**The Universe**

60 Minute Space Science Lesson Planetarium and Observatory

Program

Grades: 8-12

**TEACHER GUIDE**

**Description**

Beginning with the Big Bang, travel through time and observe the formation and evolution of stars, planets and galaxies. We will discuss the foundations of modern cosmology and provide a comprehensive overview of objects in our Universe.

**Ohio’s Learning Standards**

**Grade 8:** Earth and Space Science – Forces and Motion

* Forces between objects act when the objects are in direct contact or when they are not touching
* There are different types of potential energy
* Forces have magnitude and direction

**Grade 9 and 10:** Earth and Space Science – The Universe

* History of the Universe
* Galaxy formation
* Stars
* Formation; stages of evolution
* Fusion in stars
* Radiant energy and the electromagnetic spectrum

**Grade 9 and 10:** Earth and Space Science – Energy and Waves

* Waves
* Doppler shift
* Radiant energy and the electromagnetic spectrum

**Objectives**

* Identify planets visible to the unaided eye in the evening/morning sky.
* Name at least three constellations visible in the evening/morning sky.
* Understand the meaning of "Cosmology".
* Learn the current scientific understanding about the origin and evolution of the universe—the Big Bang.
* Discover the wide variety of phenomena of the universe - galaxies, stars, planets, visible matter and energy, dark matter and dark energy.

**The Universe**

# If this will be your first trip to the Museum for your students you may want to review the following:

**Before Your Museum Visit**

# What is a Museum?

# What is our purpose for visiting The Cleveland Museum of Natural History?

# How should we handle objects at the Museum?

# Introduce the vocabulary and additional resources provided below

**Vocabulary**

**Planetarium** - a machine that projects images of stars, the Sun, Moon and planets onto a domed ceiling. The machine rotates to illustrate celestial movements.

**Observatory** - a building equipped with a telescope for viewing the real sky.

**Cosmology** - The branch of astronomy that deals with the origin, evolution and ultimate fate of the universe.

**Universe** - The totality of everything that exists. The distance that light has had time to travel since the Big Bang determines the limits of what can be observed in the universe.

**Big Bang** - The current scientific model for the origin of the universe about 13 billion years ago. From an infinitely dense and compact state, the universe has been expanding ever since.

**Doppler Effect** - A change in the frequency or wavelength of a wave due to the relative motion of the object emitting the wave to an observer. Sound and light waves behave similarly in that the wavelength is shortened when the emitting object is approaching, and lengthened when receding.

**Inflation Theory** - A Big Bang model that claims the very early universe expanded at an exponential rate greater than the speed of light. Inflation theory explains the vastness and apparent uniformity of the overall universe.

**Mass-energy** - The sum total of matter and energy in the universe. The contents of the universe (or "cosmic mass-energy budget") as currently estimated are: ordinary matter--4%; dark matter-- 23%; dark energy -- 73%

**Light Year** - The distance that light travels in a vacuum in a year, about 9.4 trillion kilometers or 6 trillion miles.

**Matter** - Anything that has mass. The matter that we are commonly familiar with—stars, planets, school buses, etc.—is primarily made of protons and neutrons. Ordinary matter can be converted into energy, and is considered its equivalent. Only a small fraction of matter in the universe is currently observable. Exotic "dark matter" is possibly made up of an undiscovered elementary particle that formed shortly after the Big Bang.

**Energy** - In physics terminology, "the capacity to do work". There are many kinds of energy: mechanical, thermal, electrical, chemical, nuclear. Recently discovered "dark energy" is a mysterious property of space that is causing the universe's expansion to speed up. Remarkably, dark energy makes up over two-thirds of the cosmic mass-energy budget.

**Galaxy** - A collection of stars, planets and nebulae held together by gravity. Galaxies range in size from dwarf galaxies of only a few hundred thousand stars to enormous elliptical galaxies containing trillions of stars. Dark matter appears to be associated with galaxies.

**Nebula** - A cloud of gas and dust from which stars and planets form. Our solar formed from a nebula 4 1/2 billion years ago.

