Christenberry Planetarium
Educator's Guide

www.samford.edu/departments/planetarium/

INSIDE:

- Connections to Education Standards
- Preparation Questions
- Solar System Breakdown
- Synopsis
- Glossary of Terms
- Classroom Activities

Samford University
Christenberry Planetarium

Table of Contents

Connections to Education Standards

Below you will find the national education content standards that we explore in our presentation:

NATIONAL EDUCATION CONTENT

GRADE	CONTENT STANDARD
All:	Science as a human endeavor
K – 4:	Objects in the sky Changes in the earth and sky
5 – 8:	Motion and forces Earth in the solar system
9 – 12:	Motion and forces Interactions of energy and matter

Credit: Andrew C. Freeman

Preparation Questions

What is a Solar System?

A solar system is a collection of the planets and their moons in orbit around a star (in our case, the sun). It also includes smaller bodies in the forms of asteroids, meteoroids, comets, and dwarf planets.

What is a Galaxy?

A system of billions or even trillions of stars along with planets, interstellar clouds of gas and dust, and dark matter all held together by gravitational attraction. There are three kinds of galaxies: elliptical, spiral, and irregular.

How Many Galaxies are There?

There are countless galaxies in the universe of all different shapes and sizes. Images from the Hubble Space telescope show there could potentially be a hundred billion (if not a trillion) galaxies, each containing hundreds of billions of stars.

Credit: Andrew C. Freeman

What is the Milky Way?

The Milky Way is a barred spiral galaxy that houses our solar system along with 100-400 billion stars and at least the same number of planets. The Milky Way is 150,000 light years (900 quadrillion miles) in diameter. It has four main spiral arms, and our solar system is located within one sub-arm called the Orion Spur.

Spiral Galaxy

Elliptical Galaxy

Irregular Galaxy

Credit: NASA

Solar System

The Sun:

- Yellow, main sequence star
- 99.8% of mass of the solar system
- Volume of 1,300,000 Earths
- Surface temperature of 10,000 °F

Mercury:

- Terrestrial planet with no moons
- Closest planet to the sun
- Smallest planet in the solar system
- Your weight on Mercury would be 38% of your weight on Earth
- Wrinkles on surface are caused by the cooling and contracting of its molten core

Venus:

- Terrestrial planet with no moons
- Earth's sister planet, similar size and mass
- 864 °F average, the hottest planet in the solar system
- Early civilizations mistook it for two different bodies, because it is visible after sunset or before sunrise

Credit: World Wide Telescope

Earth:

- Terrestrial planet with one moon
- Only known planet to support life
- Once believed to be the center of the universe
- 70% of the Earth is covered in water

Mars:

- Terrestrial planet with 2 moons
- Largest dust storms in the solar system
- Home to the largest volcano, Olympus Mons (53 miles tall), and the longest valley, Valles Marineris (2500 miles across), in the solar system
- Mars was likely once abundant in water, but now it has very little, most of which is in the form of ice and located at the South Pole.

Solar System Cont.

Jupiter:

- Gas giant with 79 moons
- Largest planet: two and a half times more massive than all the other planets in the solar system combined
- Primarily made of hydrogen and helium
- Shortest day of all the planets, roughly 10 hours

Saturn:

- Gas giant with 62 moons
- Hexagonal vortex storms at the poles, caused by the merging of small-scale cyclones
- 30+ rings, the most extensive ring system in the solar system
- Rings extend over 175,000 miles out, but are only about 30 feet wide

Uranus:

- Ice giant with 27 moons
- Coldest planet, -357 °F
- Only one spacecraft has flown by Uranus, the Voyager 2 in 1986

Neptune:

- Ice giant with 16 moons
- Fastest winds recorded in the solar system: ~1500 mph
- In the southern hemisphere of Neptune, Voyager 2 observed the Great Dark Spot, a storm that lasted five years

Pluto:

- Dwarf planet with 5 moons
- Over 3 billion miles from the sun
- 2/3rd the size of Earth's Moon
- As it draws closer to the Sun in its orbit, Pluto's nitrogen ice surface heats up enough that it sublimates and forms an atmosphere, which re-freezes into solid nitrogen as it distances itself from the sun again

Credit: NASA

Synopsis

What is located near the center of our galaxy?

