

# Investigate Planets, Stars, Galaxies, and the Universe

## OVERVIEW

Students will investigate planets, stars, galaxies, and the observable universe. They will learn that the observable universe contains billions of galaxies, that galaxies contain billions of stars, and that most stars have planets orbiting around them.

## BACKGROUND FOR EDUCATOR

Astronomy involves gigantic objects, enormous distances, incredible speeds, and vast spaces. The observable universe contains billions of galaxies. These galaxies range in size from thousands of times smaller to a hundred times larger than our own Milky Way Galaxy, which itself contains more than 100 billion stars. Like our Sun, many other stars have planetary systems in orbit around them.

## BEFORE YOUR VISIT

In this activity, students will begin to grasp the scale of the universe and their place in it by learning their “long address.”

### Activity: Our Cosmic Address in the Known Universe

Write “Our Cosmic Address” on the board. List the address of the school, then the city, state, country, and continent. Continue with Earth, the Solar System, the Milky Way Galaxy, the Virgo Supercluster, and the observable universe (the school’s “long address”). This will give students a sense of their place in space.

Next, have them watch a video called “The Known Universe” ([youtube.com/watch?v=17jymDn0W6U](https://www.youtube.com/watch?v=17jymDn0W6U)). Developed by the Museum, it zooms out from the surface of Earth to the edge of the observable universe. Along the way, students will see our solar system; our galaxy, the Milky Way, which contains hundreds of billions of stars; and the rest of the observable universe, which contains hundreds of billions of galaxies. Invite students to “TPS” — Think, Pair, and Share — the following questions:

- What kinds of objects are found in space? (*Answers may include: planets, moons, asteroids, comets, stars, galaxies*)
- What astronomical objects have you seen? Describe your experience. (*Answers may include: Sun, Moon, planets, stars, meteors or shooting stars, comets*)
- When scientists study the universe, what challenges must they confront? (*Answers may include: time and space scales are vast; observation involves expensive and sophisticated equipment; processes must be observed remotely*)

## DURING YOUR VISIT

### Cullman Hall of the Universe 1st floor (45 minutes)

Have the pairs of experts use their student worksheets to investigate the corresponding section of the hall (Planets, Stars, Galaxies, or the Universe) in depth. Explain that they will be visiting other sections of the hall as well.

## NYS Science Core Curriculum

**S4 PI 1.1A:** Earth’s Sun is an average-sized star.

**S4 PI 1.1B:** Other stars are like the Sun but are so far away that they look like points of light. Distances between stars are vast compared to distances within our solar system.

### Plan how your students will explore the Cullman Hall of the Universe using the four different student worksheets.

Jigsaw is a collaborative learning strategy that includes “home groups” and “expert pairs.” Before coming to the Museum, set up the jigsaw by forming home groups of four students. Within each home group, have each student choose one area — Planets, Stars, Galaxies, or the Universe — in which to become an expert. Distribute the worksheets to the corresponding experts across all groups.

You may want to review the worksheets and the map of the exhibition with students before your visit. At the Museum, have students work in pairs (with another expert in the same area).

## Scales of the Universe

### 2nd floor (20 minutes)

Walk the Scales of the Universe hallway. Use the Guided Explorations in the Teaching in the Exhibition section of this guide to help students compare objects of vastly different size, from the entire universe down to particles smaller than an atom, using the central Hayden Sphere as a basis for comparison.

## BACK IN THE CLASSROOM

### Activity: Planets, Stars, Galaxies, and the Universe

To complete the jigsaw, have students return to their home groups to share their expert knowledge. Afterwards, you may wish to gather the class together and guide a class discussion, using questions such as:

