

JOURNEY TO THE STARS

ACTIVITIES for Grades 3-5

amnh.org/stars

BEFORE YOUR VISIT

Online Video: *Journey to the Stars* Trailer and Prelude amnh.org/stars

To prepare for your Museum visit, watch the trailer and the prelude with your students.

Class Discussion: Sun's Energy & Food Chains

Review with students the Sun and its role in the food web (e.g. producers, consumers, decomposers). Ask:

- What kinds of energy does the Sun provide for Earth?
Answers may include: The Sun provides heat and light. Plants capture this energy through the process of photosynthesis, create sugars and starches, and store them for later use.
- Where do a plant, a grasshopper, a chicken, and a human get their food?
Answers may include: Plants take sunlight and turn it into food. Grasshoppers feed on plants. Chickens eat grasshoppers. Humans eat chickens, and perhaps grasshoppers.
- What is the relationship between the various parts of the food chain? Or: In a food chain, what is the relationship between a plant, a grasshopper, a chicken, and a human?
Answers may include: Plants are producers because of their ability to photosynthesize. Grasshoppers, humans, and chickens cannot photosynthesize—they are consumers. Consumers eat producers or other consumers.
- How is the Sun a part of the food chain?
Answers may include: Most living organisms need the Sun's energy for fuel. Some obtain this by either capturing energy from the Sun directly. Others feed on other living organisms that have stored up energy from the Sun. This is how the Sun's energy is transferred through the food chain. Thus, grasshoppers must eat plants to obtain energy from the Sun captured by the plant, chickens eat the grasshoppers that ate the plant, and humans feed on the chicken that ate the grasshopper that ate the plant to obtain energy from the Sun.

Hands-on Activity: Web of Life Game

amnh.org/ology/features/stufftodo_bio/weboflife.php

Download and print instructions. Students can play this game to explore how all members of an ecosystem depend on each other to survive.

DURING YOUR VISIT

Journey to the Stars Planetarium Space Show (30 minutes)

Before the show, prompt students to think about these questions:

- How is the Sun important?
- What kinds of energy does the Sun provide for Earth?

Cullman Hall of the Universe: Explore an Ecosphere (20-30 minutes)

On the lower level, find the giant glass ball. It is a totally enclosed, self-sustained ecosystem called an "ecosphere." Help students observe the things that are living and non-living, and then list them on their worksheets. (Tip: You may wish to have students use magnifying glasses.) Tell students that there are bacteria inside of the glass ball and that they're microscopic. They are not visible without the aid of a microscope. Ask: What role do the bacteria play in the ecosphere?
Answers may include: These bacteria are decomposers. They break down waste material produced by the shrimp and recycle it back into the system.

Elementary Science Core Curriculum

Major Understandings

Living Environment 6.2b

- The Sun's energy is transferred on Earth from plants to animals through the food chain.

NOTE: Distribute copies of the **Student Worksheet** before coming to the Museum.

TIP: Please plan to arrive at the 1st floor space show boarding area 15 minutes before the show starts.



ACTIVITIES for Grades 3-5 (Continued)

BACK IN THE CLASSROOM

Online Activity: The Circle of Food Chain and Decomposition

amnh.org/nationalcenter/youngnaturalistawards/2000/hallie.html

Have students further explore food chains by reading *The Circle of Food Chain and Decomposition*. This article shows how a 7th-grader established an economical way of gardening at her new house. Ask students to identify the method presented in this article and record the different members of the food chain that enrich the soil for a successful garden. *Answers may include: The economical method of gardening is composting. Members of the food chain include dead and decaying plant matter, saprophytes, fungus, bacteria, earthworms, centipedes, roly-polys, and pillbugs.*

