rise, they transfer their thermal energy to other particles of the fluid and cool off in the process. With less energy, the particles move more slowly, have fewer collisions, and move closer together. This increases their density, so they sink back down through the fluid. When they reach the bottom of the fluid, the cycle repeats. The result is a loop of moving particles called a convection current—circular flow of particles in a fluid that occurs because of differences in temperature and density.



Examples of Convection

Convection currents transfer thermal energy through many fluids, not just hot water in a pot. For example, convection currents transfer thermal energy through molten rock below Earth’s surface, through water in the oceans, and through air in the atmosphere. Convection currents in the atmosphere create winds. You can see one way this happens in the Figure below. The land heats up and cools off faster than the water because it has lower specific heat --the heat required to raise the temperature of the unit mass of a given substance by a given amount (usually one degree). Therefore, the land gets warmer during the day and cooler at night than the water does. During the day, warm air rises above the land and cool



air from the water moves in to take its place. During the night, the opposite happens. Warm air rises above the water and cool air from the land moves out to take its place.

Q: During the day, in which direction is thermal energy of the air transferred? In which direction is it transferred during the night?

A: During the day, thermal energy is transferred from the air over the land to the air over the water. During the night, thermal energy is transferred in the opposite direction.

Convection Summary

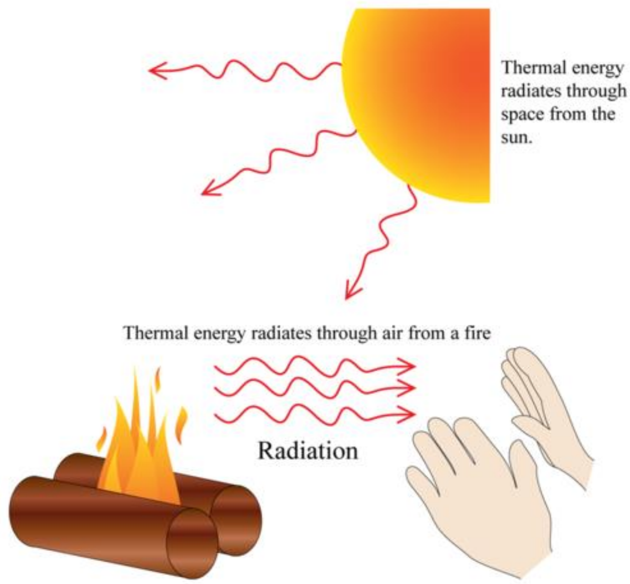
- Convection is the transfer of thermal energy by particles moving through a fluid. Fluids are liquids and gasses. Thermal energy is always transferred from an area with a higher temperature to an area with a lower temperature.
- Moving particles transfer thermal energy through a fluid by forming convection currents.
- Convection currents move thermal energy through many fluids, including molten rock inside Earth, water in the oceans, and air in the atmosphere.

Radiation

Someone is warming their hands over a bonfire. They don't have to touch the fire to feel its warmth. How is warmth from the fire transferred to their hands? In this text, you'll find out.

The third form of heat transfer presented is **radiation**- the transfer of thermal energy by waves that can travel through air or even through empty space. Radiation is the only way of transferring thermal energy that doesn't require matter. When the waves of thermal energy reach objects, they transfer the energy to the objects, causing them to warm up. This is how the fire warms the hands of the friends sitting near the bonfire. This is also how the sun's energy reaches Earth and heats its surface. Without the energy radiated from the sun, Earth would be too cold to support life as we know it.

Sources of Thermal Radiation



You might be surprised to learn that everything radiates thermal energy, not just really hot things such as the sun or a fire. For example, when it's cold outside, a heated home radiates some of its thermal energy into the outdoor environment. A home that is poorly insulated radiates more energy than a home that is well insulated. Special cameras can be used to detect radiated heat. In the figure below, you can see an image created by one of these cameras. The areas that are yellow are the areas where the greatest amount of thermal energy is radiating from the home. Even people radiate thermal energy. In fact, when a room is full of people, it may feel noticeably warmer because of all the thermal energy the people radiate!

Q: Where is thermal radiation radiating from the home in the picture?

A: The greatest amount of thermal energy is radiating from the window on the upper left. A lot of thermal energy is also radiating from the edges of the windows and door.