**Stars, black holes, planets, moons, asteroids, comets** - The primary constituents, along with nebulae, of "ordinary", visible matter in the universe. Each will be discussed and shown in this class.

**Extension Activities**

1. Have students create a list of the objects that they see in the sky. Expand the list to include objects in the universe that are known to exist, but cannot be seen with the unaided eye.
2. Have students estimate the number of stars they can see on a clear night. Brightly lit urban skies typically show several dozen, suburban skies a few hundred and country skies several thousand. Six thousand stars can be seen by keen-eyed observers from the darkest countryside. Ask students "How much medium-grained sand would be required to represent every one of the 6,000 visible stars with a grain of sand?" (Ans: 1/16th of a teaspoon!) Devise ways to count out 6,000 grains of sand (or salt).
3. There are perhaps 300 billion stars in the Milky Way galaxy. Ask students to estimate the volume of a container that could contain 300 billion grains of sand or salt. (Ans: A measuring cup the size of an elephant!) Note – over 100 billion galaxies populate the universe. There are more stars in the universe than grains of sand in the beaches and oceans of the world!
4. The air we breathe is considerably denser than the gas in a typical nebula. Blow out a candle flame and observe the smoke - the microscopic particles of smoke that you see are about the same size as the dust grains in a nebula. Consider the number of dust particles required to make a planet the size of Earth!
5. The universe has more (perhaps many more) than the 3 dimensions we are used to in everyday life. Every observer from any galaxy in the universe sees the remotest galaxies expanding away as if the observer were the center of the universe. How is this so? There is no "center of the universe". A model showing how a two-dimensional creature might presume itself the center of the universe (with all other objects moving away from him as the center) can be constructed by placing dots on a balloon with a magic marker. Choose a dot to represent our 2-dimensional creature located in a galaxy, with the other dots representing outside galaxies. When the balloon is inflated, all of the dots move away from the chosen one, but then again any dot location would witness the same effect. This is analogous to an observer in our universe (of at least 4 dimensions) thinking that he or she is the actual center of expansion, when in fact all observers anywhere in the universe see the same effect.
6. In an expanding universe, distant galaxies recede more rapidly from an observer than close ones. This can be demonstrated by cutting a large rubber band and laying it flat. With a magic marker, mark a dot to represent the Milky Way on the center of the band. Mark off 5 more dots on either side at 1 cm intervals to represent neighboring galaxies. Stretch the rubber band and measure subsequent distances to the various dots. The more distant dots (galaxies) will have moved a significantly greater distance than the nearby ones.

**Online Resources for Teachers and Students**

Click the link below to find additional online resources. These websites are recommended by our Museum Educators and provide additional content information.

CMNH Educators regularly review these links for quality. Web addresses often change so please notify us if any links have issues. Please note that aside from our own Museum website, the Museum is not affiliated with and does not endorse these online resources.

Cleveland Museum of Natural History https://[www.cmnh.org](http://www.cmnh.org/)/edlinks

The Educator Resource Center offers educator workshops, thematic teaching kits, animal dioramas, and more for loan to area teachers.

Contact the ERC at 216-231-2075 for information on individual or school membership.

Visit the Museum’s ERC website for more information on workshops https://[www.cmnh.org/ERC](http://www.cmnh.org/ERC)

**Hours**

* Monday through Friday, 1 to 5 PM
* Wednesday, 1 to 6 PM
* Saturday, 9 AM to 2 PM

**Materials for Loan**

If you’re interested in additional resources be sure to check out the following ERC materials or browse ERC materials online at

<http://cmnh.hosting.l4u.com>

Related ERC kits for this topic include:

**Portable Planetarium:** Launch into space from your own classroom! The STARLAB Portable Planetarium allows you and your students to step into the universe and explore interactive, cross-curricular lessons about astronomy, history and more. This inflatable planetarium can hold 30 students and requires teacher training and reservations through the ERC.

**Educator Resource Center (ERC)**