A star cluster and a supermassive black hole (Sagittarius A-star) exist at the center of our galaxy. However, it is a common misconception that the supermassive black hole is at the exact center of the Milky Way, whereas is actually slightly off-center. The direct center is the point at which the most mass is concentrated.

Credit: NRAO/AUI/NSF

Does a light year measure time or distance?

Because of its name, a light year is sometimes mistaken for a measurement of time, but it is actually the distance light travels in one year, ~6 trillion miles.

If you travelled to a different planet, which would change—your mass or your weight? Why?

Your weight would change, not your mass. This is because mass is constant, whereas weight depends on the strength of the force of gravity in a given place. This means that it would take the same amount of force to push you from side to side but less force to hold you up or to jump vertically.

How many stars are in our solar system?

There is only one star in our solar system, the sun, but there are between 200 and 400 billion stars in our galaxy.

Credit: ESA/Hubble

Synopsis Cont.

Which planet has a large red spot in its atmosphere?

The Great Red Spot is a region in the Southern Hemisphere of Jupiter's atmosphere. It is classified as an anticyclonic storm, which are storms that blow counterclockwise in the Northern Hemisphere or clockwise in the Southern Hemisphere, as opposed to cyclonic storms, which blow clockwise in the Northern Hemisphere and counterclockwise in the Southern Hemisphere.

Credit: Hubble

How thick are the rings of Saturn?

The main rings are only about 30 feet thick, whereas they are 175,000 miles wide in diameter.

In what identifiable shape is the icy region on Pluto?

A heart! This region is called Tombaugh Regio and the left lobe (Sputnik Planitia) is made up of slushy, shifting nitrogen ice plains about 600 miles wide.

Credit: NASA

Why is Mercury so hot during the day and so cold at night?

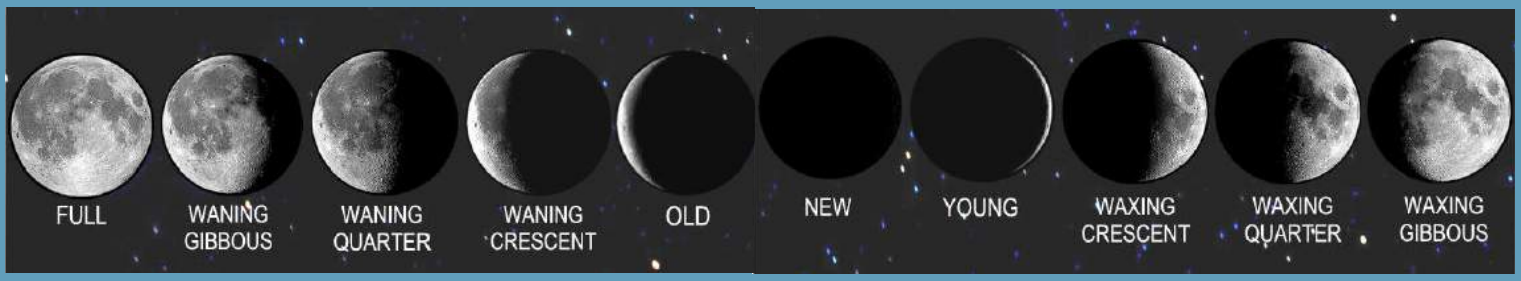
Mercury is 800 °F during the day, because it is so close to the sun. But because it possesses almost no atmosphere, 0.0000000000001% to be more exact, there is nothing to prevent any of the incident heat from reaching the surface or to hold the heat close to the planet. This allows the heat to escape into space, making Mercury as cold as -300 °F at night.