Thermal Radiation Summary

- Thermal radiation is the transfer of thermal energy by waves that can travel through air or even through empty space. This is how thermal energy from a fire is transferred to your hands and how thermal energy from the sun is transferred to Earth. Everything radiates thermal energy, even objects that aren't very warm.

Science Language Students Need to Know and Use

- **conduction**: transfer of thermal energy between particles of matter that are touching
- **conductors:** substances that transfer heat better than others
- **convection**: transfer of thermal energy by particles moving through a fluid, a liquid, or a gas
- **convection current**: flow of particles in a fluid that occurs because of differences in temperature and density
- **density** - the amount of mass per unit volume; determines whether an object will sink or float
- **heat:** the transfer of thermal energy between substances
- **insulators:** substances that do not conduct heat easily
- **specific heat -** the heat required to raise the temperature of the unit mass of a given substance by a given amount (usually one degree)
- **thermal energy:** the kinetic energy of moving particles of matter, measured by their temperature
- **thermal radiation**: transfer of thermal energy by waves that can travel through air or across space
- **volume:** determines whether an object will sink or float

Online Interactive Activities

- This interactive will allow students to test the strength of three materials as insulators by conducting an interactive experiment and collecting their data in a table. http://tinyurl.com/ut6th6-1

- This interactive will allow students to unscramble vocabulary associated with conduction, convection, radiation in a game format through NASA's "Beat the Heat". http://tinyurl.com/ut6th6-1c

- This will interactive will allow students to watch an animation on the three types of heat transfer with an interactive quiz at the end. http://tinyurl.com/ut6th6-1d

- This interactive will allow students to click and drag puzzles that review examples and content of conduction, convection, and radiation. http://tinyurl.com/ut6th6-1e

Think Like a Scientist

1. Compare and contrast the three ways heat is transferred or moves.
2. Compare materials that conduct heat to materials that insulate the transfer of heat energy.

How is light produced, reflected, refracted, and separated into visible light?

Science Standard VI, Objective 2
Grade 6
Text Structure: Description

If you were asked to make a list of all the things that give us light–energy that travels in waves and is produced by hot, energetic objects– what would you write? Light bulbs, candles or campfires may be on your list. The sun is an important source, also. Light bulbs are hot, energetic objects. If you have ever touched a light bulb while it is on, you know it is hot. You know the light bulb needs energy because you have to turn the light switch on to provide electricity for it. The electricity flows through either a thin metal wire or a gas. The wire or gas glows and gives off light when heated.

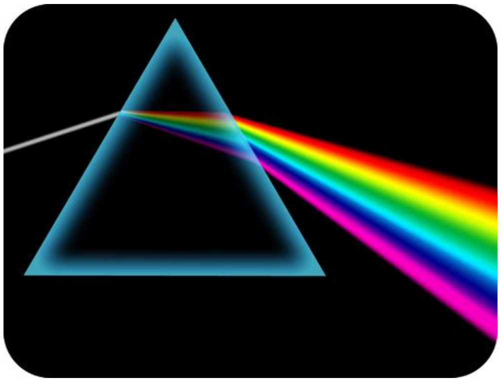
The moon may seem like a source of light, but it does not provide light like the sun. It only reflects the light from the sun to us.

Light is energy that travels in rays. Some of these rays we can see, so we call that visible light. Some of the rays we cannot see but we can feel their effect on us. We cannot see ultraviolet (UV) rays but they burn our skin when we are in the sun without sun block. We also cannot see infrared rays but we can feel how hot they are on our skin.

Light comes from a light source. Anything that produces light is called a source of light.

- The sun is a source of light.
- Stars are sources of light.
- A fire is a source of light.
- A candle is a source of light.

- An electric bulb is a source of light.