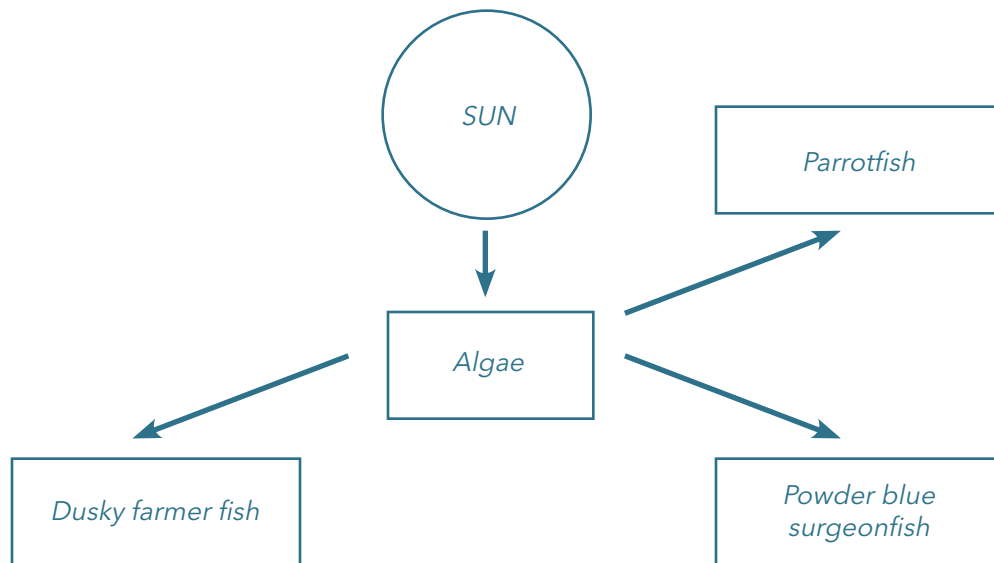
Online Activity: Diagram of a Food Web

amnh.org/exhibitions/permanent/ocean/02_ecosystems/02a3_community.php

Have students explore the coral reef ecosystem on the Milstein Hall of Ocean Life website. Ask them to identify members of the food chain for this ecosystem and create a food web diagram. As an extension, have students build dioramas of this marine ecosystem. For ideas on building dioramas, visit: amnh.org/ology/features/stufftodo_marine/coral_main.php

Sample food diagram:

Algae capture energy from the Sun through the process of photosynthesis and create food for later use. Parrotfish, dusky farmer fish, and the powder blue surgeonfish feed on algae to obtain energy from the Sun.



STUDENT WORKSHEET for Grades 3-5

Explore an Ecosphere

This giant glass ball is known as an "ecosphere." No one ever needs to feed the living things inside. What this ecosystem does need to maintain a healthy balance is sunlight. Did you notice that the ball spins slowly? It spins so that all parts of the ecosystem are exposed to sunlight.

Observe what's inside and select three things to investigate. They can be living or non-living.

NAME:	NAME:	NAME:
Draw it:	Draw it:	Draw it:
Describe how it is connected to its food web. For example, what organisms might it eat or be eaten by? Where might it get its food? How does it contribute to this ecosystem?		
Write it:	Write it:	Write it:

What role does the Sun play in this ecosystem? _____

STUDENT WORKSHEET for Grades 3-5

ANSWER KEY

Explore an Ecosphere

This giant glass ball is known as an "ecosphere." No one ever needs to feed the living things inside. What this ecosystem does need to maintain a healthy balance is sunlight. Did you notice that the ball spins slowly? It spins so that all parts of the ecosystem are exposed to sunlight.

Observe what's inside and select three things to investigate. They can be living or non-living.

NAME:	NAME:	NAME:
Draw it:	Draw it:	Draw it:
<i>Possible student selections include the shrimp, algae, rock, and bacteria (microscopic).</i>		
Describe how it is connected to its food web. For example, what organisms might it eat or be eaten by? Where might it get its food? How does it contribute to this ecosystem?		
Write it:	Write it:	Write it:
<p><i>Answers may include: All the elements found in the ecosphere are important to its function. Life functions inside just as it does on the Earth. The shrimp, algae, and the bacteria have key roles that directly affect each other and their roles in the ecosphere. The shrimp breathe out carbon dioxide (CO₂) an element essential for the algae, which use it together with light to produce oxygen. Algae produce oxygen only when light is available, during the day. No oxygen is made in the dark (or at night). Shrimp and bacteria need oxygen to breathe. When it is dark, they consume the oxygen available while none is being made. This is why there are not too many living things inside of the ecosphere; there would not be enough oxygen at night to keep them alive.</i></p> <p><i>The shrimp eat the algae, bacteria, and even their own shed exoskeleton. The shrimp eats not all bacteria, some find great hiding places in the rocks, gravel, and plant life in the ecosphere. These bacteria break down waste materials and recycle them back into the ecosystem.</i></p>		

What role does the Sun play in this ecosystem?