- What is a star? What are the characteristics of a star?  
*(Answers may include: Stars, including our Sun, are large spherical bodies made out of gas. Stars can be classified by color, size, mass, age, chemical composition, etc. Stars generate energy from nuclear fusion and release light into outer space.)*
- How many stars does our galaxy contain?  
*(Answers may include: There are hundreds of billions stars in the Milky Way Galaxy; the Sun is one of them.)*
- How many galaxies does the observable universe contain?  
*(Answers may include: hundreds of billions of galaxies)*
- What units do scientists use to measure far-away objects in the universe?  
*(Answers may include: The light year is one unit used to measure the distance between astronomical objects. Within the solar system, astronomers can use astronomical units. See glossary for full definitions.)*
- Why is studying an object that's millions of light years away from us the same as studying it millions of years ago?  
*(Answers may include: Because the speed of light is finite, we always observe objects as they were when the light left them. Light from the Sun takes approximately eight minutes to reach Earth, while the most distant objects we can see are billions of light years away. Astronomers observe those objects as they were in the distant past, when the universe was very young.)*

## ONLINE RESOURCES

### Astro Viz: The Known Universe

[sciencebulletins.amnh.org/?sid=a.v.known\\_universe.20100426](http://sciencebulletins.amnh.org/?sid=a.v.known_universe.20100426)

This interactive takes viewers from the Himalayas through our atmosphere and the inky black of space to the afterglow of the Big Bang. It is a short flight through the world's most complete four-dimensional map of the Universe, the Digital Universe Atlas, which is maintained and updated by astrophysicists at the Museum.

### Build a Big Dipper Mobile

[amnh.org/ology/build\\_bigdipper](http://amnh.org/ology/build_bigdipper)

On Earth, the Big Dipper looks like a giant connect-the-dots puzzle page. Out in space, though, you'd have a hard time recognizing the constellation. Students will build a model of the Big Dipper, and consider how distance and perspective alter the way stars look when seen from Earth.

### The Milky Way Galaxy

[amnh.org/ology/milkyway](http://amnh.org/ology/milkyway)

If you visualize our galaxy as a giant pizza, all the stars you can see from Earth fill an area no larger than a slice of pepperoni. Find out more fun facts about the Milky Way Galaxy.

### Earth's Location in the Universe

[upload.wikimedia.org/wikipedia/commons/b/b6/Earth%27s\\_Location\\_in\\_the\\_Universe\\_%28JPEG%29.jpg](http://upload.wikimedia.org/wikipedia/commons/b/b6/Earth%27s_Location_in_the_Universe_%28JPEG%29.jpg)

High-resolution images that illustrate our cosmic address.

# Student Worksheet: Investigate PLANETS

Find the “PLANETS” wall (in large green letters). Your investigation will start on the first panel on the left.

## Explore the Panel: “Planets”

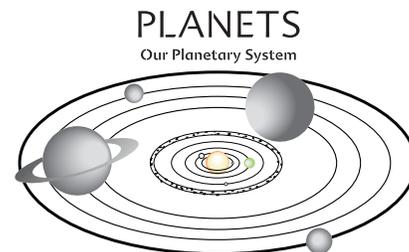
1. Look at the diagram on the left. Mark Earth’s location on it.

2. Describe where Earth is located in our solar system. \_\_\_\_\_

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3. Look through the small oval window called “Our planetary neighborhood.” This is what our solar system looks like from far away. Why do you think the planets look so small in this window?

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Sketch and label what you see.

## Explore the Panel: “What Is a Planet?”

4. Discuss with a partner: Why is it so difficult to define what makes a planet a planet? Record some notes from your discussion. \_\_\_\_\_

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## Explore the Panel: “The Solar System”

5. The planets of our solar system are often placed in two groups: terrestrial and gas giants. Compare the pictures of the planets from the two groups. What do all planets have in common? \_\_\_\_\_

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## Explore the Panel: “Other Planetary Systems”

6. Astronomers now know that most stars have planets orbiting them. Hundreds of planets have been discovered around distant stars. With a partner, discuss what you’d like to know about these newly discovered planets. Record some notes from your discussion. \_\_\_\_\_

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## Further Exploration

7. Explore the rest of the Planets section. Use the back of this page to record new information or sketch interesting things that you see. (If you have time, also visit the Stars, Galaxies, and Universe sections and record your observations.)

# Student Worksheet: Investigate STARS

**Find the “STARS” wall (in large yellow letters).** Near the wall, look for a circular table titled “Our Star – The Sun”. Your investigation will start here.