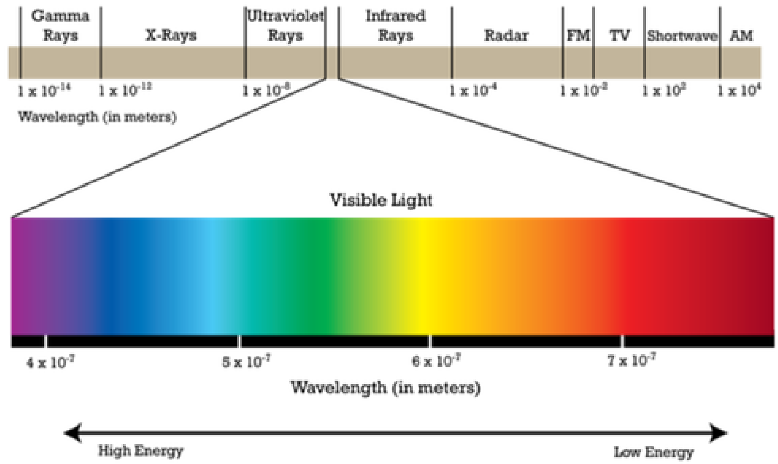


White light is composed of an infinite number of individual colors. Your eye blends the colors and your brain "sees" white light. A prism is able to separate-the light into individual colors.

Fundamentals of Light

We see objects because they either produce light or reflect light and this light enters our eyes. Light is generated by incandescent and fluorescent lamps, light emitting diodes (LED), flames, very hot objects, and even some animals. Our major source of light is the sun. **Electromagnetic radiation**–the different energies emitted by the sun- travel from the sun in waves. The waves move in a rope if you moved the rope up and down.

However, unlike the waves in a rope, electromagnetic waves are not required to travel through a medium, any substance through which a wave is transmitted. For example, light waves are electromagnetic waves capable of traveling from the sun to Earth through outer space, which is considered a vacuum. Only a very small fraction of the entire **spectrum**- energy waves ranging from low-frequency waves to high-frequency waves- is visible light as shown in the image below.

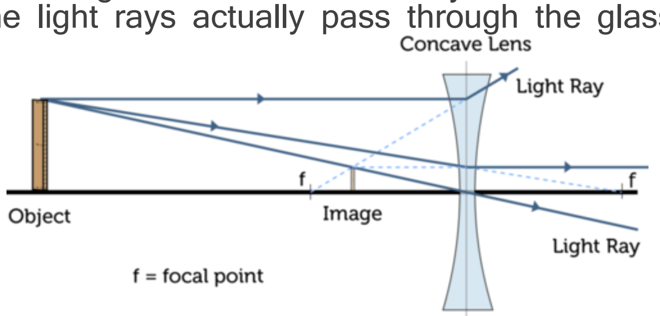


Some objects are said to be **transparent–o**bjects that allow light to pass through undisrupted. Air, glass, some plastics, and some other materials are examples of **transparent** objects. Some objects are **translucent–** objects that allow light to pass through but disrupts images. Lampshades, frosted light bulbs, and fogged glass are examples of **translucent** materials. Many other objects are **opaque–**objects that do not allow any light to pass through.

One way heat, light, and sound energy are alike is that they can be reflected. Think back to the last time you looked in a mirror. You saw a **reflection**–the bouncing back of light waves from a surface. If light wasn't reflected, you wouldn't have seen anything. Light strikes the mirror at an **angle of incidence–**angle at which light strikes a surface. It bounces off at the same angle, the **angle of reflection-** the angle at which light bounces off a surface. We are very familiar with reflection when it comes to mirrors and other items that reflect images. Did you know that everything reflects light? When we look at things, the color that we see is light that is reflected from the object. For example, if we look at a red apple it reflects red and **absorbs**– takes in–all the colors but red. What color is reflected when you look at a banana? What colors are **absorbed** when you look at a banana? All colors are reflected if an object appears white. All colors are absorbed if an object appears black. Most objects reflect more than one color, creating a vast number of color combinations. Energy waves can also be **refracted**–bent. Light is easiest to observe as it is **refracted**. Light always travels in a straight line when going through a single medium. A medium is any substance through which a light wave can travel. In some mediums, such as air, light travels quickly. In other mediums, such as water and glass, light travels more slowly. When light travels from one type of medium to another, the light changes speed and is refracted. This is seen in a rainbow. To get the same effect, shine a light through a **prism**—a clear glass or plastic medium that breaks light into the color spectrum. You will create the same rainbow spectrum as seen in a rainbow made by nature. A **lens**—a transparent object with one or two curved surfaces—can also be used for bending light.

What Is a Lens? A **lens** is typically made of glass (or clear plastic in the case of a contact lens). A lens refracts, or bends, light and forms an image. An image is a copy of an object formed by the refraction (or reflection) of visible light. The more curved the surface of a lens is, the more it refracts the light that passes through it. There are two basic types of lenses: concave and convex. The two types of lenses have different shapes, so they bend light and form images in different ways.