Answers may include: The Sun is the starting point for the food chain. The light energy that it provides is captured by the algae and used along with carbon dioxide to provide food and oxygen for the shrimp. The shrimp, which cannot create their own food, get their energy from the Sun by eating the algae. The waste that the shrimp produce is broken down by the bacteria and recycled back into the ecosystem.

ACTIVITIES for Grades 6-8

BEFORE YOUR VISIT

Online Video: *Journey to the Stars* Trailer and Prelude amnh.org/stars

To prepare for your Museum visit, watch the trailer and the prelude with your students.

Class Discussion: Solar System

Review with students the structure of the Solar System. Ask them:

- What is at the center of the solar system?
Answer: The Sun, our star, is at the center of the Solar System.
What types of planets are there and where are they found?
Answer: There are four inner, rocky planets that orbit closest to the Sun: Mercury, Venus, Earth, and Mars. Beyond the Asteroid Belt, the four outer, gas giant planets are Jupiter, Saturn, Uranus, and Neptune. The Kuiper Belt contains Pluto and other small icy objects. This area of the Solar System begins just inside Neptune's orbit and extends well beyond it.
- What is the largest planet? *Answer: Jupiter*
The smallest? *Answer: Mercury*
The furthest from the Sun? *Answer: Neptune*
The closest? *Answer: Mercury*
- Which is larger: the Sun or the planets? *Answer: The Sun.*
How much of a size difference do you think there is?
Answers may vary depending on students' prior knowledge: the Sun is about one million times larger by volume than Earth. This will be addressed in the Scales of the Universe Activity.

NYS Science Core Curriculum

Major Understandings

Physical Setting 1.1a

- Earth's Sun is an average-sized star. The Sun is more than a million times greater in volume than the Earth.

Physical Setting 1.1c

- The Sun and the planets that revolve around it are the major bodies in the Solar System.

Online Video: *New Horizons Mission to Pluto*

sciencebulletins.amnh.org/?sid=a.v.pluto.20060216

Watch this Science Bulletins video with your class. Ask students to describe what scientists are doing to find out more about the distant reaches of our Solar System.

Answers may include: Scientists are sending the New Horizons spacecraft to the outer reaches of the Solar System to send back images of Pluto and other objects like it.

NOTE: Distribute copies of the **Student Worksheet** before coming to the Museum.

DURING YOUR VISIT

Journey to the Stars Planetarium Space Show (30 minutes)

Before the show, prompt students to do the following:

- Several times during the show, the Sun will be shown along with planets and moons in the Solar System. Notice the relative distances and sizes of these objects.

TIP: Please plan to arrive at the 1st floor space show boarding area 15 minutes before the show starts.

ACTIVITIES for Grades 6-8 (Continued)

DURING YOUR VISIT (Continued)

Scales of the Universe: Investigate Sizes and Distances of Celestial Objects

(25-30 minutes)

When you exit the planetarium show (3rd floor), take the escalator down to the 2nd floor and walk through the gift shop towards the glass windows. You are now on the Scales of the Universe Walkway. Turn left and walk around the central Hayden Sphere (with the glass windows on your right) to the area that displays the planet models—some of the planets are suspended above you (look for Saturn and Jupiter), while others are mounted on the railing.

1. Investigate Sizes of Planets (Use Student Worksheet)

Draw students' attention to all eight planet models. Remind students that the 87-foot Hayden Sphere represents the size of the Sun. Ask students to observe the planets' relative sizes. Read planet information provided on the accompanying panels, and use that information to complete their worksheets.



2. Investigate Sizes of Stars

After students have completed their worksheets, have them walk back a few steps to explore the panel "Stars and Their Sizes," as well as the models above the panel. Explain that the Hayden Sphere now represents the red supergiant star Rigel, and that one of the models represents the size of our Sun in this new scale. Draw their attention to the other models mounted above, representing different stars. Point out to students that stars can vary in size as planets do.