## Explore: “Our Star - The Sun”

1. Walk around this ring-shaped station, and watch the video in the middle. What does the Sun look like in the video?

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2. Discuss with a partner what the Sun looks like to the human eye? Does it ever change? Why are the images in this exhibit so different? Record some notes from your discussion.

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## Explore “Stars” Wall

3. Go back to the wall with the word “STARS.” Start on the left side and look at the diagram. Mark the location of the Sun on it.



4. Look into the oval window called “Our Stellar Neighborhood.”

Sketch and label what you see.

5. Explore the rest of this wall. What is a star.

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6. Describe how stars change over time.

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7. Our Sun is an intermediate-mass star. Describe what will happen to the Sun as it ages.

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## Further Exploration

8. Use the back of this page to record and sketch other interesting facts about stars. (If you have time, also visit the Planets, Galaxies, and Universe sections and record your observations.)

# Student Worksheet: Investigate GALAXIES

Find the “GALAXY” wall (in large blue letters). Your investigation will start on the first panel on the left.

## Explore the Panel: “Galaxy”

1. Look at the diagram on the left. Mark the location of the Milky Way Galaxy on it.

2. Look through the oval window called “Our Galactic Neighborhood.”



Sketch and label what you see.

What’s the name of the universal force that holds the galaxy together?

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## Explore the Panel: “What is a Galaxy?”

3. What is the name of our galaxy?

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4. Record some data about our galaxy. \_\_\_\_\_

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Sketch and label what you see.

\_\_\_\_\_ light years across

## Explore the Remaining Panels

5. On the back of this page, sketch the different types of galaxies.

6. What do the different types of galaxies have in common? How do they differ?

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## Explore “Interacting Galaxies”

7. Turn around, and walk towards the “Interacting galaxies” station (near the green signs “Neptune” and “Uranus”). Watch the video of two galaxies colliding. With a partner, take turns narrating what happens in the video. Record some notes from your narration on the back of this page.

## Further Exploration

8. Use the back of this page to record and sketch other interesting facts about galaxies. (If you have time, also visit the Planets, Stars, and Universe sections and record your observations.)

# Student Worksheet: Investigate THE UNIVERSE

Find the “UNIVERSE” wall (in large white letters). Your investigation will start on the first panel on the left.

## Explore the Panel: “Universe”

1. Look at the diagram on the left. Mark the location of the Virgo Supercluster on it.
2. Why do astronomers use light years instead of kilometers or miles to measure very large distances?

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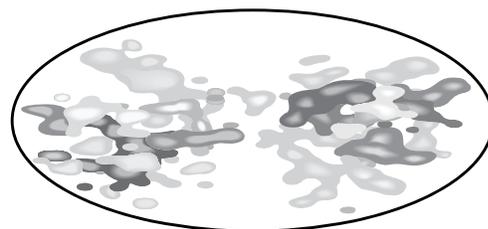


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UNIVERSE



3. About how many galaxies are in the observable universe? \_\_\_\_\_

## Explore the Panel: “What Is the Universe?”

4. The universe is all the matter, energy, and space that exist. Describe these three components. \_\_\_\_\_

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5. Stars, planets, and many other objects are made out of matter. Even the chemicals in the human body are composed of a few chemical elements. These elements are the same ones found in stars and planets because all the elements other than hydrogen in our bodies were created within stars, before Earth formed. Record the percentage of elements in the universe in the data table on the right.

Element	Percentage
Hydrogen	
Helium	
Other	

## Explore the Panel: “Our View of the Universe”

6. What is the observable universe?

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## Explore the “Formation and Evolution of the Universe”

Walk back to the beginning and find the panel to the left the Universe wall.

7. How is the universe changing over time? \_\_\_\_\_

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What will the universe be like billions of years in the future? \_\_\_\_\_

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## Further Exploration

8. Explore the rest of the Universe section. Use the back of this page to record new information or sketch interesting things that you see. (If you have time, also visit the Planets, Stars, and Galaxies sections and record your observations.)