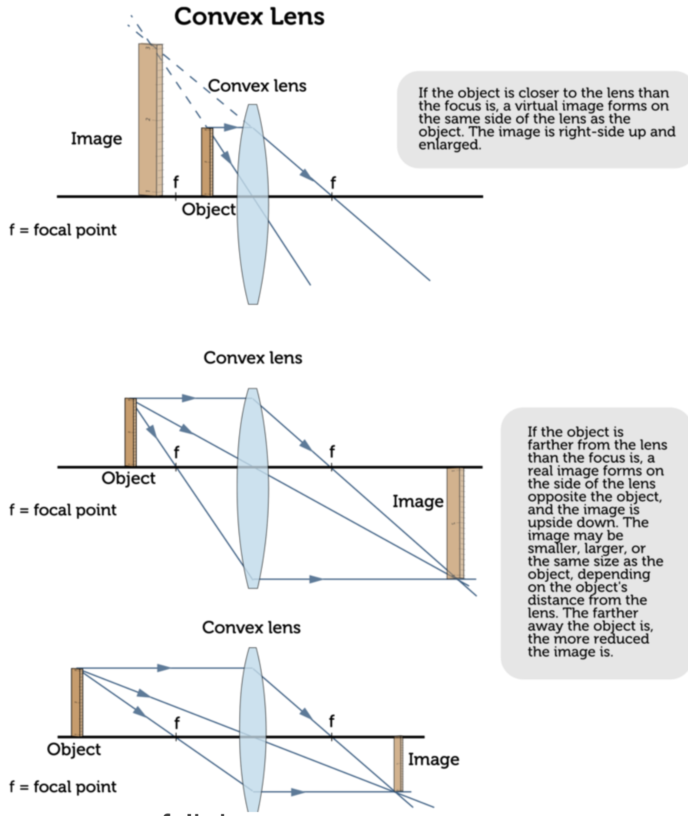
You can see the shape of a **concave lens**—a lens that is thicker at the edges than it is in the middle—in the figure below. From the diagram, it's clear that the lens causes rays of light to diverge, or spread apart, as they pass through it. Note that the image formed by a **concave lens** is on the same side of the lens as the object. It is also smaller than the object and right-side up. However, it isn't a real image. It is a virtual image. Your brain "tricks" you into seeing an image there. The light rays actually pass through the glass to the



other side and spread out in all directions.

Convex Lens

You can see the shape of a **convex lens**–a lens is thicker in the middle than at the edges–in the figure next. A **convex**



lens causes rays of light to converge, or meet, at a point called the focus (F). A convex lens forms either a real or virtual image. It depends on how close the object is to the lens relative to the focus.

Q: An example of a convex lens is a hand lens. Which of the three convex lens diagrams above shows how a hand lens makes an image?

A: You've probably looked through a hand lens before. If you have, then you know that the image it produces is right-side up. Therefore, the first diagram must show how a hand lens makes an image. It's the only one that produces a right-side up image.

- We see objects because they either generate light or reflect light and this light enters our eyes.
- Light is a small fraction of the energy we call electromagnetic radiation.
- Electromagnetic radiation is a form of energy that consists of oscillating electric and magnetic fields traveling at the speed of light.
- The energy of an electromagnetic wave travels in a straight line along the path of the wave.

Science Language Students Need to Know and Use

- **absorption**: the ability to take in or dampen
- **angle of incidence:** angle at which light strikes a surface
- **angle of reflection:** the angle at which light bounces off of a surface
- **concave lens**: a lens that is thicker at the edges than it is in the middle
- **convex lens:** a lens that is thicker in the middle than at the edges
- **electromagnetic radiation:** the different energies emitted from the sun
- **lens:** a transparent object with one or two curved surfaces
- **light:** energy that travels in waves and is produced by hot, energetic objects
- **opaque:** objects do not allow any light to pass through
- **prism:** a clear glass or plastic medium that breaks light into the color spectrum
- **reflection:** the bouncing back of light waves from a surface
- **refracted:** when light goes from one medium to another and is bent
- **spectrum:** electromagnetic waves ranging from low-frequency waves to high-frequency waves
- **translucent:** objects that allow light to pass through but disrupts images
- **transparent:** objects that allow light to pass through undisrupted