BACK IN THE CLASSROOM

Wrap-Up Activity: Calculate Planetary Size Differences

Have students refer to their completed worksheets for the question "How many Earths can fit in a hollowed-out Sun?" Have them use information they collected on the planets' sizes together with the following equation for finding the volume of a sphere: $v = \frac{4}{3} \pi r^3$ [v =volume, r =radius] to answer the following questions:

- How many Jupiters could fit in a hollowed-out Sun? *Answer*: Over 900 Jupiters*
- How many Earths could fit in a hollowed-out Jupiter? *Answer*: Over 1200 Earths*

** Answers to both questions will vary depending on how many digits of pi are used and how much students round off numbers as they work through the equation.*

Online Activity: Calculate Planetary Distances

amnh.org/resources/rfl/web/starsguide/activities/planetary_distances.html

In this activity, students will use Google Earth and an online calculator to create a scale model of the distances among the objects in the Solar System.

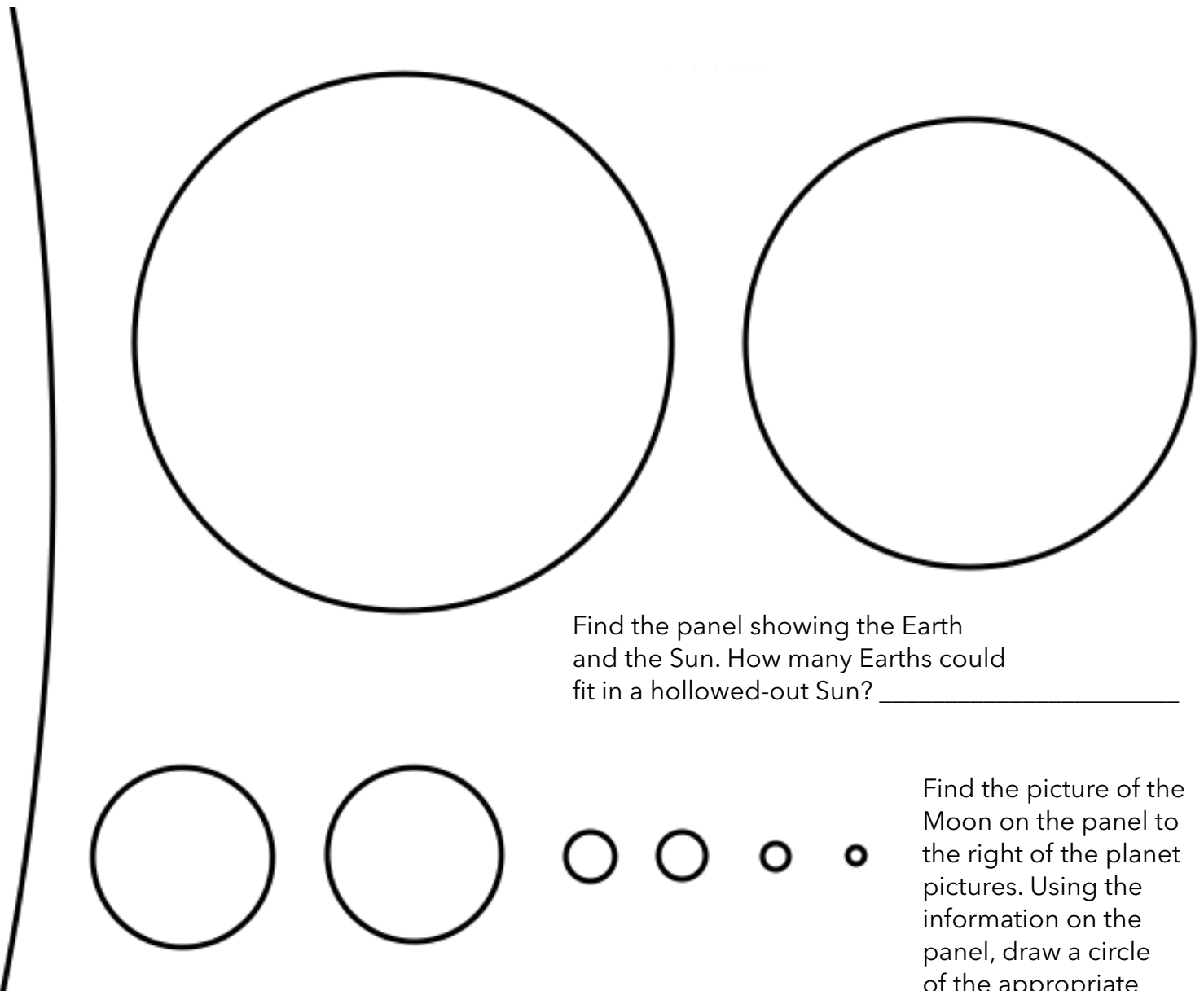


STUDENT WORKSHEET for Grades 6-8

Investigate Sizes and Distances of Celestial Objects

The circles on this page are scaled to accurately represent the relative size of objects in our Solar System. (Notice that one of circles is too large to fit on the page!) Observe the relative sizes of the **planet models and the Hayden Sphere**, which represents the Sun.

Label each circle with the name of the celestial object it represents (use the planet models and the Hayden Sphere to guide you). Then look at the panels that list the actual sizes (diameters) of each object that you've labeled. Record the actual size of each object next to the name.



Find the panel showing the Earth and the Sun. How many Earths could fit in a hollowed-out Sun? _____

Find the picture of the Moon on the panel to the right of the planet pictures. Using the information on the panel, draw a circle of the appropriate size next to the circle that you have already labeled as Earth.