National Science Education Content Standards 3 – 5

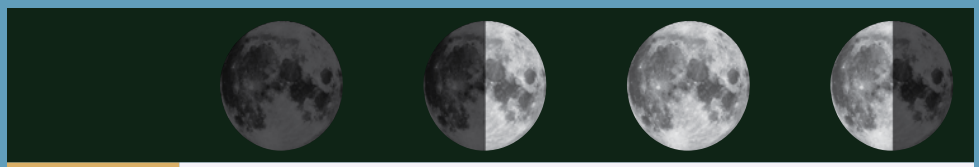
- Science as an Inquiry (Abilities necessary to do scientific inquiry
- Physical Science (Position and motion of objects)
- Earth and Space Science (Objects in the sky)

OBSERVING THE MOON

Pick a day to take your students outside to observe the moon—preferably a day when the skies are clear and the moon is visible (not during the New Moon phase). During the Full Moon phase, the smooth regions and light patterns on the lunar surface are easily visible. During crescent and quarter phases, the moon's topographical features cast distinguishable shadows across its surface.



Have your students draw two circles on a piece of paper and write down the date, time, location, and weather conditions. Have them shade in the circle with a pencil to show the phase of the moon. If you have a pair of binoculars for the students to use, they will be able to see lunar features more clearly and replicate them in their drawings. Repeat the activity at least five days later so they can observe the difference between phases.



Phase	New	First Quarter	Full	Last Quarter
Rise	Sunrise	Noon	Sunset	Midnight
Highest in Sky	Noon	Sunset	Midnight	Sunrise
Set	Sunset	Midnight	Sunrise	Noon

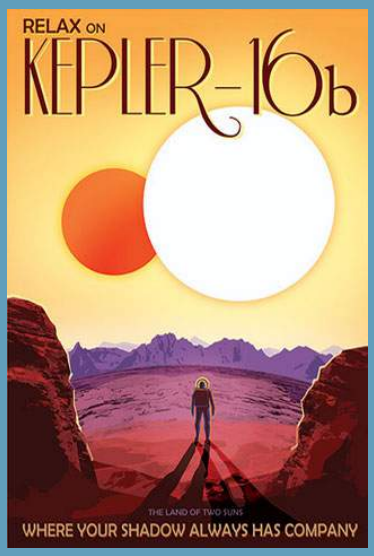
Credit: StarDate

National Science Education Content Standards 6 – 8

- Physical Science (Properties of objects and materials)
- Earth and Space Science (Earth in the solar system)

SPACE TOURISM

Have your students break into teams or work on their own to research a planet, planetary feature, or moon in our solar system. They may use the Solar System Breakdown in this guide, encyclopedias, or online resources such as StarDate or Kids Astronomy. The students can use the information they gather to design travel posters like the ones below (provided by NASA), create brochures, or write up television or radio commercials advertising trips to their planet or feature.



Credit: NASA

Students should incorporate facts about the place they have researched as well as use their creativity to think of original ways to integrate our conventional recreational activities on Earth with the unfamiliar characteristics and opportunities of their chosen destination.

National Science Education Content Standards 9 – 12

- History and Nature of Science (Science as a human endeavor)
- History and Nature of Science (Historical perspectives)

MILKY WAY MYTHS

BACKGROUND

People have always observed and discussed the Milky Way, but it wasn't until Galileo became the first person to study the sky with a telescope that we discovered that the Milky Way is composed of numberless stars. Much later, in the 20th century, astronomers determined that we live on the edge of a spiral arm of the Milky Way, which is why we can't see the shape of the rest of the galaxy very well. We are looking at it edge-on, so it appears to us as a clouded ribbon of light. Ancient cultures did not have the technology to explain this scientifically, so they developed stories that explained the existence of this curious stripe in the sky and reflected their societal values.




Credit (left to right): Jason Buck, Andy Long, Toby Harriman, Mark Dumbleton

Classroom Activities Grades 9 – 12 Cont.

Have your students read or listen to the following examples of various cultural perspectives of the Milky Way:

- AFRICAN BUSHMEN: The Milky Way is made of campfire ashes.
- NAVAJO: When the world was created, people gathered around the fire god to place stars in the sky. Another god, Coyote, grew annoyed with their slowness and threw a bag of stars up in his impatience. These stars formed the Milky Way.
- EGYPTIAN: The goddess Isis spread large quantities of wheat across the sky, which appear to us as the Milky Way.
- CHINESE: The seventh princess of Heaven fell in love with a poor shepherd and ran away with him. Her mother found them and dropped a silver pin on the ground to make a silver stream to separate her daughter from the shepherd forever. This silver stream is the Milky Way.
- POLYNESIAN: The Milky Way is a long, blue shark that eats clouds.
- GREEK: The Milky Way is along the path where the Sun once moved across the sky. The Sun scorched it, which is why the Milky Way looks different from the rest of the sky.