# Student Worksheet: Investigate PLANETS

## ANSWER KEY

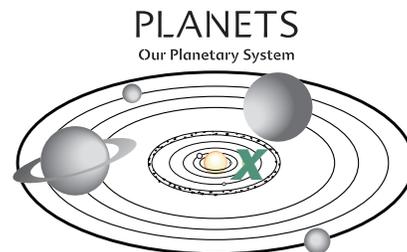
Find the “PLANETS” wall (in large green letters). Your investigation will start on the first panel on the left.

### Explore the Panel: “Planets”

1. Look at the diagram on the left. Mark Earth’s location on it.

2. Describe where Earth is located in our solar system. (Answers may include:

The Sun is the center of the solar system. Earth orbits the Sun between Mars  
and Venus. On the diagram, Earth will be the third circle out from the center.)



3. Look through the small oval window called “Our planetary neighborhood.” This is what our solar system looks like from far away. Why do you think the planets look so small in this window?

(Answers may include: The planets look small because they are much  
smaller than the solar system. When seen from a great distance,  
planets look like points of light.)

Sketch and label what you see.

### Explore the Panel: “What Is a Planet?”

4. Discuss with a partner: Why is it so difficult to define what makes a planet a planet? Record some notes from your discussion. (Answers may include: The boundaries between planets, dwarf planets, and asteroids at the

low-mass end, and planets and brown dwarfs at the high-mass end are not clear cut.)

### Explore the Panel: “The Solar System”

5. The planets of our solar system are often placed in two groups: terrestrial and gas giants. Compare the pictures of the planets from the two groups. What do all planets have in common? \_\_\_\_\_

(Answers may include: All planets are spherical; all orbit the Sun; all are thousands of kilometers in diameter.)

### Explore the Panel: “Other Planetary Systems”

6. Astronomers now know that most stars have planets orbiting them. Hundreds of planets have been discovered around distant stars. With a partner, discuss what you’d like to know about these newly discovered planets. Record some notes from your discussion. (Answers may include: How large are they? Are they mostly solid or gas? Could these

planets support life? How long would it take a spacecraft to reach them? How much would

I weigh there? What would a “sunset” look like?)

### Further Exploration

7. Explore the rest of the Planets section. Use the back of this page to record new information or sketch interesting things that you see. (If you have time, also visit the Stars, Galaxies, and Universe sections and record your observations.)

# Student Worksheet: Investigate STARS

## ANSWER KEY

**Find the “STARS” wall (in large yellow letters).** Near the wall, look for a circular table titled “Our Star – The Sun”. Your investigation will start here.

### Explore: “Our Star - The Sun”

1. Walk around this ring-shaped station, and watch the video in the middle. What does the Sun look like in the video?

*(Answers may include: The Sun is rotating, and looks huge. The surface is constantly changing. Some parts are darker than others. It looks different in different colors [wavelengths of light].)*

2. Discuss with a partner what the Sun looks like to the human eye. Does it ever change? Why are the images in this exhibit so different? Record some notes from your discussion.

*(Answers may include: The Sun is too bright to look at for long. In the sky it appears small and perfectly round. With powerful telescopes and cameras, the Sun will look larger and more details will be visible. When observed in X-ray or ultraviolet, the Sun looks very different from its appearance in visible light.)*

### Explore “Stars” Wall

3. Go back to the wall with the word “STARS.” Start on the left side and look at the diagram. Mark the location of the Sun on it.



4. Look into the oval window called “Our Stellar Neighborhood.”

Sketch and label what you see.

5. Explore the rest of this wall. What is a star.

*(Answers may include: Stars are large balls of gas. They're more massive than planets. Stars, including the Sun, emit light. Nuclear fusion provides the energy for them to burn.)*

6. Describe how stars change over time.

*(Answers may include: Stars change constantly. Over millions or billions of years, stars go through dramatic changes.)*

7. Our Sun is an intermediate-mass star. Describe what will happen to the Sun as it ages.

*(Answers may include: When it reaches the end of its life, the Sun will quickly swell, turning into a red giant. It will lose its outer layers and eventually, only its hot core, a white dwarf star, will remain.)*

### Further Exploration

8. Use the back of this page to record and sketch other interesting facts about stars. (If you have time, also visit the Planets, Galaxies, and Universe sections and record your observations.)