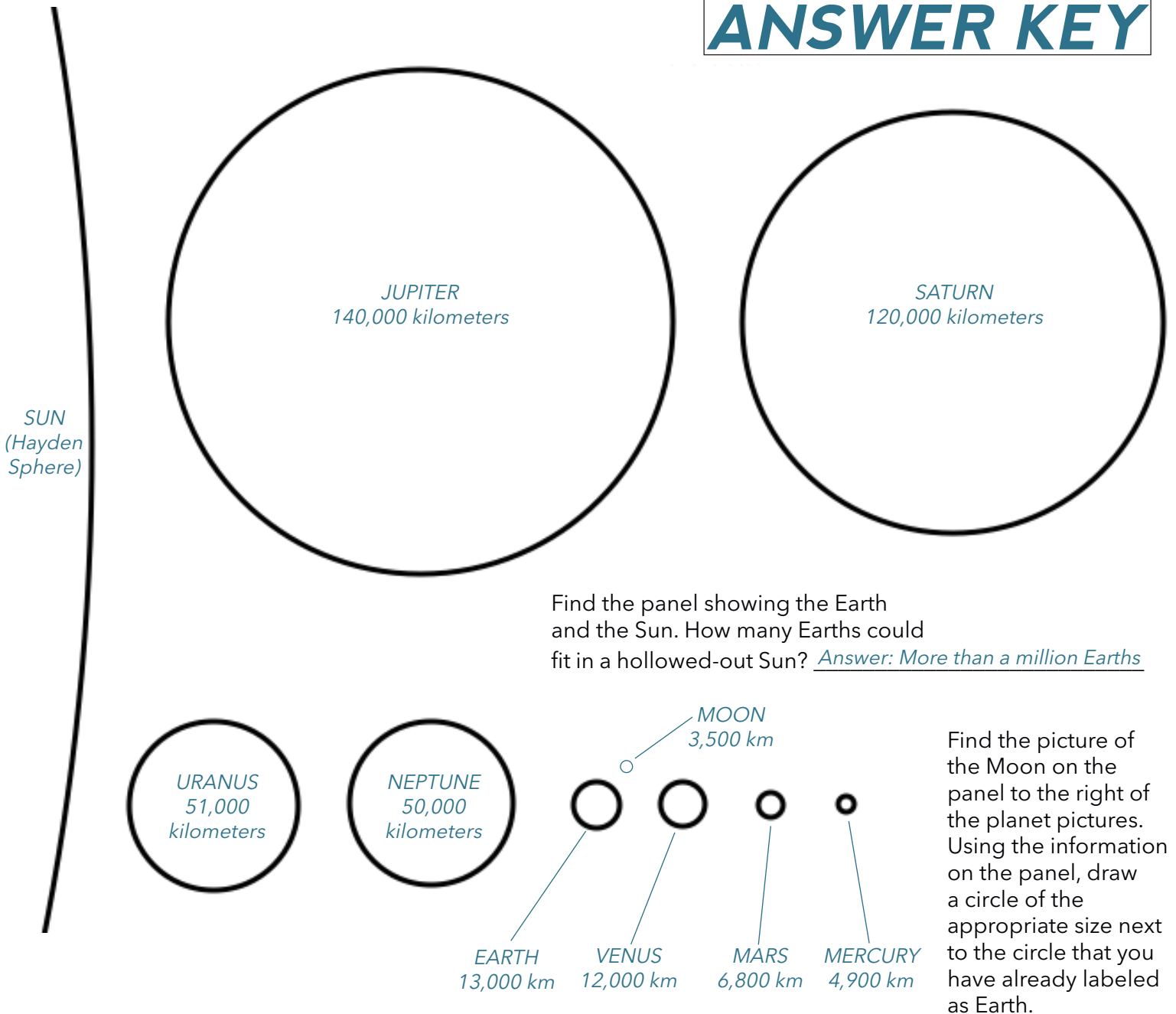
STUDENT WORKSHEET for Grades 6-8

Investigate Sizes and Distances of Celestial Objects

The circles on this page are scaled to accurately represent the relative size of objects in our Solar System. (Notice that one of circles is too large to fit on the page!) Observe the relative sizes of the planet models and the Hayden Sphere, which represents the Sun.

Label each circle with the name of the celestial object it represents (use the planet models and the Hayden Sphere to guide you). Then look at the panels that list the actual sizes (diameters) of each object that you've labeled. Record the actual size of each object next to the name.

ANSWER KEY



ACTIVITIES for Grades 9-12

BEFORE YOUR VISIT

Online Video: *Journey to the Stars* Trailer and Prelude amnh.org/stars

To prepare for your Museum visit, watch the trailer and the prelude with your students.

Class Discussion: Units of Measure

Pose the following questions to your students to introduce them to the units of measure used by astronomers:

- What types of measurements do astronomers use to quantify distances in space?

Answers may include: Distances in astronomy are too vast to be measured in kilometers and miles.

The following units are used to measure the linear distances between stars, galaxies, and other distant celestial objects: A light-year (ly) is the distance light travels in one year (1 ly = $\sim 1.0 \times 10^{13}$ km or $\sim 6.0 \times 10^{12}$ mi).