Online Interactive Activities

- This interactive will allow students to change the angle of a light source and see the resulting change in the angle of reflection. http://tinyurl.com/ut6th6-2

- This interactive will allow students to drag different angled mirrors into a path of light. http://tinyurl.com/ut6th6-2b

- This interactive will allow students to explore the bending of light through more than one medium. It will also allow them to make rainbows by playing with prisms of different shapes: white light and lasers are used. http://tinyurl.com/ut6th6-2c

Think Like a Scientist

1. Describe how light can be produced, reflected, refracted, and separated into visible light of various colors.

2. Investigate and describe the refraction of light passing through various materials (e.g., prisms, water).
3. Describe the angle of incidence to the angle of reflection. What can you state about the two angles?

Additional Recommended Resources

- http://www.astronomy.org/programs/seasons/index.html

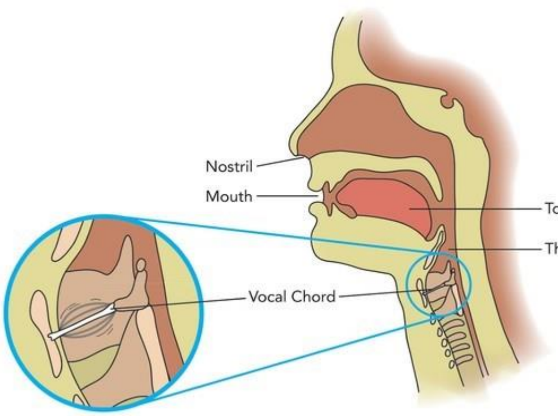
How is sound produced and transferred to other sources?

Standard VI, Objective 3
Grade 6
Text Structure: Description

If a tree falls in the forest and no one is there, does it make any sound - a form of energy that causes particles to vibrate back and forth? How would you answer the question about the tree falling in the forest? When the tree hits the ground it causes the particles in the air to vibrate. The tree creates vibrations—rapid movements back and forth—in the air as it falls. The vibrations spread out in all directions. If the vibrations in the air reach you, your eardrum will vibrate and you will hear the sound of the tree falling. Have you ever placed your hands over your ears because someone was yelling? The loudness or intensity of a sound depends on the energy used. The more energy used, the louder the sound. You use a lot more energy to yell than you do to whisper. The same is true with all sounds: the more energy expended, the louder the sound.

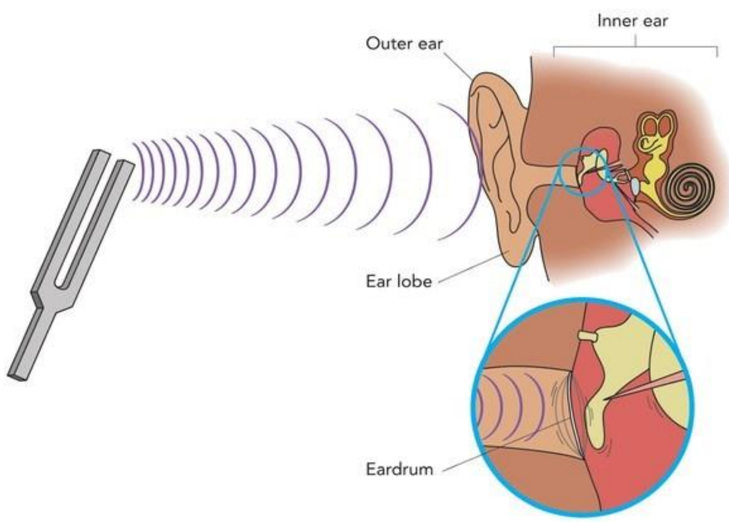
There is a vibration in your throat when you hum which you could feel with your hand. It causes the sound you make when you speak and when you shout and when you sing.

What is vibrating in your throat? You have vocal cords in your throat. As air moves over them they vibrate. As they vibrate, they create sound. Look at the picture below.



Can you see the vocal cords which vibrate to make a sound when we talk or sing?
So we make sounds when our vocal cords vibrate, but how do we hear sounds? In your ear you have eardrums. Eardrums help us to hear the sound. Your eardrums vibrate when a sound goes into your ear. This is how you hear sounds!

The human ear is actually made of many small parts! Your outer ear is what you can see on the sides of your head. Your inner ear is inside your skull and made of small bones.