# Student Worksheet: Investigate GALAXIES

## ANSWER KEY

Find the “GALAXY” wall (in large blue letters). Your investigation will start on the first panel on the left.

### Explore the Panel: “Galaxy”

1. Look at the diagram on the left. Mark the location of the Milky Way Galaxy on it.
2. Look through the oval window called “Our Galactic Neighborhood.”



Sketch and label what you see.

What’s the name of the universal force that holds the galaxy together?

*(Answers may include: Gravity holds the parts of a galaxy together.)*

*Most stars, including the Sun, orbit the center of a galaxy.)*

### Explore the Panel: “What is a Galaxy?”

3. What is the name of our galaxy?

*(Answer: Milky Way Galaxy)*

4. Record some data about our galaxy. *(Answers may include:*

*Our galaxy contains hundreds of billions of stars. It’s a spiral galaxy.*

*It’s more than 100,000 light years across.)*

Sketch and label what you see.

100,000 light years across

### Explore the Remaining Panels

5. On the back of this page, sketch the different types of galaxies.
6. What do the different types of galaxies have in common? How do they differ?

*(Answers may include: All galaxies are collections of stars, gas, and dark matter. They differ in their shape, size, mass, and in the distribution of stars.)*

### Explore “Interacting Galaxies”

7. Turn around, and walk towards the “Interacting galaxies” station (near the green signs “Neptune” and “Uranus”). Watch the video of two galaxies colliding. With a partner, take turns narrating what happens in the video. Record some notes from your narration on the back of this page.

### Further Exploration

8. Use the back of this page to record and sketch other interesting facts about galaxies. (If you have time, also visit the Planets, Stars, and Universe sections and record your observations.)

# Student Worksheet: Investigate THE UNIVERSE

## ANSWER KEY

Find the “UNIVERSE” wall (in large white letters). Your investigation will start on the first panel on the left.

### Explore the Panel: “Universe”

1. Look at the diagram on the left. Mark the location of the Virgo Supercluster on it.
2. Why do astronomers use light years instead of kilometers or miles to measure very large distances?

*(Answers may include: The light year allows astronomers to express large distances with reasonably small numbers; with smaller units of measure there would be too many zeroes.)*

3. About how many galaxies are in the observable universe? *(Answers may include: billions of galaxies)*

### Explore the Panel: “What Is the Universe?”

4. The universe is all the matter, energy, and space that exist. Describe these three components. *(Answers may include: Matter is the physical substance of things — of stars, planets, and people. Light is a form of energy that travels through space in waves. We learn about the universe by observing different kinds of light. Space is not empty.)*

5. Stars, planets, and many other objects are made out of matter. Even the chemicals in the human body are composed of a few chemical elements. These elements are the same ones found in stars and planets because all the elements other than hydrogen in our bodies were created within stars, before Earth formed. Record the percentage of elements in the universe in the data table on the right.

Element	Percentage
Hydrogen	(74%)
Helium	(24%)
Other	(2%)

### Explore the Panel: “Our View of the Universe”

6. What is the observable universe? *(Answers may include: The observable universe is the part of the universe that we can see. Other parts of the universe are not visible because light does not travel instantaneously from them to observers on Earth.)*

### Explore the “Formation and Evolution of the Universe”

Walk back to the beginning and find the panel to the left the Universe wall.

7. How is the universe changing over time? *(Answers may include: The universe is constantly expanding. The rate of expansion is increasing.)*

What will the universe be like billions of years in the future? *(Answers may include: Because it is expanding, the universe will become much more immense. Most galaxies will be farther apart from each other. Most stars will have burned out.)*

### Further Exploration

8. Explore the rest of the Universe section. Use the back of this page to record new information or sketch interesting things that you see. (If you have time, also visit the Planets, Stars, and Galaxies sections and record your observations.)

### UNIVERSE