An astronomical unit (AU) is the distance between the Sun and Earth (1 AU = $\sim 1.5 \times 10^8$ km or $\sim 9.3 \times 10^7$ mi).

A parsec (pc) is a unit of length, equal to just under 31 trillion km or ~ 19 trillion miles, or about 3.26 lys.

- Where is Earth located in the universe?

Answers may include: Earth is a planet in our Solar System, moving in orbit around the Sun. Our Sun is one of over a hundred billion stars in our Milky Way Galaxy. And our Milky Way Galaxy is one of several thousand galaxies in the Virgo Supercluster. Finally, this vast supercluster of galaxies is just a tiny part of the Observable Universe.

Reading: *Light: Its Secrets Revealed*

amnh.org/resources/rfl/pdf/du_x01_light.pdf

Have students read this online article to learn how light transmits information about the composition of distant celestial objects. These objects are so distant that even if we could travel at the speed of light, it would take us thousands of years to reach them. Ask students: What types of information does light provide about celestial objects too far for us to ever reach in our lifetime?

Answers may include: The color of the light that a celestial object emits tells us its temperature. The light given off at a specific frequency by an atom or molecule—spectra—indicates the composition of the object. Every different type of atom or molecule gives off light at its own unique set of frequencies, like a “light fingerprint.”