Look at the picture below. Can you see the eardrum which vibrates? This vibration then bumps the little bone next to it and the brain can read this as a sound.

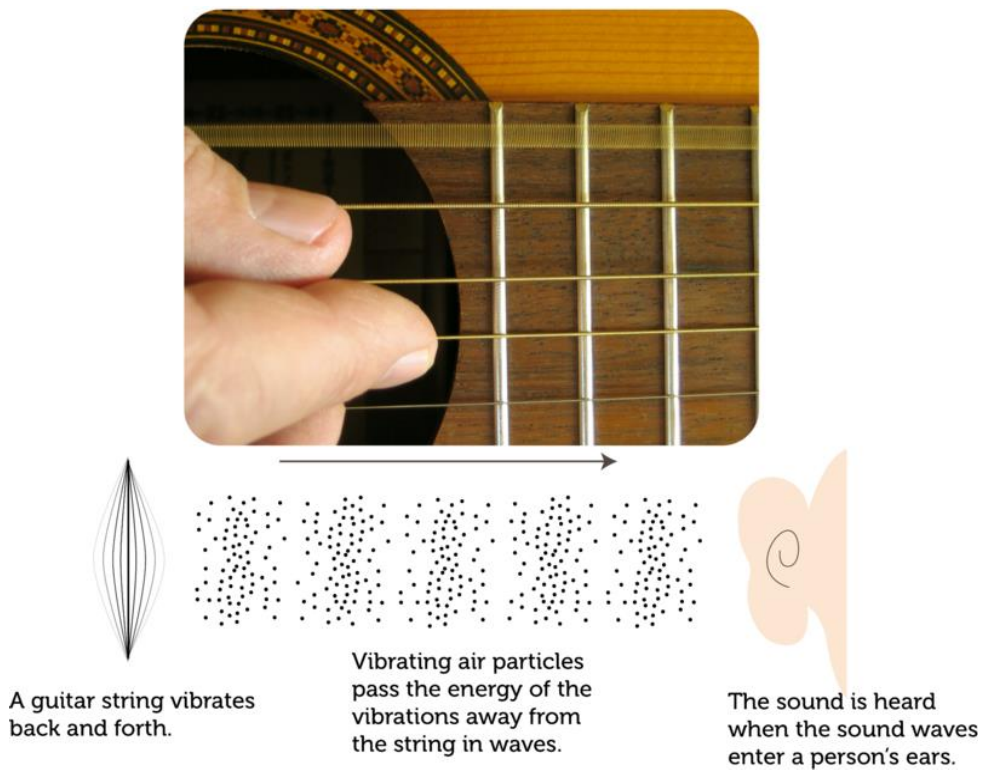
Do you sing or play a musical instrument? If you do, you understand **pitch**—how high or low a sound is. The **pitch** of an instrument changes by adjusting its length or width. A trombone's sound changes from low to high as the slide is moved in. The pitch of musical instruments can also be changed by tightening the strings, which increases the speed of vibration. To keep areas quiet, such as libraries, there are materials placed in the rooms such as carpet and upholstered chairs to absorb noise. The **absorption**—the ability to take in or dampen—soaks up any noise so people can study in quiet surroundings.

Sound waves are reflected from canyon walls if you shout loudly. You may have enjoyed hearing the echo of your voice.

Pitch Summary

- A high sound is made by fast vibrations.
- A low sound is made by slow vibrations.

You can see an animation of sound waves traveling through air at this URL: http://goo.gl/wWm8Xr



Q: If there were no air particles to carry the vibrations away from the guitar string, how would sound reach the ear?
A: It wouldn't unless the vibrations were carried by another medium. Sound waves are mechanical waves, so they can travel only though matter and not through empty space.

The fact that sound cannot travel through empty space was first demonstrated in the 1600s by a scientist named Robert Boyle. Boyle placed a ticking clock in a sealed glass jar. The clock could be heard ticking through the air and glass of the jar. Then Boyle pumped the air out of the jar. The clock was still ticking, but the ticking sound could no longer be heard. That's because the sound couldn't travel away from the clock without air particles to pass the sound energy along. You can see an online demonstration of the same experiment–with a modern twist–at this URL: http://goo.gl/u3eC4D

Most of the sounds we hear reach our ears through the air, but sounds can also travel through liquids and solids. If you swim underwater–or even submerge your ears in bathwater–any sounds you hear have traveled to your ears through the water. Some solids, including glass and metals, are very good at transmitting sounds. Foam rubber and heavy fabrics, on the other hand, tend to muffle sounds. They absorb rather than pass on the sound energy.