After your students have read or listen to the selections above, show them a picture of the Milky Way. Have them work in groups or independently to construct a myth that someone living a thousand years ago may have used to explain the existence of the Milky Way. To integrate social studies into this lesson, have your students choose a particular culture, research its customs and values, and construct a myth from that culture's perspective. Have each student or group present their myth to the class.

Credit: NASA, ESA, Z. Levay

Credit: Hubble Telescope

Glossary:

Asteroid: a small rocky body orbiting the sun, typically in the asteroid belt

Astronomical Unit: the average distance from the earth to the sun, about 93 million miles

Astronomy: the scientific study of celestial objects, space, and the physical universe

Black Hole: a place in space where the force of gravity is so strong that no matter, radiation, or light can escape it

Comet: a small, icy body from the outer reaches of the solar system that releases gas when it passes by the sun, often producing a tail

Galactic bulge: center of the Milky Way, home to 10 billion of the oldest stars and a supermassive black hole

Gas Giant: a large planet consisting mostly of hydrogen and helium gases and with a deep hydrogen mantle, i.e. Jupiter and Saturn

Gravity: the force of attraction between any two masses

Ice Giant: a large planet composed mostly of hydrogen and helium, but without a deep hydrogen mantle, i.e. Uranus and Neptune

Kuiper Belt: a region of the solar system beyond orbit of Neptune, home to cold, icy, rocky worlds such as comets

Light Year: the distance light travels in one year, about 6 trillion miles

Mass: a measure of the quantity of matter in an object. It is constant in all circumstances, whereas weight varies depending on gravity

Matter: any physical material that occupies space

Oort Cloud: a shell of icy objects that surrounds the sun at a distance far beyond the Kuiper Belt

Radiation: the emission of energy as electromagnetic waves or particles

Star: a massive ball of plasma (hot gas) that radiates energy, i.e. the sun

Sunspot: a temporary dark spot of cooler plasma on the surface of the sun

Online Resources

ASTRONOMY ACTIVITIES

https://www.amnh.org/explore/ology/astronomy

This site offers a variety of activities for students age 7+, including crafts, informational articles, and space trivia quizzes.

DOCUMENTARIES

amnh.org/explore/science-bulletins/(category)/24937

This resource displays links to an assortment of short documentaries regarding astronomy, Earth science, biology, and social perspectives.

INFORMATIVE SITES

https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Space_Math_I.html

This link provides a collection of twenty different activities that apply mathematics in space science.

http://nasawavelength.org/

This link offers a collection of resources for science educators, peer-reviewed by educators and scientists.

https://www.amnh.org/explore/science-topics/cosmology

This webpage provides articles, blog posts, and audio recordings of lectures that delve into the study of the universe and its origins.

Image credit: Andrew C. Freeman

Online Resources Cont.

INTERACTIVE STUDIES

http://www.exploringbytheseat.com/
This site is the homepage of an organization called Exploring By The Seat of Your Pants. They help teachers arrange virtual meetings with speakers and field trips with experts around the world.

https://www.skypeascientist.com/
This program gives students the opportunity to interact via Skype with a real scientist.

https://solarsystem.nasa.gov/planets/earth/overview/
This link will take you to an interactive page where your students can explore, learn facts, study pictures, and gain a deeper understanding of each of the planets in our solar system.

https://worldwidetelescope.org
This program is basically a virtual telescope, allowing users to interact with and explore the universe via a browser on a computer or mobile device.

LESSON PLANS

https://www.nasa.gov/audience/foreducators/index.html
Here NASA provides detailed lesson plans updated weekly to enhance your STEM curriculum.

Image credit: Andrew C. Freeman