Online Video: *Interferometry: Sizing Up The Stars*

amnh.org/sciencebulletins/?sid=b.s.peat_fire.20090601

Have students view this Science Bulletin video on the Center for High Angular Resolution Astronomy (CHARA), the array of telescopes that uses the technique of interferometry to spot details the size of a nickel seen from 16,000 km away. Hear astronomers discuss how CHARA’s renowned precision gleans valuable data on the properties and life cycles of stars. Engage students in a discussion about the scientific method using this video. Click on “Educator Resources” found in the “More About This Story” tab.

NYS Regents Earth Science Curriculum/ The Physical Setting

Major Understandings

Physical Setting 1.2a

- The Universe is vast and estimated to be over ten billion years old. The current theory is that the Universe was created from an explosion called the Big Bang.

Physical Setting 1.2b

- Stars form when gravity causes clouds of molecules to contract until nuclear fusion of light elements into heavier ones occurs. Fusion releases great amounts of energy over millions of years.

NOTE: Distribute copies of the **Student Worksheet** before coming to the Museum.

ACTIVITIES for Grades 9-12 (Continued)

DURING YOUR VISIT

Journey to the Stars Planetarium Space Show (30 minutes)

Before the show, prompt students to do the following as they watch the show:

- Several times during the show, the Sun will be shown along with the planets of the Solar System. Note the relative distances and sizes of these objects.
- Identify the types of energy that the Sun emits.

TIP: Please plan to arrive at the 1st floor space show boarding area 15 minutes before the show starts.

Big Bang Theater, Hayden Planetarium (5 minutes)

When you exit the planetarium show (3rd floor), take the escalator down to the 2nd floor. Turn left and proceed towards the Big Bang Theater (bottom half of the Hayden Sphere). After the show, ask students:

- What is the evidence for the Big Bang?
Answers may include: The afterglow from the Big Bang that has traveled millions of light years.
- What can light tell us about objects in the universe?
Answers may include: Through the science of spectroscopy, the light emitted by stars may be broken down into its various wavelengths. These wavelengths can be used to identify the various substances, or elements, present in that star's composition.



Cullman Hall of the Universe: Life Cycle of Stars & the Light They Emit

(30 minutes)

On the lower level, find the "Stars" wall. Have students explore this area of the exhibition using the Student Worksheet.



BACK IN THE CLASSROOM

Hands-on Activity: Build a Spectroscope

amnh.org/resources/rfl/pdf/du_u03_spectroscope.pdf

Download and print instructions. Have students build a pocket-sized spectroscope from readily available materials. They can use their spectroscopes to examine different light sources in school, home, and around their neighborhood.

Online Activity: Astro Snapshots

Use the following Astro Bulletin Snapshots to illicit discussions with your students:

Betelgeuse is Shrinking

sciencebulletins.amnh.org/?sid=a.s.betelgeuse.20090629

- What are some of the reasons, in general, for stars appearing larger, smaller, brighter or dimmer?
- What do astronomers know about the relationship between a star's lifetime and its changing size?
- What do you think may be the cause for Betelgeuse's recorded shrinkage?

Space Telescope Probes Nearby Stars

sciencebulletins.amnh.org/?sid=a.s.corot.20081103

- What part of the electromagnetic spectrum accounts for the Sun's rays?
- How does COROT's measurement of starlight reveal a star's structure?
- What information does a star's apparent texture and vibration reveal to astronomers?

Star Formation on a Black Hole's Fringe

sciencebulletins.amnh.org/?sid=a.s.black_hole.20080908

- What is the primary force that is responsible for the formation of a black hole?
- If astronomers cannot actually see a black hole, what is some of the evidence of its existence?
- How are models useful and why are the essential in most areas of astronomy?

STUDENT WORKSHEET for Grades 9-12

Investigate Life Cycle of Stars & the Light They Emit

1. Find the area of this exhibition labeled "Stars." Find and fill in the information in the table below.

Type of Star	Its mass in relation to the Sun	Life expectancy (birth to death)	Type of remnant	An example this type of star
Low-mass star				
Intermediate-mass star				
High-mass star				
Very high-mass star				

What trends do you observe in the table between mass and life expectancy? _____

Describe how the mass of a star relates to its life span. _____

2. Look for the panel labeled "Organizing the Stars" and find the Hertzsprung-Russell (H-R) **diagram**. This diagram shows luminosity increasing upward and temperature increasing from right to left.