Q: How can you tell that sounds travel through solids?
A: One way is that you can hear loud outdoor sounds such as sirens through closed windows and doors. You can also hear sounds through the inside walls of a house. For example, if you put your ear against a wall, you may be able to eavesdrop on a conversation in the next room–not that you would, of course.

Summary

- In science, sound is defined as the transfer of energy from a vibrating object in waves that travel through matter.
- All sound waves begin with vibrating matter. The vibrations generate longitudinal waves that travel through matter in all directions.
- Most sounds we hear travel through air, but sounds can also travel through liquids and solids.

Science Language Students Need to Understand and Use

- **absorption**: the ability to take in or dampen
- **angle of incidence:** angle at which light strikes a surface
- **angle of reflection:** the angle at which light bounces off of a surface
- **concave lens**: a lens that is thicker at the edges than it is in the middle
- **conduction**: transfer of thermal energy between particles of matter that are touching
- **conductors:** substances that transfer heat better than others
- **convection**: transfer of thermal energy by particles moving through a fluid
- **convection current**: flow of particles in a fluid that occurs because of differences in temperature and density
- **convex lens:** a lens that is thicker in the middle than at the edges
- **density -** the amount of mass per unit volume; determines whether an object will sink or float
- **electromagnetic radiation:** a form of energy that consists of oscillating electric and magnetic fields traveling at the speed of light
- **heat:** the transfer of thermal energy between substances
- **insulators:** substances that do not conduct heat easily
- **lens:** a transparent object with one or two curved surfaces
- **Light:** energy that travels in waves and is produced by hot, energetic objects
- **opaque:** objects do not allow any light to pass through
- **pitch:** how high or low a sound is
- **prism:** a clear glass or plastic medium that breaks light into the color spectrum
- **reflection:** the bouncing back of light waves from a surface
- **refracted:** when light goes from one medium to another and is bent
- **sound**: transfer of energy from a vibrating object in longitudinal waves that travel through matter
- **specific heat -** the heat required to raise the temperature of the unit mass of a given substance by a given amount (usually one degree)

- **spectrum:** electromagnetic waves that include very low energy electric waves up to very high energy gamma rays. A very small fraction of the electromagnetic spectrum is visible light
- **thermal energy:** the kinetic energy of moving particles of matter, measured by their temperature
- **thermal radiation**: transfer of thermal energy by waves that can travel through air or across space
- **transparent:** objects that allow light to pass through undisrupted
- **translucent:** objects that allow light to pass through but disrupts images
- **vibrations:** is a rapid movement back and forth

Online Interactive Activities

- This interactive will allow students to adjust volume and amplitude and see the sound waves change. It will also allow them to move the listener avatars and see how that affects the waves. http://tinyurl.com/ut6th6-3

- This interactive will allow students to shorten or lengthen the string on a guitar, then pluck it gently or with more energy to hear the difference it makes in the quality of a sound. http://tinyurl.com/ut6th6-3b

- This interactive will allow students to use three different instruments to change pitch and volume. http://tinyurl.com/ut6th6-3c

- This interactive will allow students to listen to different sounds at different decibels. http://tinyurl.com/ut6th6-3d

- This interactive will allow students to listen adjust amplitude and frequency and discover how it affects sound waves. http://tinyurl.com/ut6th6-3e

- This interactive will allow students to watch a video and take a quiz on sound. http://tinyurl.com/ut6th6-3f

Think Like a Scientist

1. Explain how a sound is produced and how that sound is then heard.
2. How does the size of an object effect the pitch of the sound the object produces? For example, compare a large drum's pitch to a small drum's pitch.
3. What can you do to adjust the pitch of a stringed instrument to be higher and lower?

Additional Recommended Resources

- "Conduction" http://goo.gl/eZD36r
- "Convection" http://goo.gl/TrMdA7
- "Radiation" http://goo.gl/nIF9I3
- "Formation of Images with a Concave Lens" http://goo.gl/aoIRP4
- "Formation of Images with a Concave Lens" http://goo.gl/DAkbuU
- "Sound Waves Traveling Through Air" http://goo.gl/wWm8Xr