Pick one type of star that is shown on the diagram and describe its luminosity and temperature.

How does a star's mass change as its luminosity and temperature increase?

Describe the relationship between this plot of stars and the stages in the life of a star.

3. Turn around and find a circular exhibit called "A Spectacular Stellar Finale." Describe the phenomenon that occurs as a star reaches the end of its life.

4. View the black hole video in the Black Hole Theater located on the opposite corner of where you are standing to discover what happens after the death of a star. Record some questions that come to mind about this mysterious stellar phenomenon. (*Please note that the Black Hole Theater has an additional screening that alternates with the black hole video.)

STUDENT WORKSHEET for Grades 9-12

Investigate Life Cycle of Stars & the Light They Emit

1. Find the area of this exhibition labeled "Stars." Find and fill in the information in the table below.

Type of Star	Its mass in relation to the Sun	Life expectancy (birth to death)	Type of remnant	An example this type of star
Low-mass star	8-80% of the Sun's mass	0.975 trillion years	white dwarf	Proxima, Centauri, Barnard's star, Gliese 65
Intermediate-mass star	0.8-8 times the Sun's mass	9.75 billion years	white dwarf	Sirius, Polaris (the north star), Sirius B, the Sun, Ring Nebula
High-mass star	8-20 times the Sun's mass	9.5 million years	neutron star	Antares, Cassiopeia A, Spica, Pular J1939+2134
Very high-mass star	20-100 times the Sun's mass	0.925 million years	black hole	Rigel, Eta Carinae, Cygnus X-1

What trends do you observe in the table between mass and life expectancy?

Answers may include: As mass increases life expectancy decreases.

ANSWER KEY

Describe how the mass of a star relates to its life span.

Answers may include: The mass of a star determines how bright and fast it burns. Examples include, low mass stars are the longest-lived of the energy producing objects in the universe. Some low mass stars will live for trillions of years. The very high mass stars are the rarest and shortest lived.

2. Look for the panel labeled "Organizing the Stars" and find the Hertzsprung-Russell (H-R) diagram. This diagram shows luminosity increasing upward and temperature increasing from right to left.

Pick one type of star that is shown on the diagram and describe its luminosity and temperature.

Answers may include: The vertical axis represents the star's luminosity or absolute magnitude. The horizontal axis represents the star's surface temperature. A star in the upper left corner of the diagram is hot and bright. A star in the upper right corner of the diagram is cool and bright. A star in the lower left corner of the diagram is hot and dim. A star in the lower right corner of the diagram is cold and dim. The Sun rests approximately in the middle of the diagram.

How does a star's mass change as its luminosity and temperature increase?

Answers may include: As a star's luminosity and temperature increase, its mass also increases. In fact, a star's mass is the determining factor of a star's temperature and luminosity, and how it will live and die.

Describe the relationship between this plot of stars and the stages in the life of a star.

Answers may include: Each star is represented by a dot. The position of each dot on the diagram tells us two things: a star's luminosity (or absolute magnitude) and its temperature. These are two of the main characteristics that change throughout the life of a star.

3. Turn around and find a circular exhibit called "A Spectacular Stellar Finale." Describe the phenomenon that occurs as a star reaches the end of its life.

Answers may include: When a high mass star runs out of fuel, it collapses in on itself, causing it to explode as a supernova and ejecting matter out into space. Its core becomes a neutron star, which takes millions of years to cool down. The most massive stars also explode as a supernova, and form black holes in their centers.

4. View the black hole video in the Black Hole Theater located on the opposite corner of where you are standing to discover what happens after the death of a star. Record some questions that come to mind about this mysterious stellar phenomenon. (*Please note that the Black Hole Theater has an additional screening that alternates with the black hole video.)

Some good questions may include: Why do some stars end up as black holes? If nothing travels at the speed of light, except light, how can a black hole also pull light into itself? If we can't see a black hole, how do we know it's there? What is the best evidence of the existence of a black hole? How big or small can a black hole be? How is time changed in a black hole?

ANSWER KEY